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Tendring Geodiversity Characterisation Report

2009

Tendring District Council

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Cover photographs (clockwise from top left):

1. The fossil gastropod *Neptunia contraria* (known as the ‘left handed whelk’) from the two million year old Red Crag of the Naze cliffs.
2. Part of St.Osyth Marsh from the air.
3. St.Mary’s Church, Great Bentley which is built mostly from ferricrete, one of the few building stones native to Essex.
4. Cliffs of London Clay at The Naze showing bands of volcanic ash.

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Abbreviations

ECC	Essex County Council
GCA	Geodiversity Character Area
GCZ	Geodiversity Character Zone
GIS	Geographical Information system
HER	Historic Environment Record
OS	Ordnance Survey
SSSI	Site of Specialist Scientific Interest

Acknowledgements

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1 Introduction:

Geodiversity may be defined as the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landform, processes) and soil features that make up the landscape. It includes their assemblages, relationships, properties, interpretations and systems – after Gray, 2004

Geodiversity is a fundamental resource that forms the foundation of our environment and provides us with many of the natural resources and raw materials which support our day to day existence. It shapes our landscapes, influencing the distribution of land use, the diversity of our wildlife and the location and character of our built environment, helping to define where we live and our 'sense of place'. It underpins our economy directly, through exploitation of resources such as minerals for industry and soils for agriculture, and indirectly through activities such as tourism and recreation. Geodiversity encapsulates scientific evidence allowing us to unravel past events and to understand and predict future changes such as the effects of global warming, including flood events and coastal erosion. It provides crucial environmental benefits, buffering the effects of climate change and controlling the flow of water.

In Tendring District the geodiversity resource is rich, varied and largely irreplaceable. It contains the earliest evidence for humans in Essex and is the basis of the District's rich agricultural land that attracted some of the country's earliest agricultural communities and which continues to sustain Tendring's rural economy. The Red Crag deposits exposed in the cliffs at Walton-on-the-Naze are internationally recognised as providing valuable evidence of climatic deterioration at the beginning of the Ice Age. Sands and Gravels provide evidence for the evolution of the River Thames and River Medway, and are an important source of minerals for the building industry. Areas of extensive saltmarsh, a relatively recent deposit, constitute wildlife habitats of international significance.

As a fundamental aspect of Tendring's environmental infrastructure, geodiversity has an important role to play in the District's future. At the same time it is vulnerable to change and needs to be properly understood before change is planned. The geodiversity underlying Tendring District should be understood, respected and only altered in the knowledge of its origin and form. Development can impact on geodiversity in many ways: many geological features, such as quarry faces, are man-made and are frequently found close to where people live; demand for minerals as a result of development may create new geological exposures or modify existing ones; development has the potential to destroy geological and geomorphological processes and exposures e.g. through construction of coastal defences. It is critical that the adverse impacts associated with development are mitigated and minimised to avoid unnecessary degradation. Opportunities to enhance the resource and exploit its educational potential and the environmental benefits that derive from it also need to be recognised and planned for. Failure to conserve and manage the District's geodiversity will increasingly have serious environmental, economic and social consequences, limiting our ability to achieve the goal of sustainable development.

The Tendring Geodiversity project has been designed along an approach developed for characterising the historic environment in Essex that was initiated within the Thames Gateway, and which has since been developed and undertaken in a number of Districts across the county, including Tendring (ECC, 2008). Like the Tendring Historic Environment Characterization project, characterization of the District's geodiversity is intended to inform the development of the Local Development Framework, but should also be useful for a range of other purposes, not least as the basis of a Local Geodiversity Action Plan (Burek and Potter, 2006). Geodiversity Characterisation is a new procedure in the 'tool kit' of geodiversity conservation that can be applied to recognize and manage geodiversity at a landscape scale, beyond the boundaries of protected areas.

The geodiversity of the District has been characterized from GIS-based mapping of the geology, topography, soils, hydrology, location and extent of past and present mineral working, and specific datasets from the Essex Historic Environment Record, combined to define large Geodiversity Character Areas. These are then broken down into more specific and detailed Geodiversity Character Zones which are more suitable for informing strategic planning and master planning activity in the District.

The methodology used to define Geodiversity Character Areas and Zones is presented in Appendix 2.

Purpose of the project

The Government's Planning Policy Statement on Biodiversity and Geological Conservation (PPS 9) states that: 'In taking decisions, local planning authorities should ensure that appropriate weight is attached to….geological interests in the wider environment' (ODPM, 2005, 3).

This project has been developed primarily to serve as a tool for Tendring District to use in the creation of its Local Development Framework and to facilitate the development of positive approaches to the integration of geodiversity objectives into spatial planning for the District. The report characterises the geodiversity of the District, revealing its diversity, location, extent, significance and capacity for change. The report and associated GIS information will help to provide a strong environmental evidence base for adoption of good practice in the planning system. It is intended that the geodiversity project will provide Tendring District's Local Development Framework with the following key elements (as recommended by the ODPM guide *Planning for Biodiversity and Geological Conservation: A Guide to Good Practice, 2006*):

- The broad geological and geomorphological character of the area
- Key natural systems including fluvial and coastal
- Location and extent of internationally, national and locally designated sites
- Areas of geological and geomorphological value which would benefit from enhancement and management
- Information on the geodiversity value of previously developed sites and the opportunities for incorporating this in developments i.e. brownfield geodiversity sites including quarries.

This will allow Development Plan policies within the Core Strategy to be based on the most up-to-date information for the geodiversity characteristics of the District. It will also enable Development Plan policies to maintain, enhance or restore geological conservation interests in the District and allow them to promote opportunities for geological features to be incorporated within the design of new developments. In addition, it will enable a strategic approach to be taken to the future conservation, enhancement or restoration of geodiversity resources in the District.

As well as this primary purpose and resultant benefits, there are a range of other potential benefits:

- **Provide guidance to planners at the early stage of development proposals**

This report will provide planners with background information on the geodiversity of the whole District. This can be used at an early stage of development proposals for identifying the elements of geodiversity that will be affected and can lead to highlighting the need for informed conservation, enhancement or restoration.

- **Provide the opportunity to deliver conservation of locally characteristic geodiversity in the wider landscape**

By defining the characteristic geodiversity of the whole of Tendring District, the Tendring Geodiversity Characterisation Project provides the opportunity to conserve geodiversity beyond the boundaries of designated sites i.e. Sites of Special Scientific Interest (SSSIs), Regionally Important Geological/geomorphological Sites (RIGS) and Local Geological Sites (LoGS).

- **Provide a basis for communities to engage with their local geodiversity**

This report is a key step towards the development of a Local Geodiversity Action Plan for Tendring District. The report provides a broad depth of information on the geodiversity of Tendring. An action plan would set out the objectives and actions for the sustainable management, planning conservation and interpretation of all aspects of geodiversity in Tendring, serving to promote geodiversity and make geoconservation relevant to local communities.

- **Provide the opportunity to deliver integrated conservation of the natural and historic environment**

This report and the associated GIS project, when used in combination with the Tendring Historic Environment Characterization Project (ECC, 2008) and Tendring Phase 1 Habitat Survey (EWT, 2008), provides a starting point for the integrated conservation of the natural and historic environment of the District.

Contents of this report

Section 2 provides an overview of Tendring's Geodiversity including its geomorphology, geology, soils and links to industry and biodiversity. Section 3 comprises the breakdown of the District into 18 large Geodiversity Character Areas and 90 more detailed Geodiversity Character Zones, with a description for each. Section 4 covers current Geodiversity management in the District and Section 5 is a Gazetteer of Geodiversity Sites, including recommendations for sites for future consideration by the Essex Local Sites Partnership and Tendring District as designated Local Geological Sites (LoGS).

2 Tendring's Geodiversity

2.1 Introduction

This chapter sets the geological scene for a discussion of the geodiversity of Tendring District, summarizing the geological evolution and development of the landscape. Where a site also in the Gazetteer (section 4) is mentioned in the following sections, it is underlined.

2.2 Tendring District Geological Heritage

The Tendring District has an exceptionally rich geological heritage. Pleistocene fossil elephant bones, teeth and tusks have been collected from Walton-on-the Naze since the 13th Century. According to John Wymer (Wymer 1985 p. 259) the town may claim the earliest historical record for the discovery of Pleistocene mammalia in Britain. Ralph, who was Abbot of Coggeshall, 1207-18 wrote "in the time of King Richard, on the sea-shore, in a village called Edulfinesses [Walton] were found two teeth of a giant, of such prodigious bignes, that two hundred of such teeth might be cut out of one of them. These I saw at Cogshal, and handled with great admiration" (George, 1997, pp. 3-6). At Wrabness, in 1701 "diverse bones of an extraordinary bigness, were found at fifteen or sixteen foot beneath the surface of the earth in digging for gravel to mend the roads". These were identified as elephant bones which "were buryed by their loving masters the Romans" (Lufkin, 1701, p. 924). As late as 1806 elephant bones found at Walton were being attributed to the biblical flood. The true nature of these spectacular finds only became accepted in the earlier part of the 19th century (George, 2007).

Harwich cliffs have attracted geological interest for more than 300 years. As early as 1703 Samuel Dale gave a detailed scientific description of the stratigraphy and palaeontology of the cliff, whilst in 1730 he published some beautiful plates of the cliff and fossils (Dale 1704, 1730). Harwich attracted international interest as early as 1706 when Urban Hjarne gave a splendidly detailed scientific description of the cliff (Kalm, 1892, pp. 74-75). Geological field trips were being made to Harwich, and recorded, as early as 1748 (Nichols, 1822, pp. 761-2). Elliott first discovered evidence for Eocene vulcanicity in the onshore sediments of the London Basin in the 'stone band' exposed on the foreshore at Harwich (Elliott 1971). This discovery at Harwich and Wrabness was a milestone in geological research in the London Basin and prompted much further research (Daley & Balson, 1999).

Several amateur geologists have conducted important work in the Tendring District. Two notable examples are John Brown (1780-1859) and Samuel Hazzledine Warren (1872-1958). Both worked at Walton, but their most important work was probably at Clacton. Brown described the site in 1840. Warren worked here from 1911-1950s. His finds included the famous wooden spear and 'Clactonian' flint artefacts.

Pike and Godwin's pollen diagram (1951) of the Hoxnian pollen sequence at Clacton marks an important milestone in British Quaternary studies in that it was the first sequence for any UK interglacial site.

2.3 Topography of the Tendring Landscape

The Tendring peninsula (Fig. 1) is bounded the Rivers Stour, to the north, and Colne, to the south-west. It has a fairly simple topography, with the ground surface falling from 40 m O.D. in the north-west to sea-level on the coastal and riverine marshes and mudflats. From the higher ground, the Holland, Bentley and Tenpenny Brooks flow down the regional slope, south-eastwards. These major valleys are asymmetrical, with steeper west-facing slopes. The Sixpenny Brook runs across, rather than down, the regional slope to join the Colne at Wivenhoe. These streams are between 7 and 15 km long. Only short streams, maximum 5 km long, flow northwards to the Stour.

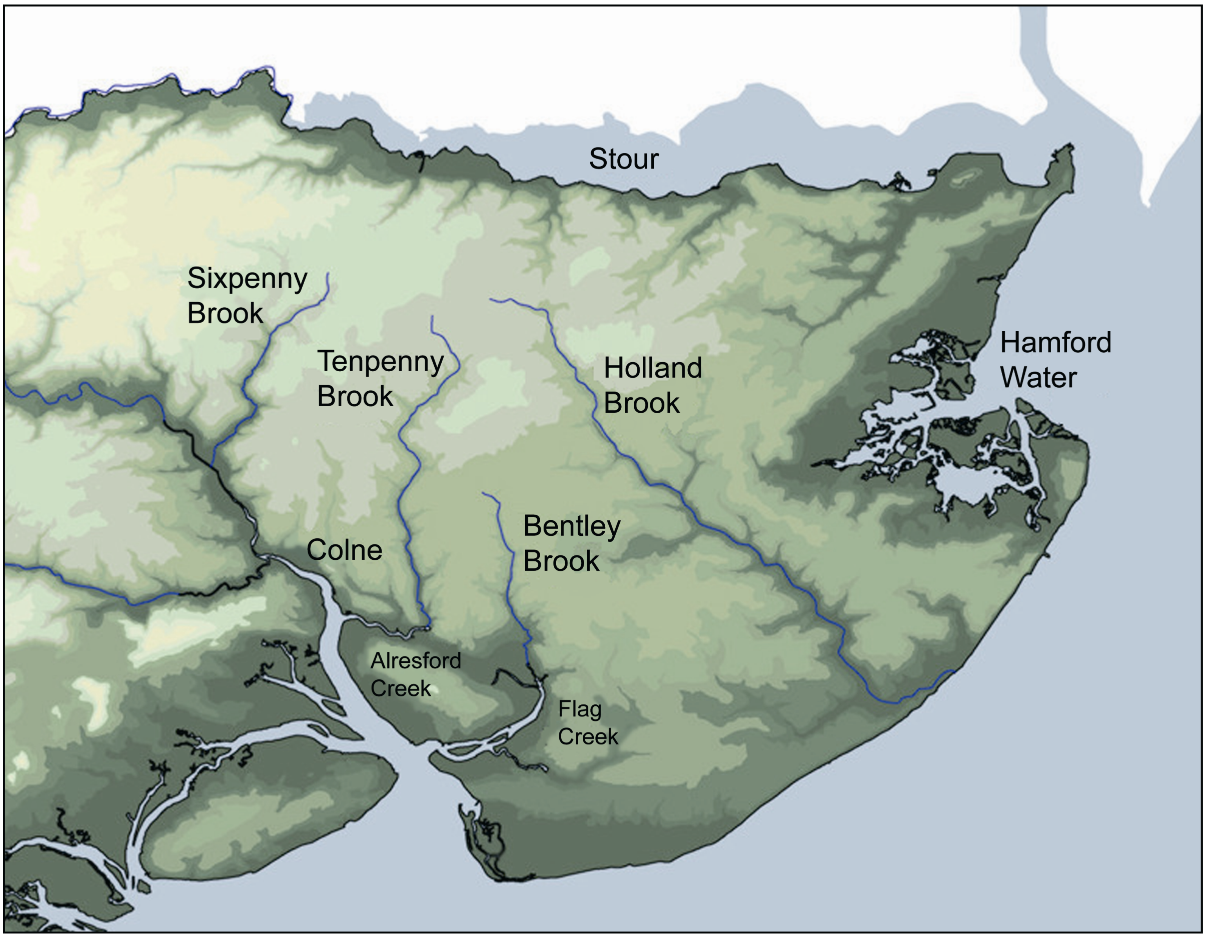


Fig. 1 The topography of Tendring

Although not immediately obvious, the regional decline in height south-eastwards is achieved by a series of steps or flats. This can be illustrated by a transect from Lamb Corner (TM 046316) to Clacton (TM 179148) following the line of the B1029 and A133 roads (to obtain spot heights). From Lamb Corner to Ardleigh Heath there is an extensive area at c.40 m O.D. From Ardleigh to Hare Green, the ground surface is at c.35 m O.D. Thereafter the surface is at 30-25 m O.D. to Little Clacton and then a narrower bench of land at c.20 m O.D. lies between Little Clacton and the outskirts of Clacton itself. The heights of these flats correspond to terraces, within the underlying Kesgrave Sands and Gravels, of an early course of the Thames, discussed below (see Fig. 13).

The bias in the streamflow to the south-east may reflect the shifts in the course of the early Thames which migrated south-eastwards, as discussed below. Early left-bank tributaries would have had to elongate in order to remain in contact with the migrating Thames.

The Tenpenny and Bentley Brooks join the Colne in an unusual manner, almost turning back on themselves to make the confluence. Their configuration suggests that they initially joined an earlier course of the Colne that flowed along the alignment of the Alresford Creek and then into Flag Creek before reaching the sea. The Colne now flows to the west of Brightlingsea.

2.4 The Geology of Tendring District

Tendring may seem to be a rather quiet, unexciting area geologically, except perhaps for the magnificent outcrop of Red Crag at Walton-on-the–Naze, but it has a goodly number of other gems. These show that the area is important and interesting geologically, contributing to the cause of earthquakes, witnessing tropical seas and volcanic eruptions, being the site where an early course of the Medway captured the waters of the Thames of the time, and then seeing the blocking of the Thames by a glacier, reducing it to a fraction of its former strength. Remarkably, Tendring has eight geological Sites of Special Scientific Interest (SSSIs) and a further one contiguous with its boundary, a high number for such a small area, which testifies to the District's importance (see Appendix 2). A further six SSSIs, designated for biological reasons, have geodiversity interest.

The Rocks Beneath:

A summary of the deep geology of Tendring is contained within Gumbler (1996) and Lucy (1999). The geological story of Tendring starts with the **basement rocks** that are about 420 million years old. Dating from the Silurian period (Table 1) these rocks consist of hard, slaty shales and mudstones and are over 300 metres below the surface. They have been encountered in boreholes at Harwich and Weeley which were sunk in search of water and coal respectively. These ancient rocks represent a time in the distant past when the first animals were leaving the sea to colonise the land. Similar rocks can be seen at the surface in the Welsh Borderland.

Age (in millions of years)	**PERIOD OR EPOCH**	**GEOLOGICAL FORMATIONS IN TENDRING**	
0.1	HOLOCENE	**Saltmarsh, shingle spits, beaches, peat and alluvium**	
	PLEISTOCENE	**Head**	
		Loam and brickearth	
		Interglacial channel deposits	
		Thames-Medway gravels *(post-diversion Thames)*	
0.5		**Outwash gravel from the Anglian ice sheet**	
		Kesgrave Gravels from pre-diversion Thames and the Medway	
2	PLIOCENE	**Red Crag**	
10	MIOCENE	**Red Crag 'coprolite bed'** *(Miocene rocks & fossils found at the base of the Red Crag*	
30	OLIGOCENE	*No evidence in Tendring*	
50	EOCENE	**London Clay**	
		Harwich Formation *(the oldest rock exposed at the surface in Tendring)*	
55	PALAEOCENE	**Woolwich & Reading Beds**	*Present beneath Tendring but not at the surface*
		Thanet Sand	
65	CRETACEOUS	**Chalk**	
100		**Gault & Upper Greensand**	
180	JURASSIC	*No evidence beneath Tendring*	
200	TRIASSIC		
250	PERMIAN		
300	CARBONIFEROUS		
400	DEVONIAN		
430	SILURIAN	**Hard Silurian shales and mudstones** *(encountered in Harwich and Weeley boreholes)*	
460	ORDOVICIAN	*No evidence beneath Tendring*	
540	CAMBRIAN		
4,600	PRECAMBRIAN		

Table 1 Geological formations and events in Tendring

Although these rocks are of great antiquity and at considerable depth, they have affected humans by being a factor in the occurrence of earthquakes in recent times (see below). About 300 million years ago, during a mountain-building episode, the marine rocks were uplifted to form a broad ridge of high land (a massif) running from Wales to the Continent, part of which is known as the London - Brabant High (Fig. 2).

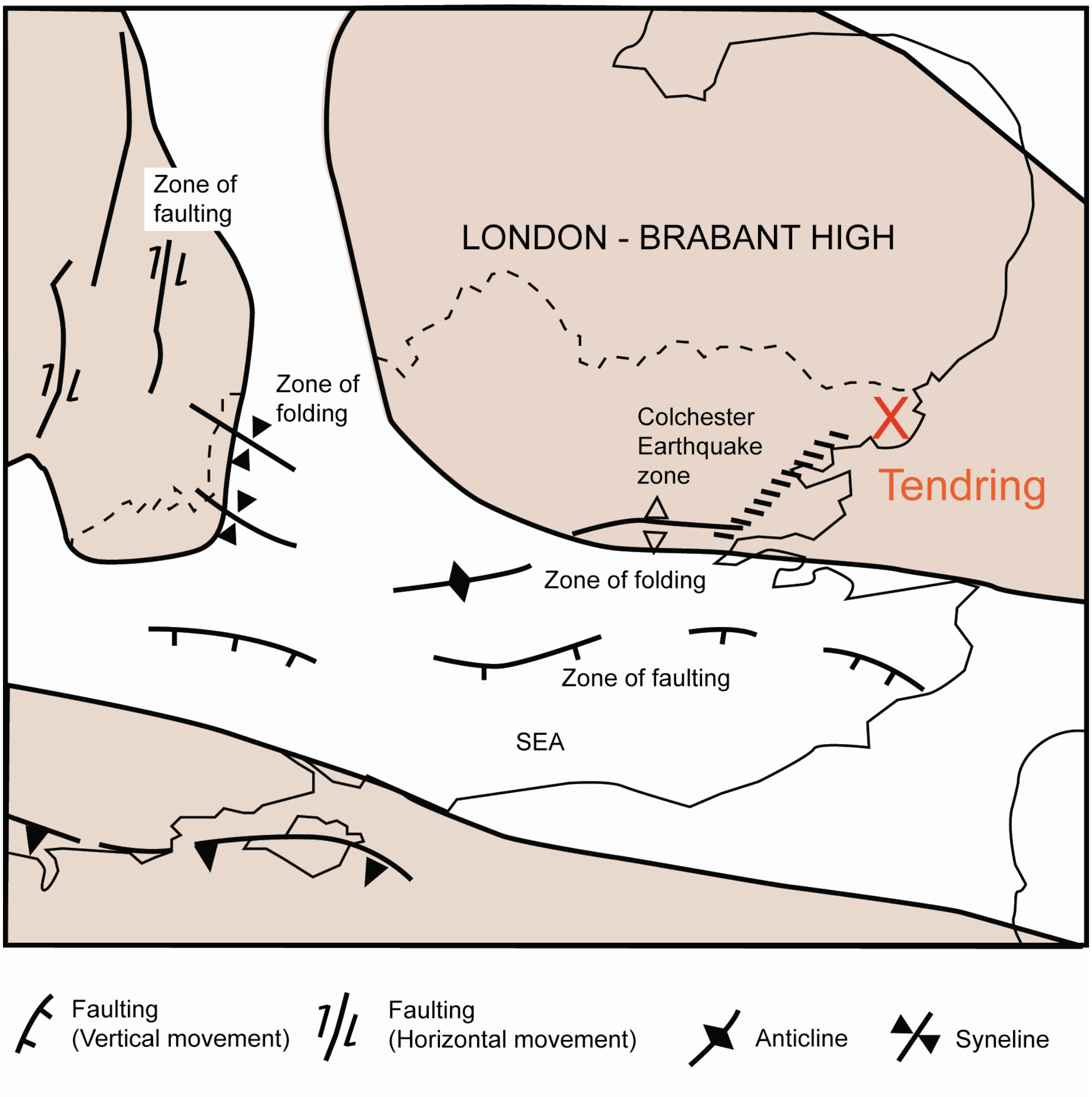


Fig. 2 The deep geology of SE England (after Gumbler, 1996)

The northern side of the ridge was in the area of what is now the Wash and Norfolk, the southern side running along the Thames estuary and through South London. During the uplift, the rocks were folded and faulted. After desert conditions during the Permian, for the next 200-250 million years great thicknesses of sediment accumulated in the seas either side of the ridge during the Triassic, Jurassic and early Cretaceous periods. No rocks were laid down on the ridge, so there is a major gap in the geological record of Essex, until the **Gault**, a marly clay from a muddy sea that flooded over the ridge in the middle of the Cretaceous period, was deposited about 100 million years ago. 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 widespread flooding of the continents, the conditions under which the next rock was formed, the Chalk.

Chalk underlies the whole of the Tendring district but is not present at the surface. A great thickness of several hundred metres of chalk was originally deposited horizontally, having been laid down as a limy mud on the floor of a tropical sea between 80 and 100 million years ago during the late Cretaceous period. Chalk contains billions of nodules of flint, a variety of quartz formed in the mud on the Chalk sea floor. The Chalk is an important source of water in Essex.

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. During this time the Chalk, being softer, was eroded, exposing countless billions of flint nodules which were broken down to form pebbles and sand. These form the basis of most of the geological formations laid down in subsequent geological periods.

The first rocks to be laid down on the eroded Chalk surface were a variety of sands clays and shell beds deposited in shallow marine or estuarine conditions. Beneath Tendring these are the **Thanet Sand** the **Woolwich and Reading Beds** (now reclassified and referred to as the Lambeth Group) (Table 1). Resting on these is the Harwich Formation and the London Clay which are the oldest rocks present at the surface in Tendring District.

Southern Britain lies at the edge of the area affected by the formation of the Alps, created when the African continent pushed against southern Europe 15 million years ago. The result was that the sediments laid down to the south of the London-Brabant High were pushed up against the massif creating great stresses, causing faulting and buckling the Chalk and other rocks to form an arch, or anticline, where the Weald is now (the Wealden Anticline) and a downwarp, or syncline, that now forms the

Thames valley (the London Basin or Syncline). Thus Chalk is exposed at the surface at Saffron Walden, passes beneath Essex and comes to the surface again in Thurrock. Within Tendring, there is a minor expression of this folding as the Hamford Water embayment, not a true estuary because it is not fed by a significant river, occupies a structural depression in the London Clay.

These great pressures still cause slight movements along the faults in the massif and the adjoining sediments setting off minor earthquakes, perhaps the best known being the Colchester earthquake of 1884 (epicentre just east of Peldon at TM 010175)(Meldola & White, 1885). Estimated at 4.7 on the Richter Scale, tremors were felt throughout the Tendring District and structural damage was caused to buildings in the west (Fig. 3). Tremors are felt every few years even today in south-east and eastern England, a recent case being the 'Harwich Earthquake' of 1994. The epicentre was 40 km offshore and the quake measured 3.2 on the Richter Scale, sufficient for tremors to be felt onshore. Few cause damage, though a repeat of the Colchester earthquake would have serious consequences. Usually there is only occasional injury, mostly due to falling masonry.

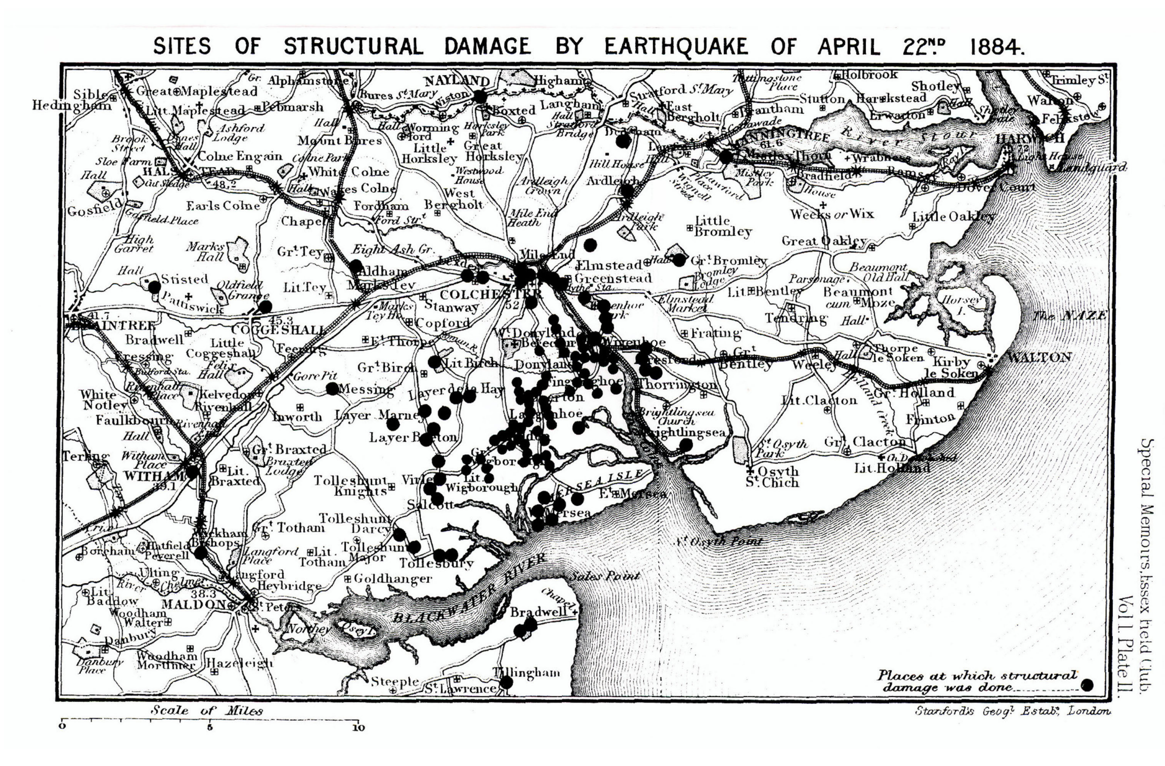


Fig. 3 Sites of damage caused by the Colchester Earthquake, 22 April 1884. (Medola & White, 1885)

The Surface Rocks:

The London Clay

With a deepening of the sea during the Eocene period a sandy clay called the **Harwich Formation** was laid down in the Tendring area. It contains layers of volcanic ash, which are bluish grey, silty clays when fresh, but weather to a pale yellow-brown, as can be seen in the cliffs of Wrabness on the River Stour. At least 34 ash beds have been identified at Wrabness. The volcanic ash is evidence of volcanoes in Scotland around this time which were associated with the opening of the Atlantic Ocean about 60 million years ago. The most prominent ash bed lies within the **Harwich Stone Band**, a sequence of flat, calcareous siltstone concretions exposed on the foreshore at Harwich.

Sea level continued to rise eventually 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 rainforest vegetation which existed on the land at this time. Similar coastal areas are now found in present day Indonesia and Malaysia. Rivers flowed into this sea bringing mud and silt which settled and became compacted, eventually to form a thickness of up to 150 metres (500 feet) of London Clay. During this period Essex was situated around latitude 41°N, the same as present day Naples.

Fossilised wood, replaced by the mineral pyrite (fools' gold), is often found washed out of the London Clay onto the foreshore around the Essex coast; at Walton-on-the-Naze, for example, parts of the beach are found to consist almost entirely of well preserved twigs and small fragments of fossilised wood. All the plant fossils found in the London Clay would have been brought down rivers and carried out to sea. The London Clay contains nodules of calcium phosphate, septaria or 'cement stones', in layers and these are common in the London Clay cliffs at The Naze. In the middle of the nineteenth century the collection of cement stones for the Harwich cement industry led to important fossils being found, including many fine turtles. Of particular interest was the first discovery of *Coryphodon*, one of the largest Eocene plant-eating mammals, from a fragment of jaw, with teeth, dredged up off the coast. From subsequent fossils found in North America this creature appears to have been almost as large as a rhinoceros, having a large head and knife-like upper canine teeth. Also dredged up off the coast was a fragment of the Harwich Stone Band containing the skull and partial skeleton of the earliest horse *Hyracotherium*, also known as Eohippus. This tiny creature, no larger than a fox, had toes instead of hooves and its bones, like those of *Coryphodon*, must have been carried down a river and been deposited on the floor of the London Clay sea. Many more fossil vertebrate bones from the London Clay have been found since those days, mostly from The Naze, where collectors frequently search the beach for specimens. These fossils are of great importance as they provide us with an insight into the evolution of mammals following the extinction of the dinosaurs.

London Clay fossils, particularly sharks' teeth, turn up all around the Essex coast but the most famous site is at The Naze, where the beach is very popular with collectors. The London Clay also contains remarkably well preserved bones of birds, again mostly from The Naze, a site which has produced a large number in recent years, mostly due to the efforts of local amateur collector, Mike Daniels. In fact, the finds from Walton are the best preserved bird fauna of this age to be found anywhere in the world. The fossils are mostly from silty pockets in the lower part of the cliff (probably originally hollows on the ancient sea bed) which often contain associated bones of single individuals.

The Red Crag

In Tendring District there is a gap in the geological record after the London Clay which represents a time interval of nearly 50 million years. During this time the geography of Britain changed dramatically as rocks were uplifted and then eroded away. By about 2.6 million years ago, the forerunner of the North Sea was present, in which the **Red Crag** was deposited across much of north-east Essex, although it is only at The Naze that it is well exposed. This red, iron-stained sand is teeming with fossil shells and forms spectacular layers on top of the London Clay. The Red Crag outcrop at the Naze is of international importance and it has been given the status of a Site of Special Scientific Interest (SSSI).

At the base of the Red Crag, at the junction with the London Clay, is a layer of phosphatic nodules called the **Red Crag nodule bed**. The nodules were originally thought to be coprolites (fossilised droppings or excreta of prehistoric animals) and the layer was given the name ‘coprolite bed’. This bed was of great importance for the manufacture of phosphate fertiliser and was worked at Wrabness, Walton and Little Oakley (G). The nodule bed contains the fossil bones of whale and other mammals and occasional shark teeth, the largest of which belonged to *Carcharodon megalodon*, the largest species of shark that ever lived, possibly weighing as much as 50 tonnes. These bones and teeth were derived from rocks dating from the Miocene period and had probably been recycled several times before being incorporated into this bed.

Patches of Red Crag have survived at <u>Dovercourt</u>, <u>Beaumont</u>, Wrabness and <u>Little Oakley</u> and sand pits at these sites yielded Red Crag fossils in the nineteenth and early twentieth centuries. Most famous of these was a shallow pit at Little Oakley that was opened by geologist F.W. Harmer who sieved the sand for fossil shells over a period of several years. The result of these efforts was a two volume scientific work, published in 1919, in which he states that over 600 different species of mollusc were found in this one pit (nearly 400 of the species illustrated are from Little Oakley). Harmer’s work has shown the extraordinarily rich molluscan fauna of the Red Crag sea which existed over Essex and East Anglia about two million years ago. Harmer recorded that all of the fossils came from ‘an area of twenty yards square’ and said that they were obtained ‘during many years labour, and by the sifting and examination of something like 200 tons of material’.

The Red Crag was deposited in near-shore conditions as part of a huge delta building out into the southern part of the North Sea, which at the time stretched into the London Basin as far west as Rothamsted (Herts) and Netley Heath (Surrey), where an early Thames flowed into it. The sea was connected to the Atlantic across southern Britain but not through the English Channel as we know it. Slowly this link was cut and by 1.9 million years ago, not only was the link lost but the top of the delta was becoming dry land, now named Doggerland (after the Dogger Bank), between Britain and the Continent (Fig. 4). As the shoreline moved northwards, so the Thames and other major rivers flowing to the North Sea extended across the former sea bed. The shells (Mollusca) of the Red Crag show a cooling of climate compared to previous periods and the Red Crag is considered by some to mark the onset of the last Ice Age.

At Walton silts, lying within a channel cut into the Red Crag and underlying the Cooks Green Gravel, have had a chequered history. They were first mapped as Chillesford Clay, the only representative in Tendring of the Norwich Crag, a deposit younger than the Red Crag. Later, a pollen sequence was obtained indicating interglacial conditions. Initially this was correlated with deposits from Hoxne in Suffolk (following on from the Anglian ice advance), but the stratigraphic position of the silts below the Cooks Green Gravel (which pre-date the Anglian ice advance) indicate an older age, probably part of the Cromerian Complex (see Fig.5).

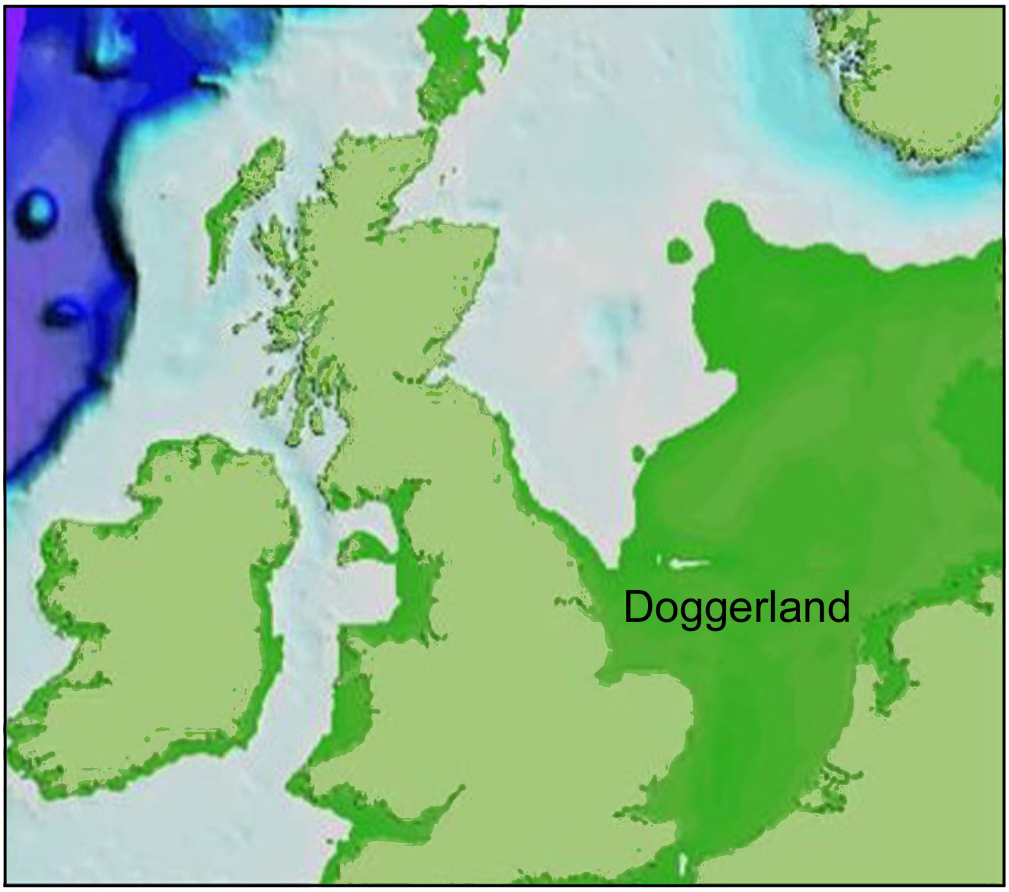


Fig. 4 The geography of Doggerland

The Ice Age

For most of geological time, the Earth's surface has been warm and free of ice but about every 150 million years, for reasons not fully understood, global temperatures dropped and the world experienced an ice age. The story of the last Ice Age (the Quaternary or Pleistocene Ice Age) starts 2.6 or 1.8 million years ago, depending whether or not you include the Red Crag. At this time the climate was probably not too dissimilar from 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, more markedly so in Red Crag times.

However, 'ice age' is not an accurate term to use as there are cycles of cold and warm periods, more recent cycles taking about 100,000 years, with a short-lived warm period (an interglacial), lasting 10-20,000 years, slowly giving way over about 80,000 years eventually to a cold period (glacial stage), also of short duration, after which the temperature rises quickly to the next interglacial and the next cycle (Fig. 5).

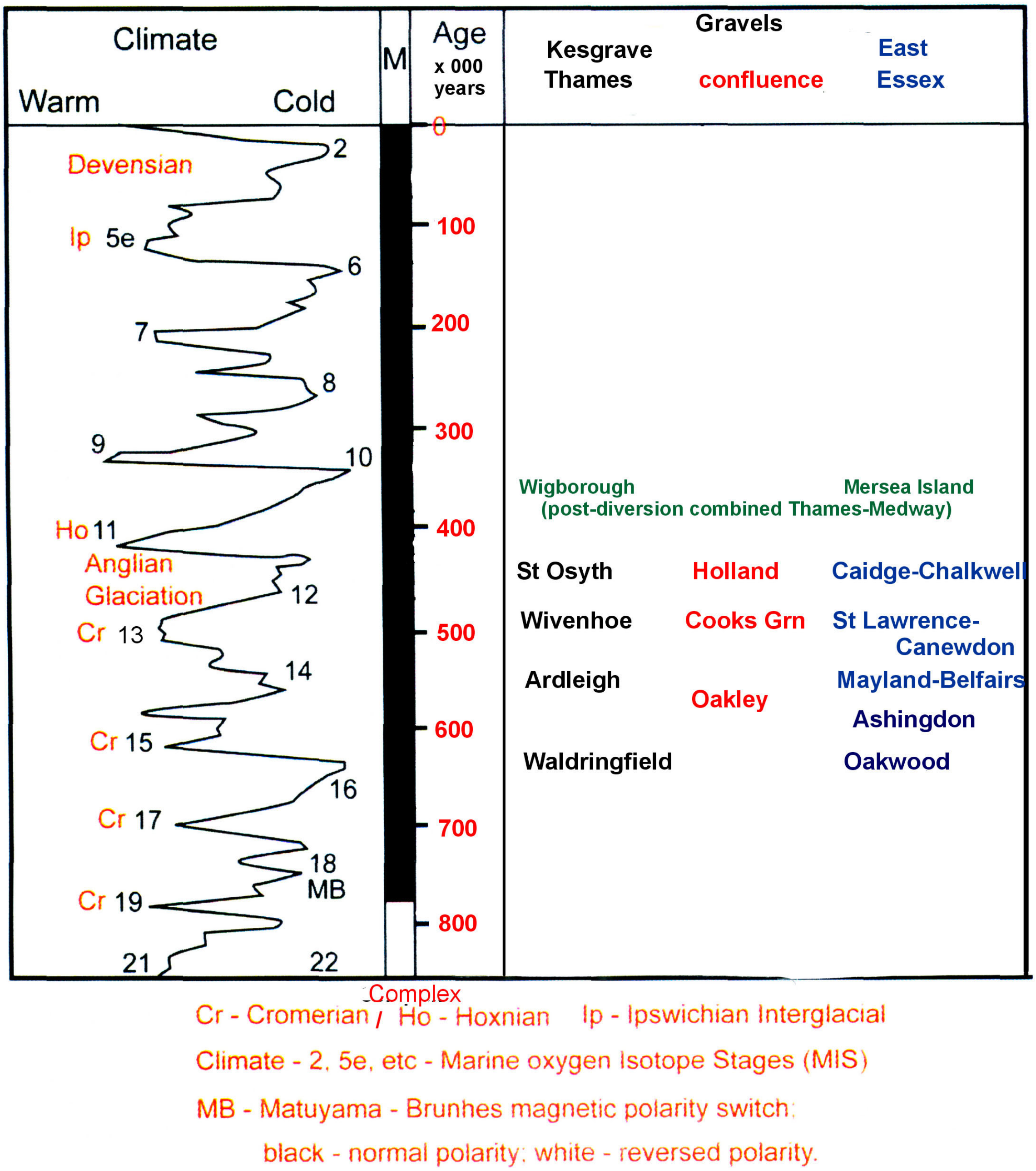


Fig. 5 Climate and terraces of the last 800,000 years in Tendring (after Westaway, 2002)

Evidence for these fluctuations in global temperature from 650,000 years to 350,000 years ago has been preserved in the clays, sands and gravels of Tendring District, connected with previous courses of the rivers Thames and Medway through this area (Bridgland, 1988, 1994, 1999; Bridgland & Allen, 1996).

During the early Ice Age the Thames flowed to the north of London, through central Essex, Suffolk and Norfolk (see Fig. 13A) and out across what is now the southern North Sea; the evidence for this being a substantial thickness of what are called **Kesgrave Sands and Gravels** which, remarkably, represent 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 possibly draining from the Welsh mountains and bringing their characteristic volcanic rocks into the Thames basin. Over time this early Thames migrated eastwards. As the Thames migrated eastwards, it cut down to successively lower levels forming a series of flat surfaces known as terraces (see Glossary).

Research has also shown that the River Medway flowed across coastal Essex. The evidence for this is in the form of a line of gravel deposits trending northwards, roughly parallel with the coast, which contain a mixture of rocks from Kent (Fig. 13A).

By 650,000 years ago the early Thames had migrated sufficiently far to the east to be crossing the Tendring peninsula, depositing the Waldringfield Gravel, a sub-division of the Kesgrave Sands and Gravels with a surface height of c.40 m O.D. (Figs 6, 13B). The Medway also crossed the peninsular, but in a separate valley of which we have no trace, though its course can be extrapolated from deposits south of the Blackwater. The two probably met offshore of Suffolk, the coast of the time, of Doggerland, was far to the north. These gravels cannot be dated with certainty and the estimate of their age is derived by comparison with, and extrapolation from, other data.

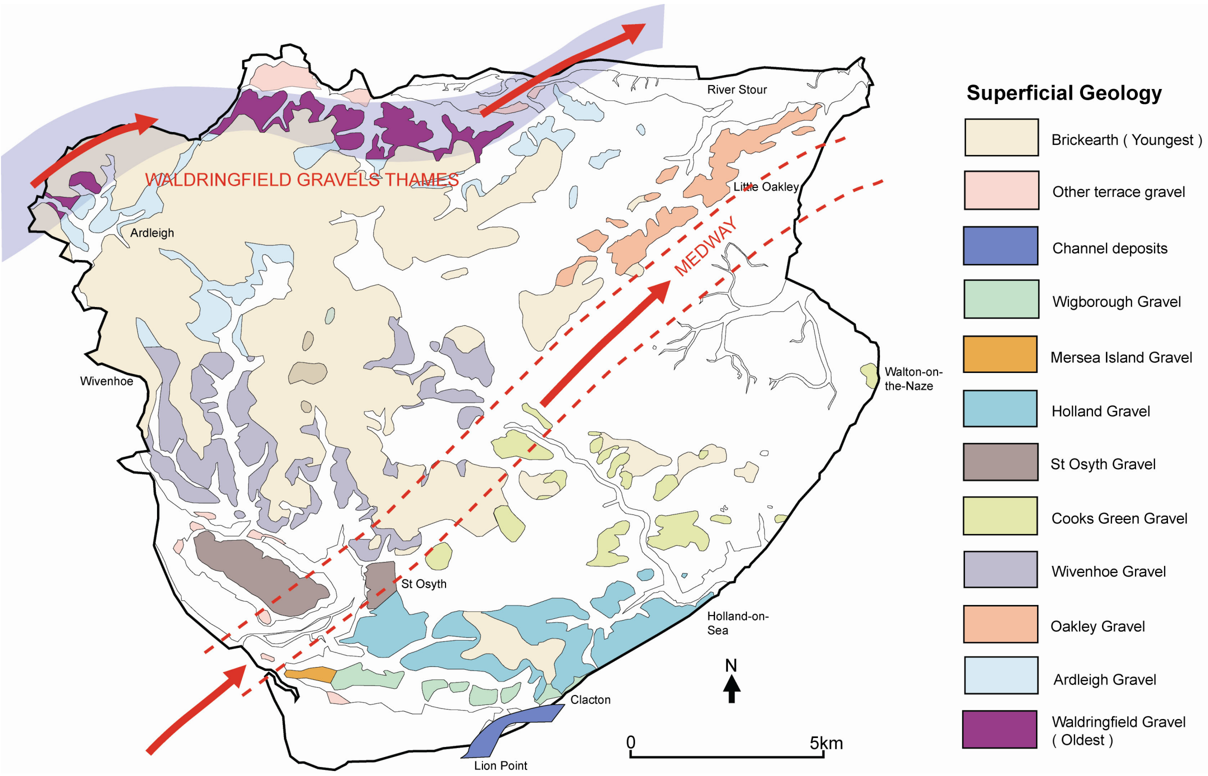


Fig. 6 The course of the early Thames in Waldringfield Gravel times (After Bridgland (1999) based on B.G.S. mapping)

The next course of the Thames is marked by the Ardleigh and Oakley Gravels at c.30-35 m O.D. (Figs 7, 13C), with SSSIs at Ardleigh and Little Oakley. Within these gravels there are interglacial fossiliferous deposits laid down about 550,000 years ago, but arguments about their age and their relationship to one another depends on comparisons with deposits in the Netherlands and discussions about the rate of evolution of the teeth of fossil voles. The topmost Ardleigh Gravels are enriched by a red clay and are deformed. This horizon is thought to be an ancient complex soil initially formed during a warm, dry period, the degree of reddening (the Valley Farm Soil) indicating the temperature and moisture conditions under which it was formed, and later under intensely cold conditions, during which the temperate soil was deformed (the Barham Soil). This river was at least 5 km wide, but as its southern edge may have been eroded away by a later course of the river, it may have been wider. Again there are no Medway deposits and the Medway course has to be extrapolated from deposits south of the Blackwater. The Thames and Medway were likely to have been confluent in the Oakley – Harwich area.

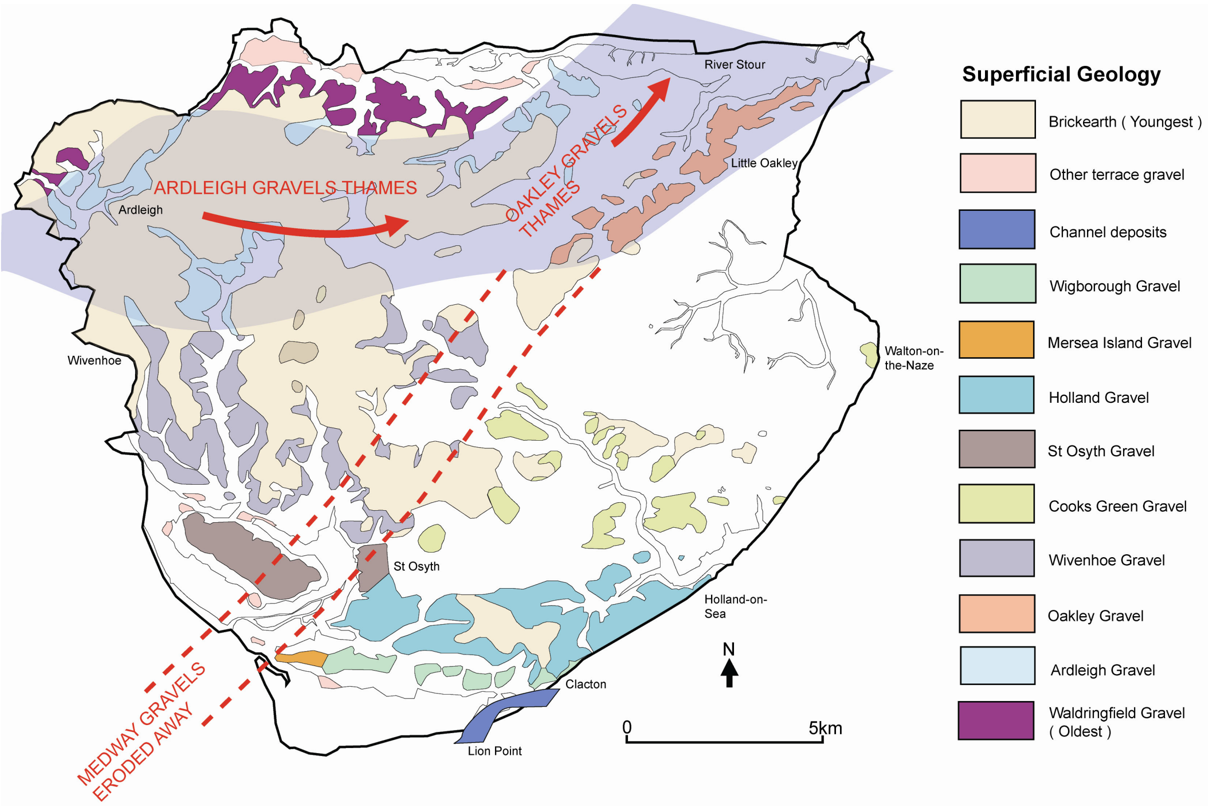


Fig. 7 The course of the early Thames in Ardleigh and Oakley Gravel times (After Bridgland (1999) based on B.G.S. mapping)

The course of the Thames changed again, marked by the Wivenhoe Gravels forming a ground surface at c.25-30mOD. Again within the gravels there is fossiliferous material deposited c.500,000 years ago (Figs 8, 13D). The Medway of the time was crossing coastal Essex and the two rivers were confluent between St Osyth and Walton, witnessed by the Cooks Green Gravel whose content includes stones from both rivers. The Thames would have been much the same width as before, but the confluent river may have been 7-8 km wide. The Wivenhoe Gravel and Valley Farm – Barham soil complex are preserved in the SSSI at Wivenhoe. The Cooks Green Gravel is conserved within the SSSI at Walton.

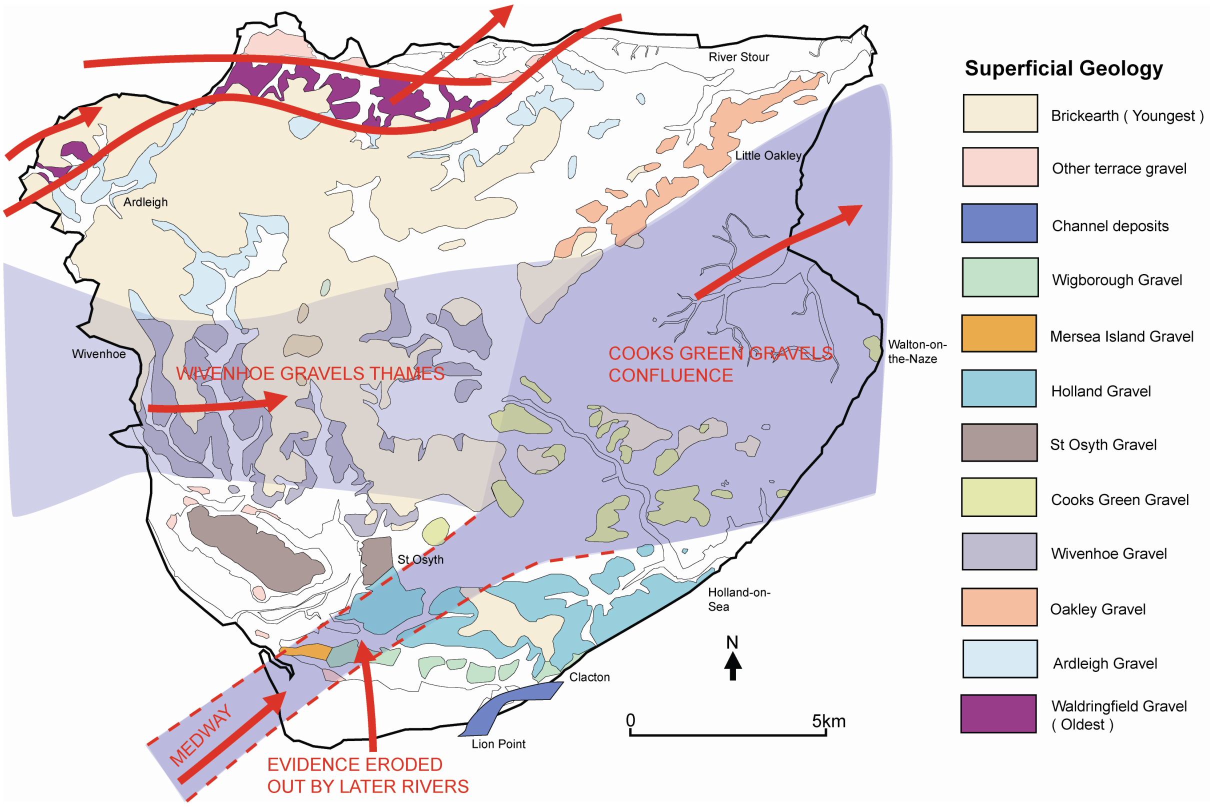


Fig. 8 The course of the early Thames and Medway in Wivenhoe and Cooks Green Gravel times (After Bridgland (1999) based on B.G.S. mapping)

The next course of the early Thames cut through the older gravels, depositing the St Osyth Gravels in a river only 2-3 km wide with a surface height of c.20 m O.D., and being confluent with the Medway between St Osyth and Holland-on- Sea, where the Holland Gravels indicate that the river widened to 4-5 km (Figs 9, 13E, 13F). The reduction in size of the river, compared to its earlier forms, might have been a precursor of a major event. About 450,000 years ago a great ice sheet, the Anglian ice sheet, spread south into Hertfordshire and Essex blocking the Thames valley between Watford and Colchester and diverting the river to roughly its present course. When the diverted Thames reached Southend it then flowed north as a combined Thames/Medway river along the old Medway valley to Holland-on-Sea where it rejoined what remained of the early Thames. This was a catastrophic change in the course of a very large river but just how rapid this change was can be appreciated by the study of gravels in a quarry at St. Osyth and in the cliffs at Holland-on-Sea, both SSSIs. At St Osyth Pit, the lower part of the St Osyth Gravel (Lower St Osyth Gravel) has the full complement of coarse Thames gravels, indicating the Thames in full flow.

The Upper St Osyth Gravels have finer gravels (showing lesser flow due to the blockage by ice) and the pebble suite includes types brought in by the Anglian glacier. A similar history is seen in the cliffs at Holland-on-Sea.

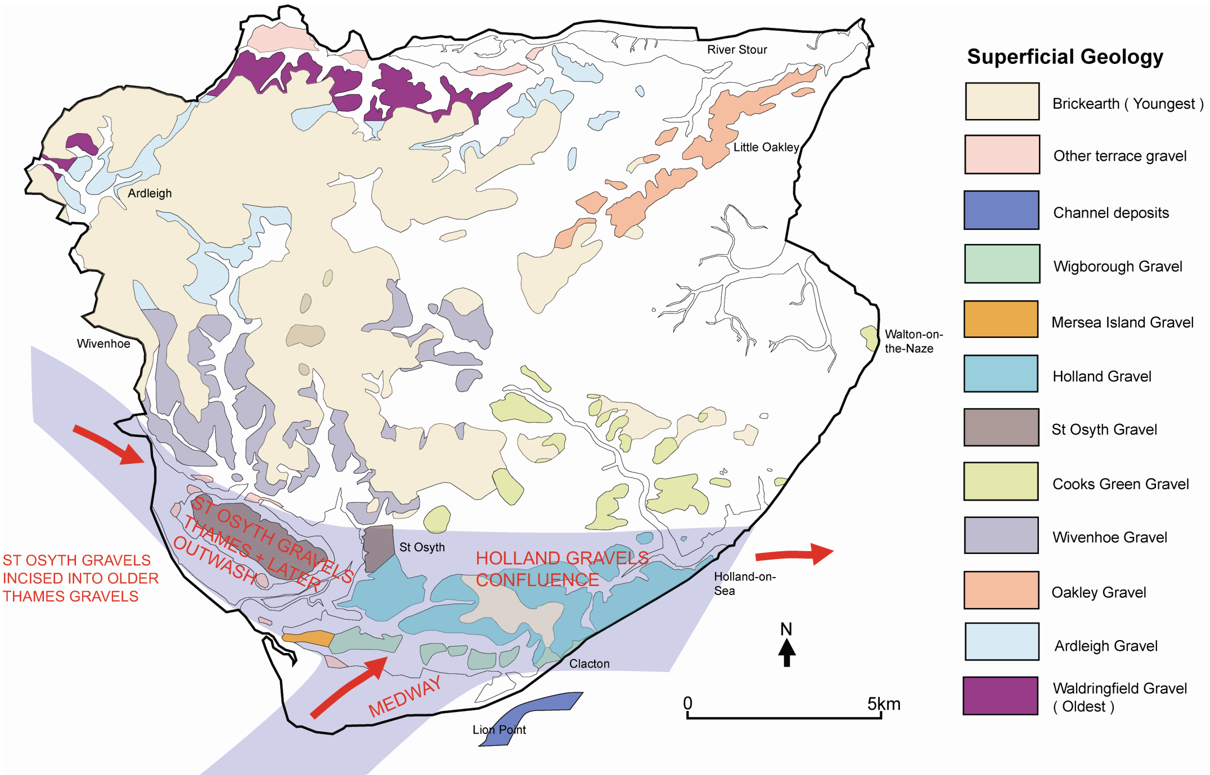


Fig. 9 The course of the early Thames and Medway in St Osyth and Holland Gravel times (After Bridgland (1999) based on B.G.S. mapping)

Cut into the Upper St Osyth Gravel, in West Cliff, Clacton, and the foreshore at Jaywick there is a complex of channel deposits, approximately 500 metres wide, associated with the Thames-Medway River (Figs 10, 11, 13G). These deposits can be traced between these two points and they have been investigated at West Cliff at Clacton, the former holiday camp, Clacton Golf Course and the foreshore at Jaywick. The deposits were first discovered in the West Cliff in the 1830s by Essex amateur geologist John Brown, and they have produced not only the bones of lion, rhinoceros and straight-tusked elephant, but also flint tools representing the earliest undisputed evidence of human presence in Essex (though there is possibly evidence of older occupation at Wivenhoe, see site report for Wivenhoe Gravel Pit SSSI). Pollen obtained from these channels show a sequence that is correlated with that at Hoxne in Suffolk, dating to an interglacial (the Hoxnian, MIS 11, c.400,000 years ago) that followed on from the Anglian glaciation. This site can be further associated with the East Anglian sequence by its relationship to the terraces of the Tendring Peninsula and to the sequence at Swanscombe in the Lower Thames by means of its archaeology and palaeontology. Hence the site is in a crucial, pivotal position to link the Thames and East Anglian Quaternary sequences.

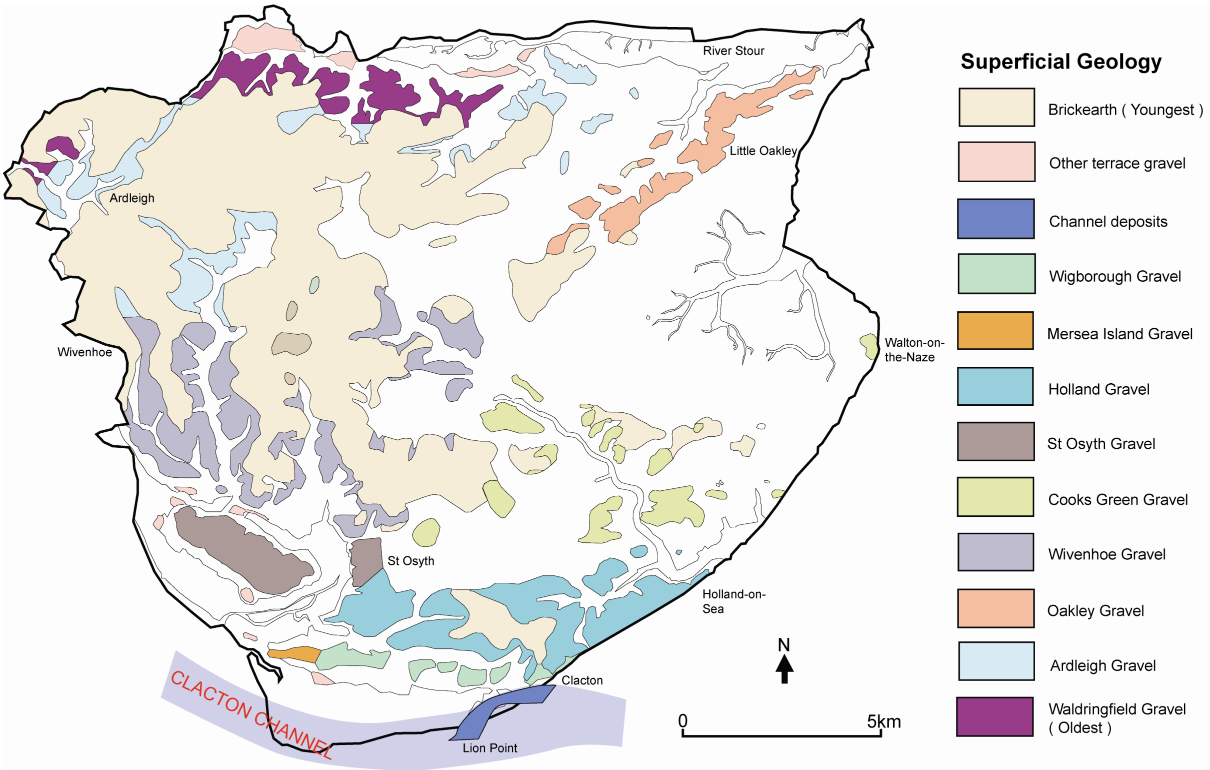


Fig. 10 The course of the early Thames-Medway in Clacton Channel times (After Bridgland (1999) based on B.G.S. mapping)

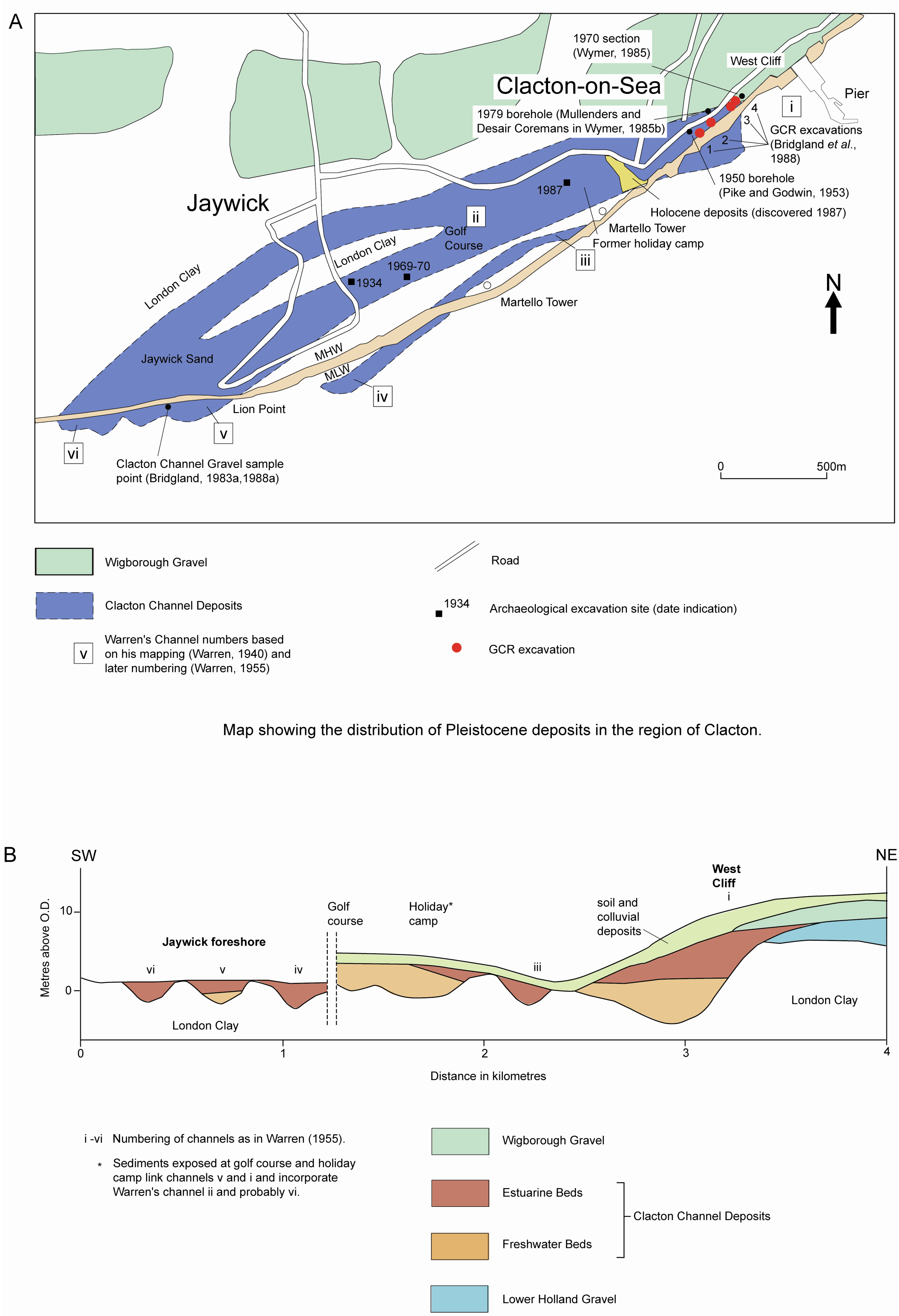


Fig. 11A & B The Clacton Channel complex

A fourth channel, on the foreshore at Jaywick (Channel IV), still under investigation, has revealed a palaeontology (vertebrates and molluscs) and geochemical analyses of the amino acids obtained from mollusc opercula that indicate deposition in a much later interglacial, the Ipswichian (MIS 5e, c.120,000 years ago). This indicates that the cliff and foreshore geology is more complex than previously thought, increasing the importance of the need to preserve the deposits.

The sequence is capped by the Thames-Medway Wigborough Gravel in the West Cliff (Figs 12, 13H). This Gravel may have covered much or all of the rest of the channel complex, but if so, it hassince been eroded away. The Wigborough Gravel is the equivalent of the Mersea Gravels, seen at the SSSI at Cudmore Grove on Mersea Island.

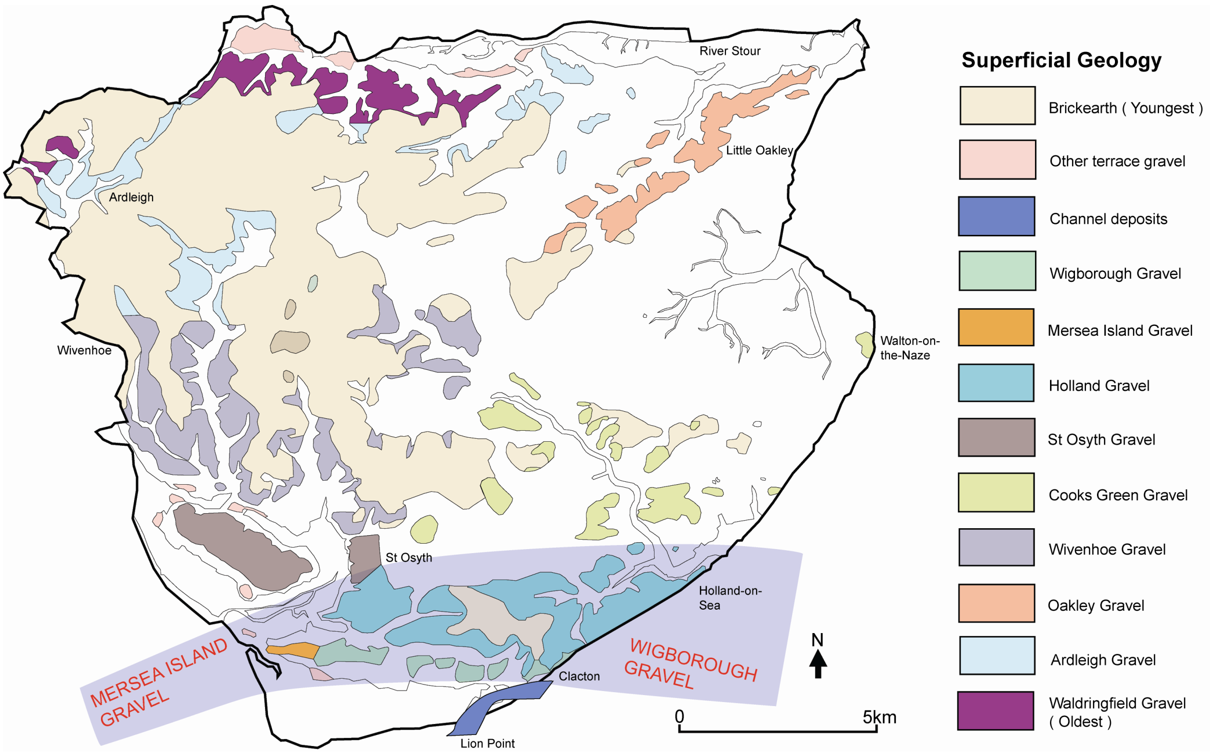


Fig. 12 The course of the early Thames-Medway in Wigborough Gravel times (After Bridgland (1999) based on B.G.S. mapping)

The above sequence is summarized in Figure 13. At each stage, the river Thames migrated southwards and also cut down to a lower level. Thus the various stages form a series of steps downwards, shown in Figure 14.

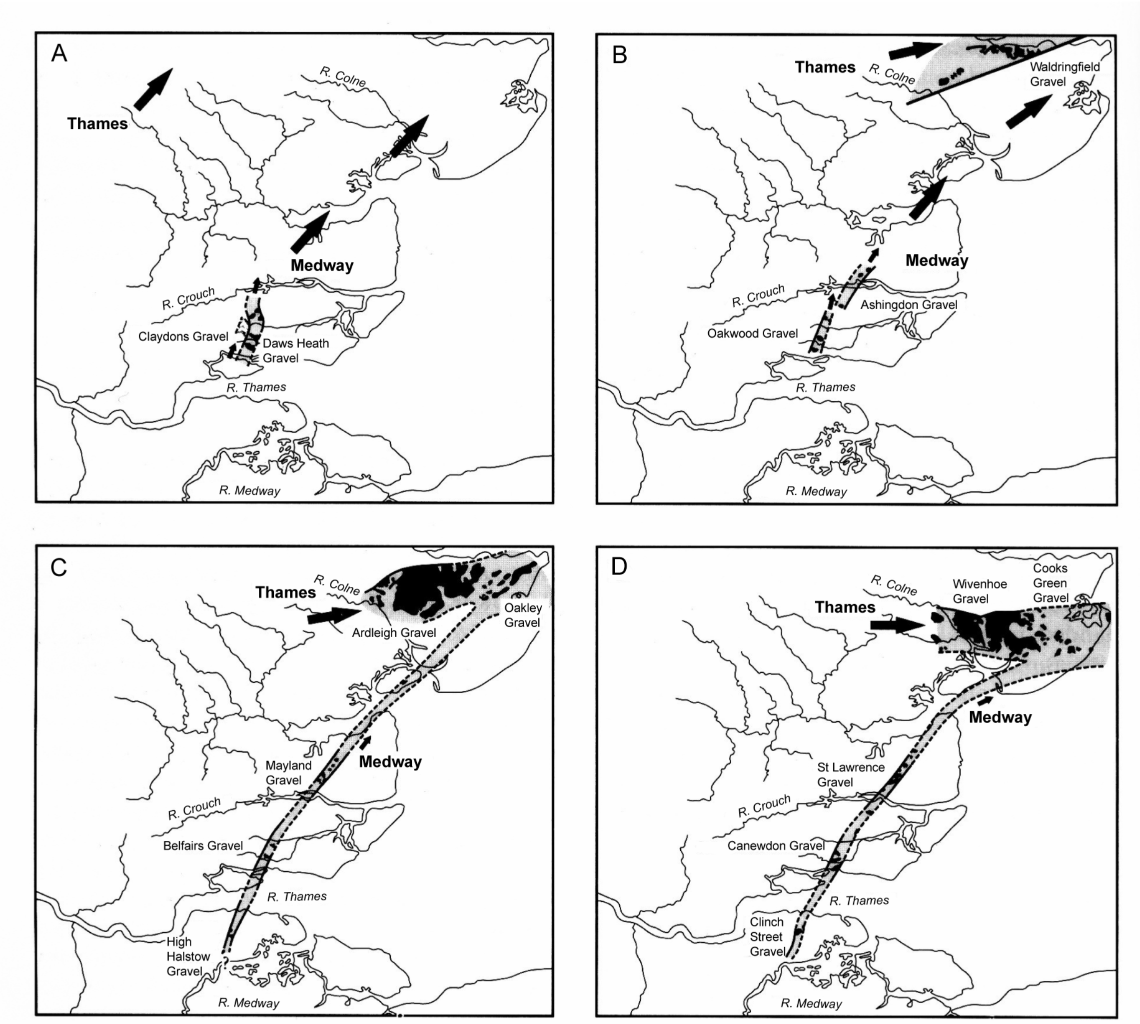


Fig. 13 Summary of the former courses of the Thames and Medway in Tendring (After Bridgland (1999) based on B.G.S. mapping)

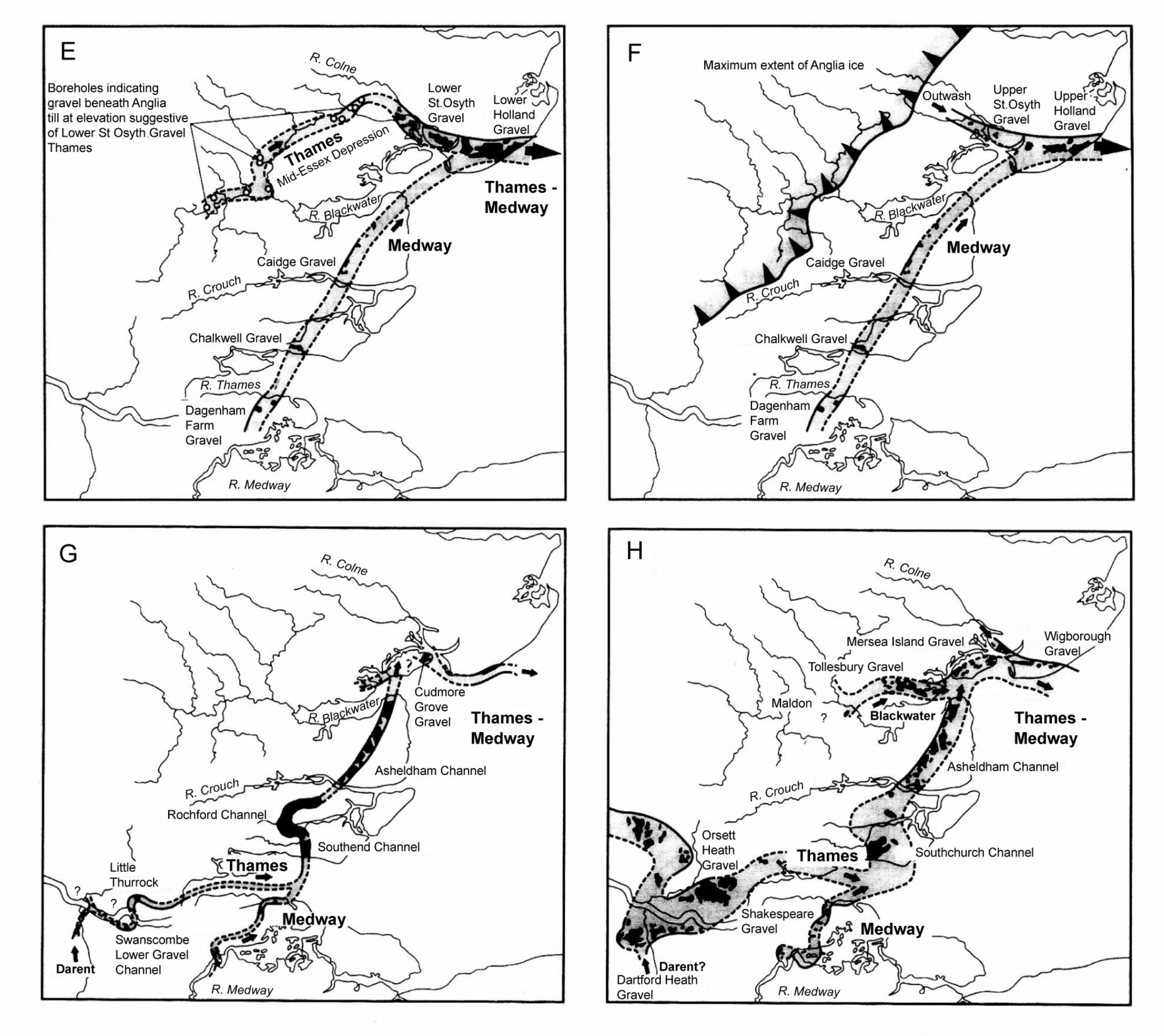


Fig. 13 cont. Summary of the former courses of the Thames and Medway in Tendring (After Bridgland (1999) based on B.G.S. mapping)

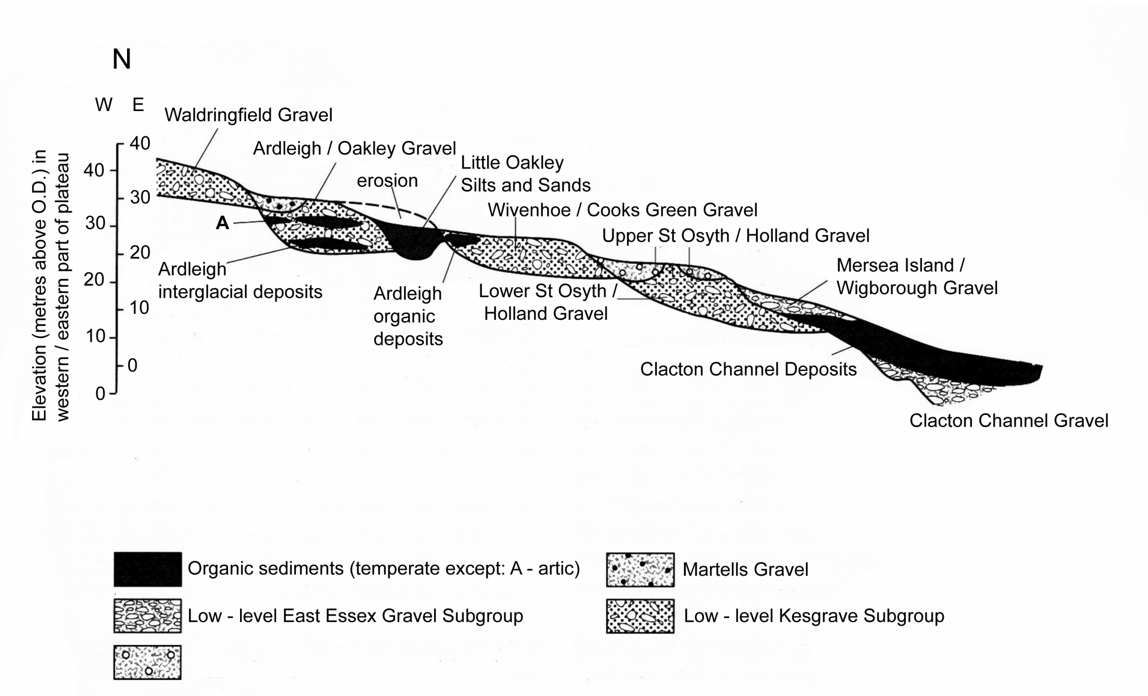


Fig. 14 Idealised section through the early Thames terraces of Tendring (After Bridgland, 1988)

After the Diversion of the Thames - Brickearth and patterned ground

After the migration of the Thames and Thames-Medway to the coast, the story of that river system continues south of the Blackwater. Within the Tendring area, rivers, slope processes and coastal erosion slowly ate into the landscape, revealing the London Clay. The major sedimentary event was the deposition of the brickearth though it is clear that there was more than one period of brickearth deposition.

The oldest brickearth is found in the low cliffs at Wrabness, which has yielded a variety of vertebrates, particularly elephant, which links it with similar deposits immediately across the Stour at Stutton, which has been assigned to a temperate stage known as MIS 7 on the basis of its vertebrate assemblage, dating to c.200,000 years ago. However, such deposits are usually associated with cold stages, so this brickearth was almost certainly reworked from an earlier cold stage.

The main outcrop of brickearth is younger and blankets much of the peninsula, resting indiscriminately on surfaces of all the ‘Kesgrave’ terraces. However, the finer sizes of its sand grains and, more so, the components of its mineral suite are different from the Kesgraves below, hence ruling out any genetic connection with them.

The British Geological Survey (BGS) has variously shown the brickearth on their maps as ‘Lowestoft Formation’ or ‘boulder clay and morainic drift’ which invites consideration of it as till/boulder clay. However, mapping an area east of Colchester from a relatively close network of boreholes by the BGS Mineral Assessment Unit (MAU) (Ambrose, 1975), shows the deposit to be loam (mostly silty clay or sandy clay, sometimes with traces of gravel). The Soil Survey (Sturdt & Allen, 1981), who classify it as ‘cover loam’, and a study by Eden (1980) provide much more detail. The basal element of the brickearth through most of the region is a thin, fine sand. Its grain size and widespread distribution indicates an aeolian origin. The grain size corresponds to a similar aeolian deposit, known as coversand, found as a belt across northern Europe, reaching into Russia. The aeolian origin is further confirmed as rivers and the sea deposit sediments over a limited area and altitudinal range at any one time; the wind is an exception as it deposits can blanket a whole landscape, irrespective of altitude. Resting on top of the fine coversand is a predominantly silty deposit, known by the German word ‘loess’. Where this is thick, as at Walton-on-the Naze (over 1 m), its basal part shows a mixing with the fine sand beneath. However, over much of the peninsula, the silty deposit is much thinner, usually less than 0.75 m, and usually has a component of fine sand throughout, due to mixing. Mixing would be far more effective in a thinner deposit, due to the activity of ground biota such as worms and roots and physical processes such as freezing and thawing, rainwash, translocation of fines by downward-percolating soil water and upward movement of coarser grains by frost activity. The last is also responsible for small stones within the brickearth being worked upwards from the Kesgrave Gravels below. The silts are similar to others found through much of eastern England, Kent and spreading across Europe into Asia, forming a loess belt to the south of the coversand.

The heavy mineral content of the Tendring coversand and loess are similar, linking them together and to the one period, albeit prolonged, of aeolian activity. The coversand and loess belts were formed by reworking of outwash from the melting glaciers of the last cold stage, the Devensian, 15-20,000 years ago. The Tendring deposits are thought to have been derived from glacial outwash in Doggerland when, during the Devensian, sea-level was low and much of the area dry land.

The brickearth at Mistley Heath is problematic in that it lies on the plateau and so would appear to be part of the Devensian brickearth cover, but elephant and rhinoceros have been recovered from it, suggesting a link with the older brickearth of Wrabness and Stutton.

Another Devensian phenomenon is patterned ground, best seen from the air in dry conditions. Water, if kept for prolonged periods colder than -20°C, or suffers rapid cooling, contracts. Groundwater behaves similarly, but being an integral part of the make up of the soil and its substrate, such contraction causes the ground to crack open, usually in an imperfect polygonal form (defined, clumsily, as ‘non-sorted’ patterned ground). Subsequently the cracks get infilled. This infill usually has different moisture retention properties from the host sediment, affecting plant growth, so the former cracks show up in aerial photographs, particularly if taken in dry weather.

The patterning is restricted to the flat surfaces of the terraces, particularly where there is a covering of brickearth, often associated with the Tendring Soil Series (see below), or the gentle slopes linking them, on the Bentley and Wix Soil Series, and most are found within 1 km of the Holland Brook (Fig. 15). The polygonal forms show a degree of hierarchy in that the wider cracks form polygonal patterns 40-60 m in diameter while narrower cracks, nested within them, are associated with patterns of 5-20 m diameter. As the patterning affects the brickearth, it must post-date its deposition; hence its Devensian age.

Fig. 15A Patterned ground around Beaumont Hall & Church (copyright David Grayston)

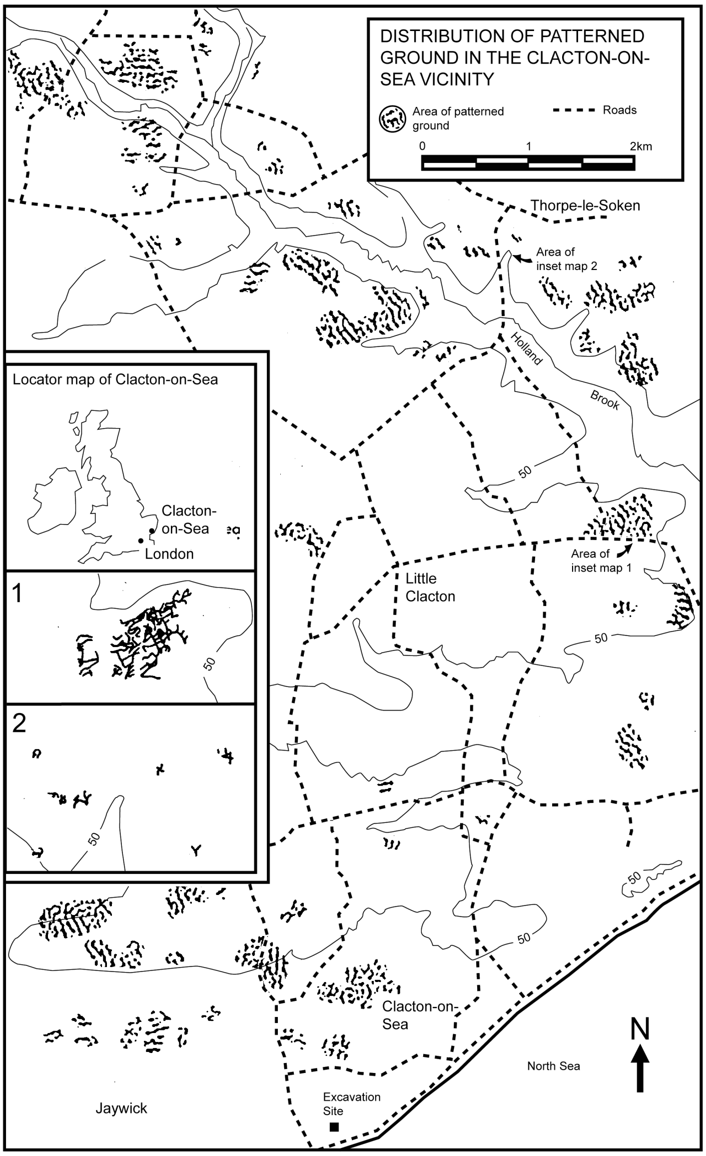


Fig. 15B Distribution of patterned ground between Clacton and Weeley. (After Sturdy & Allen, 1981)

After the Ice Age

The 10,000 years or so that have elapsed since the end of the last glaciation (the Holocene Period) is widely regarded as simply another interglacial stage and is sometimes referred to as the Flandrian Interglacial. Deposits laid down during this time are usually marked as ‘Recent’ on geological maps. It was during this period that most of the detail of the present landscape came into being. There are a number of specific landscape features that variously characterise the region or are unusual.

Along the valley bottoms, above the tidal limits, the rivers deposited alluvium (silt and clay) at times of flood. It sometimes contains bones of mammals such as horse, elk, wild boar, bear and wolf as well as Mesolithic and Neolithic flint flakes and arrowheads made by humans. Below the tidal limit, the Colne and Stour are flanked by saltmarshes, mudflats and, to a lesser extent, sandflats. These give way to sand and shingle beaches on the open coast. This is typical of the estuaries of East Anglia.

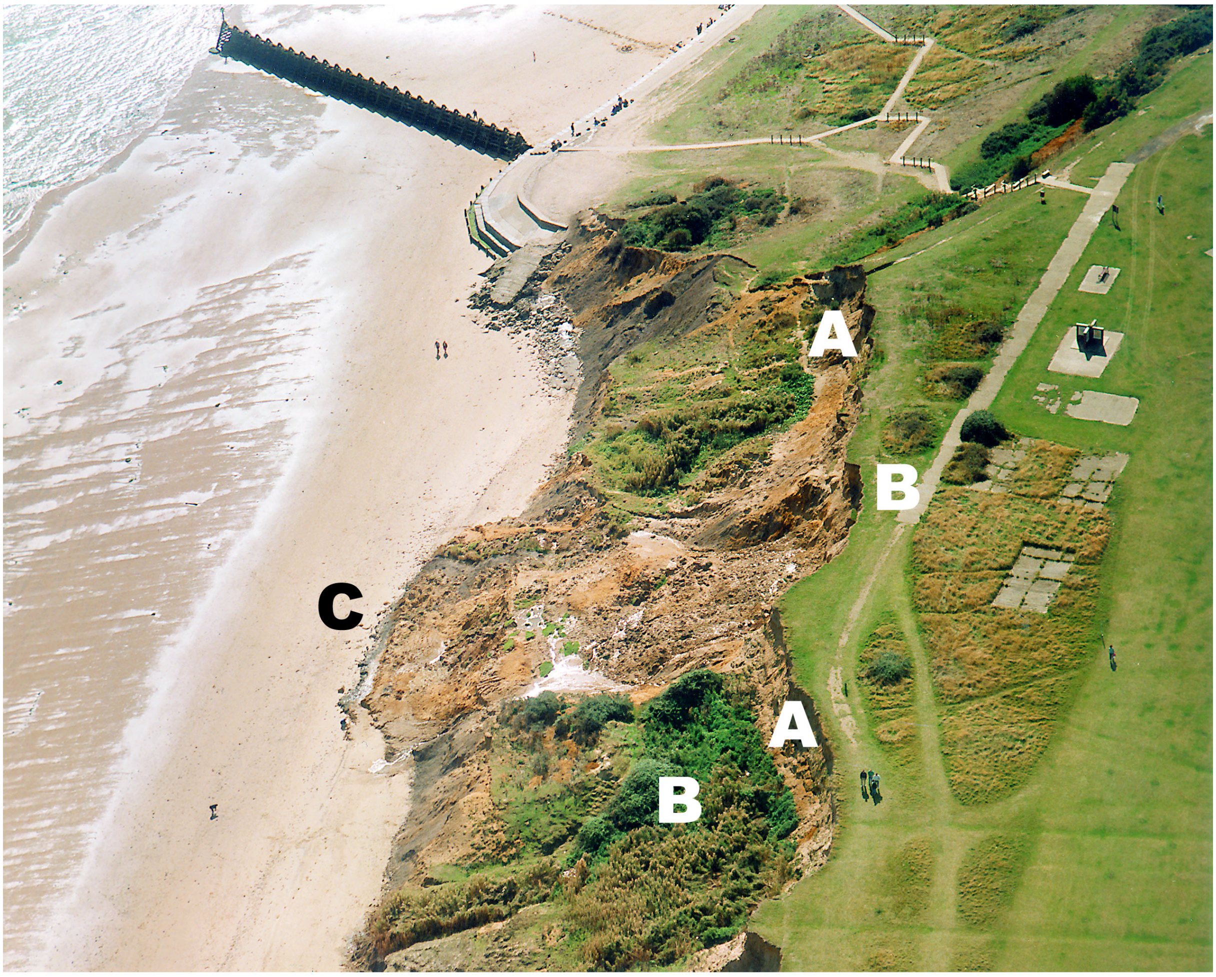
The saltmarshes at St Osyth Marsh show clays and peat. The clays are deposited by the sea initially as saline mudflats at the high tide level and then grow to the height of the prevailing spring high tides, thereby giving an indication of sea-level at the time of deposition. The peats indicate a drop in sea-level, allowing land plants and even trees to colonise the former mudflats. Subsequent rises in sea-level kill off the plants and cover the decaying matter (later to become peat) with saline mud. The saltmarshes record an oscillating sea-level in recent times and are a useful tool in deciding to what extent current rising sea-levels are natural or due to human activity. Unfortunately the saltmarshes are suffering a major decline. The Stour lost about 27% of its saltmarshes between 1988 and 1998, with one site losing 50%. Saltmarshes within Hamford Water suffered even greater loss. These losses relate only to the 10 year period; over a longer time span the loss has been much greater. The loss is due to rising relative sea-level of 60cm/century bringing the marshes under stronger wave attack. This is exacerbated by the presence of sea-walls preventing the natural landward migration of the marshes in such a situation, known as ‘coastal squeeze’ (Gibson, 2000). The saltings have taken thousands of years to form and are an extremely important recent deposit and wildlife habitat. Hamford Water and Colne Estuary National Nature Reserves (NNRs) contain the two prime areas of saltmarsh in Tendring. Their reduction is a major cause for concern. It is possible that some loss may be attributed to human intervention. The high rate of saltmarsh loss along the Stour may be related to dredging operations, allowing silt to settle in the deeper water, though this may be offset marginally by the slightly reduced tidal range, so that attack at the high tide level is reduced. Some mitigation can be achieved by coastal retreat. At Hamford Water unrepaired sea-wall breaches, c.1900, have allowed saltmarsh retreat. Further, managed, retreat may occur in the future.

At the mouth of the Colne, within the Colne Estuary NNR is Colne Point, a 4 km long shingle spit (G – St Osyth, Colne Point) with chenier (shelly) ridges. This is the best example of a shingle spit in Essex.

Fig. 16 Aerial view of 'fishtail' groyne off Jaywick

Beach management is mostly achieved through the use of simple groynes, but at Jaywick a 'fish-tail' groyne is employed (Fig. 16). These provide data for studying coastal erosion and movement of beach material, and the effectiveness of its management.

At The Naze, to the north of Walton, the geological configuration of cohesive permeable strata (Red Crag) overlying impermeable clay (London Clay), inevitably leads to a spring-line at the junction and saturation of the sediments causing landslips, rotational in form in this case (Fig.17). The slippage is still active, so there are characteristic features such as crescentic scars where the slips have torn away from the parent bedrock, back-tilting of the crowns of the slips indicating their rotational nature, and lobate toes where the wetter front area moves more as a flow, often with crescentic ridges indicating thrusting within the toe if there has been recent movement.



A - Scar **B** - Back Tilted Block **C** - Lobate Toe

Fig.17 Aerial view of rotational landslip at Walton on the Naze.

Relationship of the Geology to the land surface

As described above, the overall pattern is of a landscape declining in height from the north-west (c.40 m O.D.) to the south-east (at sea-level) in a series of flats or steps corresponding to the underlying Kesgrave Sands and Gravels terraces. In places these gravels form the surface geology, but much of the terraced area is covered by a veneer of brickearth, mostly less than 0.75 m thick, but still reflecting the flat terrace morphology. The brickearth is the basis of the rich agricultural land of Tendring. London Clay is exposed in the sloping ground (bluffs) between the terraces.

Elsewhere the brickearth and the Kesgrave Sands and Gravels have been eroded away, mainly by the local streams, and the surface geology is the London Clay. The streams generally cut through to the London Clay close to their sources and their valleys become relatively steep-sided.

Above the tidal limits the valleys are usually floored by alluvium, but below the limit the rivers are flanked by mudflats, saltings and occasionally sandflats.

2.5 The Soils of Tendring:

The soils of Tendring mostly correlate with the underlying geology, but when the geology and soil maps are compared, there is a great deal of difference in detail. Some of this is due to different field mapping methodologies and some to differences in the presentation of the information. Some soils relate to geomorphology, particularly the valley slopes. An introduction to soil formation is outlined in the Glossary. The soils of the Weeley area are described in detail by Sturdy & Allen (1981).

Soils of the plateau

Soils on the flat or gently sloping surfaces of the plateau are stable and have had time to adjust to the characteristics of the underlying geology, which comprises the brickearth/cover loam, overlying the various members of the Kesgrave Sands and Gravels or the Red Crag. The Kesgraves often have a clay- and iron-enriched palaeosol at their surface while the Red Crag also has iron- and clay-rich sedimentary horizons. These horizons are referred to as 'hoggin' by the soil surveyors and they influence the soil types that develop on the plateau.

The most extensive soil type is the **Tendring Soil Series**, developed on the thicker spreads of brickearth/cover loam and the **Bradfield Series** where it is thinner. The brickearth in these cases overlies the palaeosols horizon developed on the Kesgrave Sands and Gravels. The brickearth is a slightly sandy silty clay, rich in minerals, the soil on it is fertile and drains reasonably well but it can also retain sufficient water to avoid drought most years. These soils are described as palaeo-argillic brown earths. (Argillic = clay-rich; palaeo – refers to the palaesols; brown earth – a soil in which downward percolating groundwater moves clays, humus and minerals such as iron to lower levels, creating a deficient, eluvial, upper horizon and an enriched, illuvial, lower horizon, the iron is oxidised giving the soil its brown colour). The Bradfield Series is affected by the hoggin of the palaeosol and is more water retentive. Both soils are very productive and are particularly suited to arable agriculture and horticulture.

The **Oakley Soil Series** comprises a thin loam overlying the hoggin of the palaeosols and Red Crag, has greater water-retaining properties and is defined as a palaeo-argillic stagnogley (stagno – relates to seasonal saturation by surface water; gley – indicates lesser oxidation of the iron present or even loss of oxygen due to the greater amount of water present, usually mottled brown where the iron has oxidised to FeO_2 in dry periods and grey where the iron was oxygen-deficient as FeO during periods of saturation; because of the water retention, there is not the same degree of groundwater movement and the development of horizons). This soil is suitable for arable agriculture and horticulture, but there is some danger of waterlogging.

Where the Red Crag is free of clay and iron-panning, it is a freely draining shelly sand on which the **Beaumont Soil Series** develops, a calcareous brown earth (brown earth- see above; calcareous component derived from the shells). This soil is suitable for arable agriculture and horticulture, but will benefit from irrigation.

On the gentle convex slopes at the margins of the cover loam on the plateau, there are soils of the **Wix Soil Series**. These are flinty gleyic argillic brown earths developed on head deposits which are a mix of cover loam (giving the argillic component) and Kesgrave Sand and Gravel (providing the flint and allowing the groundwater movement and aeration for the formation of the brown earth). These soils are often associated with polygonally patterned ground. The main land use is arable.

A more enigmatic, but relatively widespread, soil is the **Weeley Soil Series**, a stagnogley developed on relatively stoneless clayey deposits resting on the Kesgrave terraces, possibly channel fills or lake deposits. A stony version is developed on clay-rich head deposits at the plateau edge. As for the Oakley Series, this soil is suitable for arable agriculture and horticulture, but there is some danger of waterlogging.

Soils of the upper valley slopes

On the valley sides, the lower parts of the Kesgrave Sands and Gravels, below the palaeosols horizon, are exposed. The Kesgrave Sands and Gravels are less rich in minerals than the brickearth and are free-draining, giving a poorer quality soil that is prone to drought in dry summers. These form the **Bentley Soil Series**, which is classified as a brown sand. As such, its pedogenic history has parallels with a brown earth (see above), but being clay deficient, it does not have a clay-rich illuvial horizon. However, the Kesgraves can have a degree of clay in them, the Bentley Series brown sands can be slightly argillic and gleyed. The dry nature of these soils make then suitable for arable farming of crops such as cereals and sugar-beet, though the range of crops can be improved with irrigation.

Soils developed on the London Clay are heavy and water retentive, forming the **Windsor Soil Series** which is a pelo-stagnogley. (pelo – refers to the poor development of eluvial and illuvial soil horizons because groundwater moves downwards through the clay so slowly). These soils are difficult to work when wet and drainage effects only a limited improvement. This soil is mostly used for grass and cereals, though with careful management a wider range of crops can be grown such as peas and beans; it is not suitable for root crops.

Where there is a sandy head overlying the London Clay, the soil is somewhat better draining, as the **Wickham Soil Series**, a stagnogley with slightly better horizonation. Like the Windsor Series, these soils are best suited to grass and cereals, but where the soils are lighter a wider range of crops grown. Drainage can have an improving effect.

Soils of the valley bottoms

Most of the valleys are narrow-bottomed and have only limited spreads of alluvium, primarily a mixture of sand, silt and clay. Where present, the alluvial soils form the **Conway Soil Series**, an alluvial gley soil due to the high water-table, particularly in winter. The gleying is due to the seasonal saturation. This soil is suitable for grass and cereals. Drainage can help summer crops.

Soils of the coastal marshland

The marshy nature of the lower parts of the valleys draining to Hamford Water, the Colne and Stour give rise to **Landermere and Wallasea Soil Series**.

The **Landermere soils** are formed on the slightly higher ground above the creeks and may be associated with clayey head on the London Clay footslopes, but subject to periodic sea flooding. The clayey nature of these soils means that they are stagnogleys, suitable for grassland and cereals, but on lighter variants potatoes and vegetables can be grown.

The Wallasea soils are developed on clayey marine alluvium laid down in or adjacent to the former creeks. Their clayey nature and high water-table makes them pelo-alluvial gley soils. They are, however, suitable for cereals, grass, possibly peas and beans; unsuitable for root crops. However, these soils are extremely susceptible to saline deflocculation. Following landclaim, salinity gradually reduces by leaching; which causes the flocks which are held together by salt to collapse, such that the soil structure rapidly collapses, and then fine silt blocks the land drains. All of which makes the initially highly productive soils (often Grade 1) lose the high quality after a few decades, unless there is continued intervention (usually gypsum application).

Saltings occur on the tidal flats. These are described as unripened gley soils consisting of clayey muds of slimy consistency.

2.6 Biodiversity links to Geodiversity in the District

In the way that soils in Tendring District correlate with the underlying geology, many of the District's habitats are directly influenced by the soils and, particularly along the coast, by geomorphological processes. The most important habitats in Tendring District in terms of their wildlife value from a national and international perspective are the estuarine and intertidal habitats of the Rivers Stour and Colne Estuaries and the tidal embayment of Hamford Water. The rich invertebrate fauna of the mudflats provide a food source for internationally important numbers of wading birds and the saltmarsh vegetation is of national nature conservation importance supporting nationally rare plant species. Within the Colne Estuary, the exposed mudflats, shell banks and shingle pools of the Colne Point shingle and sand ridge support highly localized plants, such as the nationally scarce sea heath, and hold a large range of marine invertebrates and algae and provide a feeding ground for waders. The area is also important for invertebrate populations. The saltmarsh and grazing marsh habitats that occur in the upper reaches of the Colne Estuary (e.g. Colne Point, Howlands Marsh, St Osyth Marsh), Stour Estuary (Cattawade Marshes) and Holland Haven are also recognized as being of national importance for nature conservation. These sites generally support a diverse mix of saltmarsh and coastal grazing marsh habitats of high avifauna value. The grazing marshes of these areas also support distinct and diverse assemblages of aquatic plant and invertebrate species that reflect the salinity of the water, which can range from fresh to brackish across a single marsh.

Tendring District is also noted for its Ancient Woodland that occurs across a central belt within the District. Three of the District's Ancient Woods are of national importance. In Riddles Wood, the varied soils derived from the Kesgrave Sands and Gravels in the west and London Clay in the east results in a diversity of woodland types and a rich and varied ground flora. At Weeley Hall Wood the diversity of woodland types reflects the varied soils: sandy loams and gravels overlying London Clay, and soils derived from loess which are moderately to strongly acidic. In Bullock Wood, situated on an almost level plateau with acidic soils developed over brickearth, the principal woodland type is the nationally rare Lowland Hazel-Sessile Oak woodland type modified in places by the presence of Sweet Chestnut *Castanea sativa*. Other notable habitats in the District are a range of grassland types, from coastal pasture to acid grassland.

2.7 Geodiversity and evidence for early human occupation

Tendring District, and in particular the southern coastal area from Clacton to Jaywick is known to contain Palaeolithic deposits of international importance.

Much of the evidence for early human occupation within Tendring is associated with the deposits laid down during the temperate stages by the Thames and Medway Rivers. These deposits often overlie and are overlain by sand and gravel sediments that were deposited by the rivers under cold-climatic conditions. Under cold climate conditions the energy of the rivers increase and the size of the sediment it can transport and deposit also increases. Consequently much of the evidence that may have been 'left behind by early hominids is either destroyed or becomes reworked into later deposits. Generally it is the more durable forms of evidence that survive in these depositional environments.

During the early Ice Age the Thames flowed to the north of London, through central Essex, Suffolk and Norfolk and out across what is now the southern North Sea; the evidence for this being a substantial thickness of what are called **Kesgrave Sands and Gravels** which represent the actual bed of the river. Research has also shown that the River Medway flowed across coastal Essex. The evidence for this is in the form of a line of gravel deposits trending northwards, roughly parallel with the coast, which contain a mixture of rocks from Kent. Both rivers were of considerable size and extent and as they flowed across the district successive bodies of gravel deposits were left behind. Evidence for possible early human occupation has been recovered from the Wivenhoe Gravels at the type-site at Wivenhoe pit which would indicate occupation by humans *c.*500,000 years ago, pre-dating the Anglian glaciation. Recent discoveries in Suffolk have revealed that there was human presence in East Anglia before the Anglian glacial stage, within the Cromerian Complex. If further artefacts were recovered from the Wivenhoe Gravels or their corresponding Thames-Medway deposit, Cooks Green Gravels these would be the oldest evidence for human occupation in Tendring District.

About 450,000 years BP, the Anglian ice sheet moving south diverted the course of the Thames River to approximately its current position. When the diverted Thames reached Southend it then flowed north as a combined Thames/Medway river along the old Medway valley to Holland-on-Sea. At West Cliff, Clacton, and the foreshore at Jaywick there is a complex of channel deposits, associated with the Thames-Medway River after the Thames was blocked by ice. The deposits have produced flint tools representing the earliest undisputed evidence of human presence in Essex. In addition these deposits have proved to be rich in palaeo-environmental remains, including pollen, plant macrofossils, molluscs, small mammals and much larger animals including horse, red deer, bison, rhinoceros, giant beaver, lion and straight tusked elephant. This assemblage indicates much warmer climatic conditions than today. The deposits in the Clacton area are particularly significant, they have produced a range of flint artefacts and the tip of a wooden spear, the oldest wooden artefact ever recovered from Britain. This site has given the name 'Clactonian' to an industry of European flint tool manufacture that dates to 300,000–200,000 years ago.

Fig. 18 Palaeolithic wooden spear tip from Clacton

Often the only opportunity for the recovery of evidence dating to the Palaeolithic period is from commercial gravel extraction. Over 200 Palaeolithic flint tools known as 'handaxes' were recovered during mineral extraction at the Gants Pit quarry in Dovercourt, the largest assemblage ever recovered in Essex. These gravels date to after the Anglian glacial period. Much of the gravels have been quarried.

2.8 Industries linked to geodiversity in the District

Everything humans need that cannot be obtained from farming has to be dug from the ground. The geology of a given district affects not only the character, landscape, soils, and wildlife of an area but also industry and employment. Sand and gravel quarrying is the major local industry connected with geology but there have been several others that have contributed to the district's economy over the years. The following industries in Tendring have a direct link to geodiversity. Sites or places underlined are listed and described in the gazetteer of geological sites (section 5).

Prehistoric flint working

The making of primitive tools from flint by Stone Age man must be the most ancient industry in Essex. Large numbers of such tools have been found throughout Tendring District. Flint tools from Clacton are the earliest undisputed evidence of humans in Essex and the site has given the name 'Clactonian' to this particular style of stone-working which consists of chopper tools but no hand-axes, made by humans living on the banks of the early Thames. Hand-axes, however, are the most common Palaeolithic flint tool and thousands have been found in Tendring. Gants Pit in Dovercourt was the richest site for hand axes in Essex with over 200 hand-axes coming from this one pit. Two flint flakes from Wivenhoe, however, may be evidence of human occupation in Tendring even before that of Clacton.

Sand and gravel

Sand and gravel for buildings and roads is of great importance and Essex possesses vast resources. Most of the sand and gravel worked in Essex is known as the Kesgrave Sands and Gravels which was laid down by the Thames when it flowed north of its present course before it was diverted south into its modern valley by the Anglian ice sheet. Most working and disused quarries in Essex are therefore situated along the former route of the Thames, particularly around Chelmsford and Colchester, but also and extending right across Tendring District. There are therefore also numerous working and disused pits in Tendring district along the former route of the Thames and also the former route of the River Medway, which originally flowed north across eastern Essex to join the Thames in what is now the floor of the North Sea (Doggerland) or the Tendring peninsula. The geology of these Thames and Medway gravels is complex, with each river having many terraces of various ages. The commercial value of all these sands and gravels has been of immense benefit to geologists who have taken advantage of the excavations – literally windows into the past – that these quarries have provided. Much has therefore been learnt about the evolution of the Tendring landscape as a result and three quarries have been designated as Sites of Special Scientific Interest (SSSIs) specifically for their geological value.

The gravels largely consist of sub-angular and sub-rounded flint pebbles (originally derived from the Upper Chalk) but they also contain a proportion of ‘exotic’ rocks derived from distant sources. It is this ‘exotic’ component of a gravel, together with other tantalising evidence, that has been the key to working out the routes of these ancient rivers and a reconstruction of the Tendring landscape over nearly half a million years.

In recent years the sand and gravel workings have been more localised to the west of the District around St.Osyth, Brightlingsea, Alresford and Wivenhoe. There have been several proposals received from the Minerals Industry for further sites in the area. These proposals are being assessed at the moment and may be included in the emergent Minerals Development Document.

There is one quarry to the north west of the district near Ardleigh that produces silica sand used as industrial and horticultural sand. Also in Ardleigh an extension to the reservoir has been approved subject to a legal agreement, the material to be extracted is from the Kesgrave Lowestoft formation.

Building stone

Good stone for building is very scarce in Essex and many early buildings had to be constructed of whatever rocks were available locally. The commonest of these were **flints** which are obtained from the Chalk. Flint is not an ideal building stone as it is difficult to work and, when freshly dug, occurs in nodules of irregular shape; but it is extremely durable. Flint walls are common and these sometimes consist of whole nodules carefully selected for uniform shape. The majority of flint buildings are found in north-west and south Essex where chalk occurs at the surface but elsewhere, including in Tendring District, flint was often used for the most important buildings such as churches and abbeys. For such buildings ‘knapped’ flints were used (flints skilfully worked to produce a flat face) and one of the finest examples of this craftsmanship in Britain can be seen on the fifteenth century gatehouse of St. Osyth’s Priory. When flint is knapped the resulting face has a wonderful lustrous, almost translucent, quality and can be various colours from black to bluish grey through brown to almost milky white. The fine quality flint for this type of work, however, probably did not come from Essex, but from Brandon in Suffolk, an area where flint has been mined since the Stone Age.

Septarian nodules from the London Clay have been used in the construction of many older buildings in Tendring District, particularly churches close to the coast. More usually referred to as '**septaria**' they consist of nodules of phosphatic limestone which occur in the London Clay at various levels and are washed out of the cliffs to accumulate on the foreshore. They are often grey but sometimes are a delightful chocolate brown colour. The boundary wall of St.Osyth's Priory is an excellent example of the use of septaria and it has also been used in many other churches near the coast such as at Great Clacton. Perhaps the most striking example of the use of septaria is the lofty tower at St.Osyth's Priory which was built in 1853 after the priory became a private residence. It is entirely faced with a chequer board pattern of imported limestone and local septaria, the stone most probably obtained from the demolition of monastic buildings. Unfortunately the tower is not accessible to the public but a chequerbord pattern of septaria and flint can be seen at St.Osyth church, opposite. Samuel Dale, the Essex naturalist and author of '*The History and Antiquities of Harwich and Dovercourt*' (1730), records that in his time the streets of Harwich were cobbled with dressed stones taken from the 'Harwich Stone Band' – a thick layer of stone similar to septaria and known as 'cement stone' as it was used in the Harwich cement industry.

In Tendring District there are church walls that include various erratic boulders from the gravels and harvested from the fields or from the coast. There are also churches built partially or almost entirely from blocks of **ferricrete** (an iron-cemented sand or gravel) which makes a remarkably good building stone. The best example of the use of ferricrete is the church at Great Bentley. The types of stone used in the fabric of a church can be a valuable guide to the age of the building.

Bricks and tiles

Brick making was probably introduced to Britain by the Romans nearly 2000 years ago and their bricks, because of their durability, can be found re-used in the structure of many ancient Essex churches. The dimensions of Roman bricks vary but they can be recognised by their characteristic shape, being more like tiles than present day bricks. Following the departure of the Romans, brick making was not carried out again in Britain until the twelfth century; some of the earliest surviving examples of this non-Roman brickwork can be found in Essex.

The main geological formations in Tendring that have been found suitable for brick making are the London Clay of Eocene age and various brickearths dating from the Ice Age. In the nineteenth century virtually every town had its own brickyard and several of the old overgrown pits are still in existence. The largest brickworks in the district were situated in the Clacton area but there were also many brickworks in Harwich and Dovercourt, working alongside the cement factories. Noticeable variations in the level of the land in Harwich are due to the old Harwich brickpits. There are no brickworks currently operating in Tendring District and very few in the rest of Essex. Most of the bricks used in Britain nowadays are made in large brickworks in Bedfordshire, Cambridgeshire and Surrey from clays of Jurassic or Cretaceous age.

The copperas industry

A little-known industry, formerly of great importance in Essex, was the copperas industry. It was nothing to do with copper. It consisted of the gathering of nodules of iron pyrite from Essex beaches, where they had been washed out of the London Clay. The nodules were known then as 'copperas stones' and are perhaps more commonly referred to today as 'fools gold'. The process involved allowing them to oxidise for several months in open vats and the resulting liquor was then boiled in lead cisterns, whereupon a solution of ferrous sulphate (green vitriol) was formed. This was an essential chemical for dyeing leather and cloth black, for making black ink, and for making other chemicals, such as sulphuric acid. The process appears to have been lengthy, noxious and dangerous. The wives and children of local fishermen were employed to gather the stones from the beaches and were paid in 'copperas tokens'. Old records show that over 230 tons a year were removed from the beach at Walton in the period 1715-1720.

Daniel Defoe, in his *Tour through the Whole Island of Great Britain* (1724) noted: "At Walton, under the Nase, they find on the shoar, copperas-stone in great quantities; and there are several large works call'd Copperas Houses, where they make it with great expense”. Samuel Dale, in his book *The history and antiquities of Harwich and Dovercourt* (1730) provides an engraving of boys collecting the stones from the beach at Harwich. The main copperas works was at Walton but there were also ‘copperas houses’ at Ramsey and Brightlingsea. It died out over 100 years ago but evidence of it still survives, for example ‘Copperas Bay’ and ‘Copperas Wood’ near Ramsey. There is also a ‘Copperas Road’ in Brightlingsea. An interesting account of the industry is given in the booklet *Copperas and Copperas Tokens of Essex and Kent* by W.H. George and the *Victoria History of the County of Essex* (Volume 1).

The copperas industry has been intensively studied by archaeologists researching the copperas works at Whitstable in Kent. They conclude that copperas manufacture was completely unlike the traditional, small-scale chemical industries of the medieval and early modern period. It required a huge investment in plant and materials and the chemical took four years to produce. Copperas played a key role in numerous industries at the time, not only textiles. In the mid eighteenth century the domestic copperas industry was a major economic asset in terms of export earnings. This research has shown that the copperas industry was a direct ancestor of the modern pharmaceutical and chemical industries. It has even been claimed that the industrial revolution started not with coal and iron but with chemistry; and not in the north but in sixteenth century Essex and Kent!

The Roman cement industry

Before the invention of Portland cement, ‘Roman cement’ was made in Essex from accumulations of septarian nodules washed out of the London Clay cliffs along the coast. Invented by James Parker in 1796, it was also called ‘Parker’s cement’. Harwich was the main centre of this industry, where the nodules were collected from the foreshore, excavated from the cliffs and later, when the supply of stone dwindled, dredged offshore where nodules had accumulated on the sea bed. During the early part of the nineteenth century up to 500 men were employed in this industry at Harwich and the cement was supplied to all parts of Britain and northern Europe.

The method of manufacturing Roman cement was to break up the cement stones into small pieces and place them in a kiln to be burned, just as chalk is burned for lime. Finally, the product was ground up and packed in barrels for transport. When required for use it was mixed with the correct proportions of sand and water. The quality of the cement deteriorated rapidly when kept, so that it was always used as fresh as possible. Roman cement was used for most of the purposes for which Portland cement is used today and there was, therefore, a great demand for it. It was a very rapid setting 'hydraulic' cement, which set hard even under water. Much of the waterproof external rendering known as 'stucco' used during the Regency period was made from this cement, particularly by the famous architect John Nash for London's buildings.

There was much difficulty in obtaining sufficient quantities of cement stone to meet the enormous demand and the collection of cement stones at Harwich caused great concern because of the effect it was having on the erosion of the cliffs and the threat this was causing to Harwich Harbour. At Harwich there was, and still is, a continuous layer of cement stone at the base of Beacon Cliff which provided a degree of protection from erosion. This natural barrier was soon removed and the cliffs themselves were attacked for the stone. The scale of the industry is clear from a report to the Admiralty in 1843 which stated that since 1812 upwards of a million tons of the stone had been carried away from the shores at Harwich and at Felixstowe on the other side of the river. There were many disputes and the matter was even raised in Parliament. When at last the taking of stone from the cliffs was prohibited by a Government Commission, dredging for the stone from the sea bed off Harwich began, using smacks - sailing vessels each with a crew of three or four men. In 1851 it was estimated that over 300 smacks were engaged in this work, most of them from Kent ports, and it was not uncommon for them to race each other to and from the dredging grounds. The dredging of stone was also carried out at other places on the Essex coast including Brightlingsea. By the 1870s the Roman Cement industry was in decline, having been replaced by Portland Cement for most uses although the property of rapid-setting gave it an advantage for special purposes. From a total of five cement factories in the 1830s, this had dropped to three by 1852 and by 1859 John Pattrick was the sole manufacturer. By then, Pattrick had started producing Portland cement alongside Roman cement. Pattrick's works finally closed in 1890 bringing an end to the cement industry in Harwich.

The digging of stone by hand from the cliffs and the dredging of stone from the sea bed has proved to be of great value to science. Numerous priceless fossils of early mammals were found to be preserved in the Harwich cement stone nodules together with giant turtles and other marine creatures. Many of these fossils went to the Natural History Museum in London but several are in the collections of Colchester, Ipswich and Norwich Museums. Of particular interest was the first discovery in the world of the skeleton of the earliest ancestor of the horse (*Hyracotherium*).

The Portland Cement industry

Following the invention of Portland cement, the Roman cement industry at Harwich went into decline as Portland cement factories opened on the south bank of the Thames exploiting the chalk and clay necessary for Portland cement manufacture. However, the first Portland cement factory in Essex appears to have been in Harwich, and not on the north bank of the Thames in Thurrock which later became a centre of this industry. John Pattrick, the most successful Harwich Roman cement manufacturer, started producing Portland cement in 1850, bringing the raw materials, chalk and clay, in from the Medway area of Kent by boat. Competition from the giant cement works in Thurrock and Kent led to the closure of Pattrick's works 1890.

Water supply

Water supply for villages and towns in Essex was formerly obtained from numerous local wells and boreholes driven into water-bearing rocks at various depths. The Chalk is permeable and rain falling on the outcrop passes down to form a vast underground reservoir of water known as an aquifer. The Chalk aquifer is still an important source of the county's water supply, particularly in Tendring District where the Tendring Hundred Water Company currently obtains 80% of its supply from borehole sources.

The Tendring Hundred Water Company was established in 1884 and the company's origins can be traced back to Harwich where the lack of good drinking water had long been a complaint among residents. Several attempts had been made to find water but none had been successful including two boreholes that were carried down into the Chalk, one of which was recorded to be almost 300 feet deep. Undeterred by this failure the sinking of an ambitious new borehole was commenced in 1854. Two years later the Harwich borehole had penetrated deep into the Chalk but had still not encountered a satisfactory supply of water and the decision was made to continue through the Chalk to the rocks below. In November 1857, three years after the work had commenced, the borehole had been carried through the Chalk, the Upper Greensand and the Gault into the hard, slate-like basement rocks of Essex. Although no satisfactory water supply was obtained from this borehole, and it was to be several more years before a good supply was found for the town, the borehole had reached a depth of over 300 metres (1,000 feet) and proved to be of great value to geology. The hard basement rocks of Essex – dating from the Silurian period and about 420 million years old - had been revealed for the first time.

Medicinal springs and spas

Water from wells and natural springs was, in parts of Essex, thought to have medicinal value and in the eighteenth and nineteenth centuries many towns became noted for their spas. One of the most successful Essex spas was at Dovercourt where a fine spa house was constructed in 1854 overlooking the sea. The water was described as 'chalybeate' (containing a high concentration of iron compounds) and was considered to be of high therapeutic value. The Spa was very successful and continued to do business until at least 1910. It was probably demolished shortly after the First World War and was the last of the Essex spas. The chemical compounds in spa water vary depending on the rocks through which it passes; each source therefore possesses a unique character. There are records of at least 24 spas and medicinal wells in Essex; although some of these were very fashionable during the reign of Queen Victoria, the industry died out during the early years of this century.

Phosphate digging

The fossilised droppings or excreta of prehistoric animals are called 'coprolites' and these are common in some sedimentary rocks. The phosphatic nodules within the nodule bed at the base of the Red Crag were originally thought to be coprolites and it was formerly given the name 'coprolite bed'. In Suffolk, these nodules were the basis of an agricultural phosphate industry dominated, in the middle of the nineteenth century, by firms such as Fisons. In the Tendring District, on a much smaller scale, these nodules were worked as a source of phosphate fertiliser at Wrabness, Walton-on-the-Naze and Little Oakley. Phosphate was an important U.K. industry before overseas discoveries were made.

The coprolite bed is a concentrated deposit formed on the sea floor several million years ago, and contains many bones of marine creatures, some dating from the Miocene period such as the bones of whales and the teeth of giant sharks. Many magnificent fossils from this bed were obtained by the phosphate diggers in the nineteenth century, or dredged off the coast of Walton where the nodules have accumulated on the sea bed. Colchester and Ipswich museums have fine collections of such fossils.

Lime burning

In the eighteenth and nineteenth centuries there was a great demand for lime for agricultural use and for lime mortar. It was made by heating chalk or limestone in a chimney-like kiln and vast numbers of limekilns were built. Limekilns were usually built in chalk quarries to be close to the raw material used for making lime but in coastal areas more permanent and substantial kilns were built in harbours where chalk and fuel for the kiln could be brought in by sea. There is now virtually no trace of this industry in Essex but there is a remarkably complete limekiln at Beaumont Quay which is the only surviving limekiln in Essex. Although the Chalk underlies the whole of Tendring District it is not present at the surface and chalk for the limekiln would have been brought in by boat from elsewhere.

The search for coal in Essex

In the latter part of the nineteenth century, the discovery of a deep coalfield near Dover stimulated the search for coal in East Anglia. The Eastern Counties Coal Boring and Development Syndicate was formed for this purpose and it sunk a borehole at Weeley in 1896, its previous borehole being at Stutton on the Suffolk side of the Stour estuary. The borehole penetrated the deep Palaeozoic basement rocks at a depth of over 330 metres (1,100 feet) and continued to 372 metres (1,221 feet) before the project was finally abandoned. As at Harwich, the basement was found to be Silurian rocks (approx. 420 million years old) and not the younger Carboniferous coal measures that had been hoped for. A further borehole at Great

Wakering near Southend was suggested but finance was not forthcoming. Directors and shareholders had invested a considerable amount of money in the venture but the syndicate was finally wound up a year or so later. A section of the core from the bottom of the borehole is on display in Colchester's Natural History museum and another has been preserved in the collection of the Essex Field Club.

It is an interesting thought that had the borehole results been different and coal discovered at Weeley, the economy and character of the entire district would have been transformed with the development of perhaps several coal mines across the area with the associated infrastructure and port facilities – a further example of how geology affects the character of the landscape.

Salt

The extraction of salt from sea water was undertaken on an industrial scale during the Late Iron Age and Roman periods utilising a process whereby sea water was collected and evaporated in large shallow dishes of baked clay. The visible signs of this industry are the distinctive 'red hills' that can be seen along the estuaries; these were formed from an accumulation of ash and broken fired clay vessels, a by-product of the fires used to apply heat to the salt pans. There are the remains of red hills at many places on the Tendring coast, particularly around Hamford Water, west of Jaywick and north-west of Brightlingsea. Salt continued to be produced in the Anglo-Saxon and medieval periods, utilising a different process, but the location of these manufacturing sites is less well known. Sea salt is still produced at Maldon by the Maldon Sea Salt Company. A comprehensive account of Essex red hills is given in *The Red Hills of Essex: Salt-making in antiquity* published by Colchester archaeological Group.

3 Characterisation of the Resource

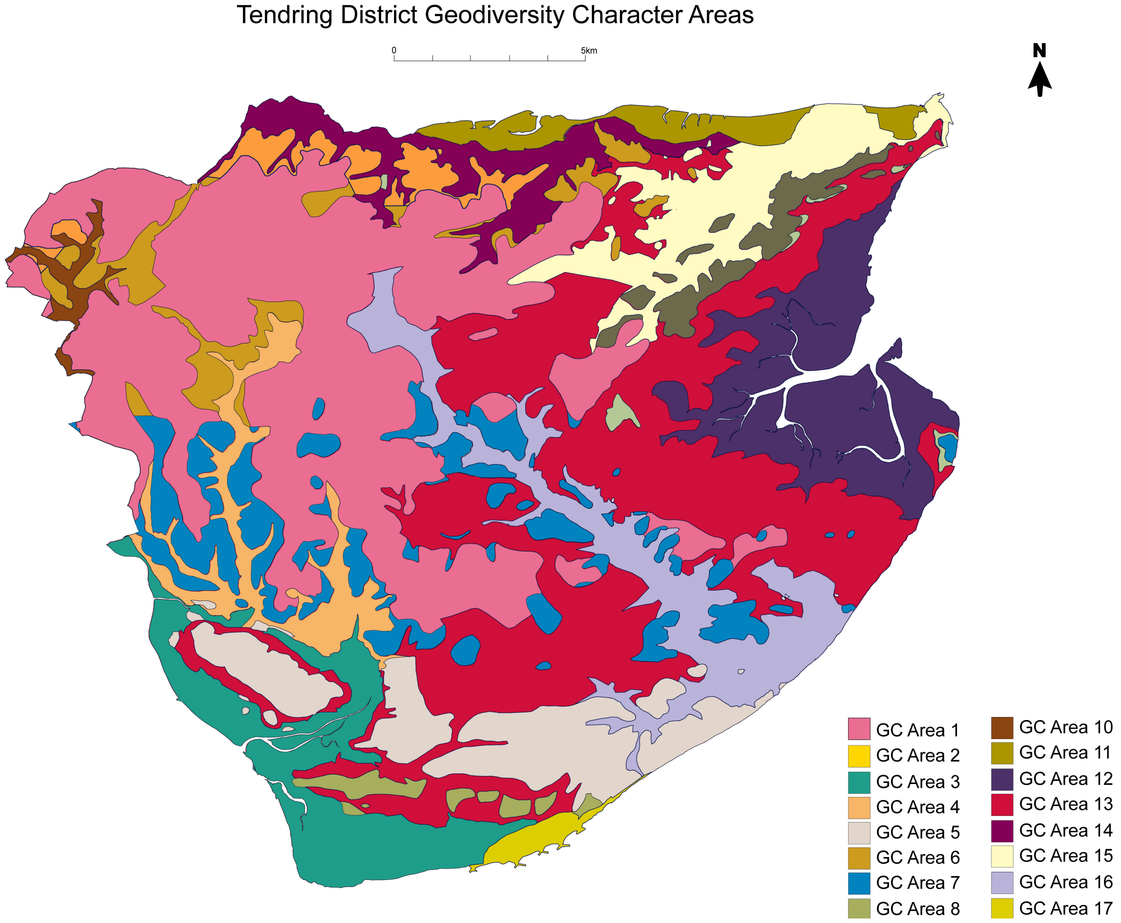


Fig. 19 Geodiversity Character Areas

Note: The GIS component of the project was based on the current (2008) BGS 1:50k Superficial and bedrock geology shapefiles which are polygons. **Geological mapping boundaries of soft sediments is inherently inaccurate, thus the boudaries shown herein must be regarded as strongly indicative rather than definitive.**

3.1 Geodiversity Character Area Descriptions

GCA 1 Tendring Plateau

Summary

This area comprises the Tendring Plateau which covers much of the north-west portion of the Tendring Peninsula (Fig.19). The plateau is flat or gently undulating and dissected by a number of stream valleys. The area is largely covered by brickearth deposits which cover gravels that were deposited by ancient courses of the River Thames and River Medway. The brickearth gives rise to rich and fertile soils which have been exploited for agriculture since the earliest prehistoric agrarian communities.

Geology

The bedrock of this area, as with the rest of Tendring District, is London Clay; mud laid down on the floor of a sub-tropical sea some 50 million years ago. The London Clay contains fossilised plants and wood and nodules of calcium phosphate (cement stones) in layers, which contain fossil bones of mammals, birds, sharks and other animals.

After the Anglian glaciation the River Thames, which had previously flowed across the district, was diverted to its modern channel leaving a series of terraces, the Kesgrave Sands and Gravels, exposed (principally the Ardleigh and Wivenhoe Gravel Members). The next major sedimentary event was the deposition of brickearth, which blankets the area, resting indiscriminately across the surfaces of all the ‘Kesgrave’ terraces. The brickearth was probably laid down during a number of phases of wind-borne (aeolian) deposition. The brickearth deposits on the plateau are thought to have been derived from sediments washed out from the retreating glaciers (glacial outwash) during the Devensian glacial stage (15-20,000 years BP). As the glaciers ‘locked up’ much of the available water, sea level dropped and areas of the North Sea, where these sediments had been deposited, were subsequently exposed to sub-aerial weathering processes. The basal element of the brickearth through most of the District is a thin, fine sand. Its grain size and widespread distribution indicates an aeolian origin (coversand). Resting on top of the fine coversand is a predominantly silty deposit (loess). The deposit is usually less than 0.75 m thick but reaches over 1.0 m in depth at Walton. Frost action is responsible for small stones within the brickearth being worked upwards from the Kesgrave Gravels below. In some areas, such as at Mistley and Wrabness, there is evidence for brickearth sediments that must have been deposited during earlier cold-climate episodes (pre-Devensian) and have subsequently been reworked under temperate-climate phases (interglacials). The deposits at Wrabness contain faunal remains that have dated them to MIS 7 temperate stage, which dates to c.200,000 years BP. These fossil brickearth deposits may not all be of the same age and may be more extensive than those presently identified.

Soil

The brickearth is the basis of the rich agricultural land of Tendring District giving rise to the Tendring and Wix Soil Series, which are coterminous with the brickearth across the area and are the most extensive soil types in the District. The soils are generally sandy silt loams and sandy loam topsoils, usually deep and stoneless and drain reasonably well, although they can also contain sufficient water to avoid drought in most years. The plateau is classified as Grade 1 or Grade 2 Agricultural Land due to its soils richness and fertility.

The Wix Soil Series are characterised by deep loams, often formed on gravels and so have a coarse, often flinty component which makes them permeable. They are fairly resistant to erosion by water. Their main land use includes cereals and other arable crops. Market gardening became important in the 1930-1940s but went into decline in the 1950-60s. Recently extensive vegetable production has increased. Both fruit and vegetable production tend to be located on the sandy silt loams of the Tendring Series.

Topography/Geomorphology

The surface of the plateau is flat or gently undulating. The plateau includes the highest parts of the District ranging between 40 mOD in the north-west corner of the area and 20 mOD, declining in height towards the south-east. In the north, the plateau marks the watershed between drainage northwards into the River Stour and south-east into the Colne and Greater Thames Estuary. The Plateau has been dissected by a number of small streams which have formed pronounced valleys, including the Bentley, Sixpenny and Tenpenny Brooks (GCA 4) which drain into the Colne and the Holland Brook (GCA 16), which discharge into the North Sea.

Human exploitation

Cropmark features provide evidence for past agricultural land use in the area, excavation of features near Ardleigh reveals this land use to date back to prehistoric times. The agriculture of the plateau is largely based on intensive arable and horticultural cropping with relatively little livestock. This pattern of farming arises partly as a response to the level terrain and soil type and partly to geographical location. The brickearth has been a source of raw material in the making of bricks and tiles since Roman times but became industrialised in the post medieval period. Surprisingly only four historic brickworks were located within the mapped area of brickearth, with other brickworks utilising the London Clay and exploiting the proximity to transport links nearer the coast. There has been extensive quarrying into the adjacent gravels at the extent of the brickearth in the past and new quarries are proposed within the extent of the mapped brickearth for the extraction of the underlying gravels in the areas around Ardleigh, Thorrington, Great Bentley, Little Bentley and Frating.

GCA 2 Oakley Ridge

Summary

The Oakley Ridge is made up of London Clay and Red Crag overlain by Oakley Gravel, the second highest of the Kesgrave Group which represents the course of the pre-Anglian Thames river. Incised into the Red Crag of the Oakley Ridge are exposures of deposits dating from the Cromerian period including the Little Oakley Channel deposits. A quantity of Palaeolithic implements and Pleistocene fauna has been recovered and there is the potential for further discoveries. The Little Oakley Channel deposits have statutory protection as a geological SSSI. The stratigraphy of these sediments is of regional and national significance to Quaternary studies.

Geology

The ridge is underlain by London Clay with patches of Red Crag exposed on the southwest facing slopes. The fine-grained sediments of the London Clay represent the accumulation of mud on a subtropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Red Crag is composed of sediments and shells deposited in the near-shore environments of the Red Crag sea, which existed over Essex about two million years ago. At the base of the Crag, phosphatic nodules form a layer or bed; this deposit contains fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells.

The sediments that form the flat top of the ridge are Oakley Gravels, part of the Kesgrave Sands and Gravels, which represent the bed of a former course of the Thames when it flowed across Essex towards Suffolk. The coarse-grained deposits are composed of sands and gravels deposited under cold-climate conditions. It is possible that the Medway River system was confluent with the Thames in this area around the time the Oakley Gravels were deposited. The Oakley Gravels are thought to be contemporary with the Ardleigh Gravels (GCA 6).

At Little Oakley a single channel cutting through the Oakley Gravels in a WSW-ENE direction has been located (GCZ 2.5). The fine-grained deposits within the channel represent a low energy depositional environment under temperate conditions. The sediments are highly fossiliferous, including pollen, molluscs, ostracods, mammals and fish within a deposit of fine sand with silt, clay and occasional pebbles. The deposit is up to 4 m’s in thickness and has been buried by up to 3 m’s of colluvium. The sediments are thought to be the only recognised deposits representing an interglacial period during the Cromerian period from around 550,000-600,000 years. A small exposure of the Little Oakley Channel deposits survives.

Soil

At the southern end of the ridge are soils of the Tendring and Oakley Soil Series. The Tendring Soil Series is characterised by deep often stoneless coarse loamy soils formed over aeolian and glaciofluvial drift and finer loams over clayey soils. It can be prone to some seasonal waterlogging. Towards the northern end of the ridge are soils which form part of the Wix Soil Series. They belong to the argillic brown earths group and are characterised by deep permeable coarse loamy soils affected by groundwater often formed over gravels and London Clay. They exhibit a slight risk of water erosion. The Windsor Soil Series (stagnogley soils) are generally seasonally wet deep soils formed over London Clay. The soils are slowly permeable mostly with brown subsoils, however on slopes they tend to have only slight seasonal waterlogging. The distribution of the Tendring and Wix soils correlates with the higher-grade agricultural landscape.

Topography/Geomorphology

The Oakley Gravels represent those sediments deposited upon the bed of the Thames River as it flowed north-eastwards towards Suffolk. The river is thought to have been at least 5 km wide at the time the gravels were deposited. The majority of the surviving deposits lie upon the Oakley Ridge between 20 m – 30 mOD and falling to c.15 mOD towards the coast at Harwich. The Oakley Ridge forms a distinct flat topped ridge running northeast-southwest between the Stour Estuary and Hamford Water. The northeast facing slopes are steeper than the southwest facing slopes and form the sides of the Ramsey Valley.

Human Exploitation

The area has been subject to historic ridge-top settlement and is largely urban in nature at its northeast end. At the southern end lies Great Oakley village with scattered settlement and farms along the main road (B1414) north to Little Oakley and Dovercourt. The open landscape of the ridge is largely agricultural with large scale arable fields divided by intermittent hedgerows and ditches. The smaller scale and irregular boundaries within field pattern around Great Oakley suggests a historic origin.

Quarrying has taken place within the area but not on a large scale. In the past the bed of phosphatic nodules at the base of the Red Crag was worked at Little Oakley for the manufacture of phosphate fertiliser. A small quarry operated from Gant's Pit, near Pound Farm, is believed to have produced the largest known collection of handaxes and mammalian remains, including beaver, rhino, fallow deer, red deer, ox and straight tusked elephants, in Essex. Recent investigation of the stratigraphy in the vicinity of Gant's Pit has led to the recovery of Palaeolithic flints within the gravel sediments. The gravel is post-Anglian in age.

GCA 3 Colne Estuary and Marsh, Brightlingsea and St Osyth marshes

Summary

This area covers the Colne Estuary and marshes in the southwestern corner of the district. Much of the area is covered by SSSIs for both geological and ecological interest. Colne Point and St Osyth Marsh are of importance for a number of geomorphological features, including the sand-dunes and shingle ridges at Colne Point which form one of the few dune systems in Essex.

Geology

The bedrock of this area, as with the rest of Tendring District, is London Clay; mud laid down on the floor of a subtropical sea some 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rain forest vegetation brought/washed in by rivers.

The superficial geology of the area includes isolated patches of sands and gravels of uncertain age and origin, some assigned to the Kesgrave group, but is dominated by alluvium comprising sands, silt and clay and peat deposits which overlie the London Clay.

The Colne Estuary has a narrow intertidal zone predominantly composed of saline alluvial mud flats. The muds (clay) were deposited by the sea. Above mean high tide alluvial sediments are deposited. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarse-grained deposits reflecting periods of higher-energy such as storms. In sheltered areas the alluvial deposits can build up over time and the exposed surface allows the colonisation of plants and formation of saltmarsh. Subsequent flood events or sea-level rise cover the vegetation with muds and the buried vegetation eventually breaks down to a peat deposit. A seam of peat has been dated at St Osyth to around 4,300 years BP. Along the exposed areas of coast coarse-grained alluvial sediments are deposited due to higher wave energy. From St Osyth a narrow beach composed of sand and gravel (shingle) extends westwards from St Osyth to Colne Point. Sandy mudflats border the beach above low mean tide level.

Soil

Much of the area is within or just above the intertidal zone and so the soils are flooded by high tides. The saline soils are of variable texture, many soft and unripened, whereas on higher sites they can be sandy, firm and ripened, often calcareous. In places where the saltmarsh has been reclaimed or is now beyond the influence of the sea, soils develop on the marine alluvium. The Wallasea Soil Series are seasonally wet deep clay soils. They are characterised by deep stoneless, non-calcareous and calcareous, clayey soils. Soils locally have humus or peaty surface horizons and there is some risk of flooding.

Topography/Geomorphology

The area includes all coastal areas down to low tide that are mapped as alluvium. The area comprises saltmarsh, sandflats, mudflats, beaches, shingle spits and tidal creeks as well as the reclaimed and drained marsh landward of the sea wall. From St Osyth a narrow beach extends from St Osyth to Colne Point. During periods of higher wave energy the coarse-grained beach material is transported along the coast in the direction of the prevailing current (longshore drift). Over time the build up of the coarse-grained sediment forms a ridge. At Colne Point sand-dunes which top the shingle ridge form one of the few dune systems in Essex. The finer grained sediments are transported further along the ridge towards the distal end to form a small, narrow barrier spit. At Colne Point the spit shows a historical pattern of extension and shortening as well as destruction and reworking of the landward end of two older beach ridges. In the lee of the spit saltmarsh has developed. The estuary and marsh are typically low-lying (usually lower than 5 mOD), flat landscapes that surround the coast along the River Colne, Brightlingsea Reach and Alresford Creek. St Osyth marsh is an important site for saltmarsh morphology, and is one of a few marsh areas in Britain to have been dated, the maximum age being 4280+/- 45 years BP.

Human Exploitation

The coastal areas have been an important resource since prehistoric times. The saltmarshes were used for grazing sheep from at least the Bronze Age. The area has a history of industrial activity from the Iron Age period onwards. The remains of salterns (red hills) provide an indication of the tidal limits in the past as they were used for the processing of salt and positioned on the edge of the tidal zone with easy access to saltwater. In Brightlingsea, copperas was manufactured as early as 1542. The copperas industry involved gathering of pyrite nodules (known as ‘copperas stones’) from beaches, where they had been washed out of the London Clay. They were converted to ferrous sulphate (green vitriol) which was an essential chemical for making dyes, ink, and several industrial chemicals. The presence of a number of brickworks within the zone is more likely to be related to transportation rather than a resource of raw material. The creeks and inlets have been subject to alteration in places in order to make them more navigable and wharfs and quays built. Trade and transportation would have been vital to the local economy. Reclamation of the salt marsh took place from at least the medieval period and the rural coastline is now protected by sea walls and much of the landward marshland drained for arable use.

GCA 4 Alresford Valley System

Summary

The Alresford valley consists of a series of relatively steep-sided river valleys, flowing southwards into the Colne (Fig.19).

Geology

The geology of the area is London Clay with some gravels and alluvium. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The London Clay slopes have been exposed through erosion removing the overlying Pleistocene gravels and brickearth which survives in places at the head of the valleys.

Within the Tenpenny Brook are discrete patches of freshwater alluvium, fine grained silty deposits which were laid down during periods of flood within the Holocene period

Soil

The former gravel and brickearth deposits upon the now exposed London Clay slopes gives rise to a range of soils, from clayey soils to deep permeable sandy and loamy soils providing some good quality agricultural land. Much of the valley slopes of the area is mapped as the Wix soil series. The Wix Soil Series are characterised by deep, often sandy or sandy silt loams. Where they are formed on gravelly lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. There is meadow and unimproved grassland in less well drained areas of the valleys. Much of the land is used for pasture with arable land on the shallower slopes.

Topography/Geomorphology

The Sixpenny, Tenpenny and Bentley Brooks are small, fast-flowing streams, forming part of the Colne catchment. The valleys run north to south and are asymmetrical with steeper west-facing slopes. The Sixpenny Brook crosses the regional slope whereas the Tenpenny and Bentley turn back on themselves to join the Colne. The main brooks are generally less than 8 km in length with shorter brooks and tributaries feeding into them throughout the catchment. Towards the south the valley slopes become less steep as they enter the Alresford and Thorrington Creeks. Parts of the valley are wooded.

Human Exploitation

Historically the settlement in the area was sparse with cottages and isolated farms. More recently there has been some ribbon development on the edge of villages. There has been some quarrying in the past, such as at Alresford Lodge Pits. The grasslands are used for pasture and the higher grade agricultural land found on the shallower slopes is used for arable.

GCA 5 St Osyth & Holland Gravels

Summary

The St Osyth and Holland Gravels belong to the fourth highest of the four Kesgrave Formations on the Tendring Plateau. These gravels are contemporaneous and cross the southern part of the District trending west-east towards the south-east coast. The St Osyth Gravels were deposited by an earlier course of the Thames while the Holland Gravels were laid downstream of the Thames/Medway confluence. The stratigraphy of the gravels reveal just how rapidly the Thames ceased to flow through central Essex as a result of being blocked upstream in Hertfordshire by the Anglian ice sheet around 450,000 years ago.

Geology

The gravels are underlain by London Clay, and in places cut through older gravels laid down by the Thames. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The superficial geology in the western band of gravels is sand and gravel belonging to the St Osyth Gravels. The gravels have two distinct lithological suites relating to depositional events immediately prior to and during the glaciation of the Thames Valley. The Lower St Osyth gravels have the same source and input of earlier Thames gravels (fluvial), however the Upper St Osyth Gravels are finer-grained and more (geographically) extensive in their suite of gravels reflecting an input of glacially (glaciofluvial) derived material.

Similarly towards the east, the 'Lower Holland Gravel' is the final terrace aggradation by the confluent Thames-Medway River before the glacial blocking while the overlying 'Upper Holland Gravel' is largely a Medway deposit with a proportion of glacial outwash material due to the Thames being blocked by ice and not reaching this lower part of its valley.

The stratigraphy of the gravels was visible at St Osyth Pit and Holland-on-Sea cliffs and they are protected as SSSIs.

Soil

The soils developed upon the gravels are of the Wix Soil Series according to the NATMAP soil data (1:250,000). These are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water.

Topography/Geomorphology

The gravels give rise to a fairly level or gently sloping landscape of well-drained open arable fields and small wooded areas. The Holland Gravel deposits are located generally below heights of 15 mOD in a wide band across the lower central part of the District running west-east and widening in distribution at the coast. The confluent river systems would have formed a channel c.4-5 km wide. The St Osyth Gravels survive at heights of around 10m -20 mOD across the ‘island’ of Brightlingsea and down the relatively gentle slopes and to the east of Brightlingsea on the southwest facing slopes near St Osyth. The distribution of the gravels indicates a river system with a more restricted channel c.2-3 km wide representing a significant change in the dynamics of the system.

Human Exploitation

The elevated position of the gravels has proved popular for settlement and the area includes the large urban development of Clacton and its suburbs as well as the historic settlements at Brightlingsea and St Osyth. Much of the area has residential settlement and associated industries and transport routes.

The gravels are considered to be of low potential for artefacts/faunal remains. (Wenban-Smith, 2007). However re-evaluation of existing collections reveal flints that are typologically similar to recently discovered pre-Anglian flint tools, which may have come from the Lower Holland Gravel (Wenban-Smith, 2007). The area contains two recorded historic brickworks and placename evidence for another. A large proportion of the area has been quarried and there are mineral applications for further extraction. The remaining undeveloped areas are largely used for agricultural purposes.

GCA 6 Ardleigh Gravels

Summary

The Ardleigh Gravels belong to the second highest of the four Kesgrave Formations on the Tendring Plateau (Fig.19). They are thought to be contemporary with the Oakley Gravels (GCA 2). The band of sands and gravels located in the north of the District was deposited by the pre-diverted Thames c.550,000 years ago, when it flowed across the north of the district. The stratigraphic sequence is interbedded with significant interglacial deposits and a buried soil. Where the Ardleigh Gravels are overlain by brickearth they form part of GCA 1.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface sediments that form the flat topped ridge are Ardleigh Gravels, part of the Kesgrave Sands and Gravels which represent the bed of the former course of the Thames when it flowed across Essex. The gravels were deposited under cold climate conditions and indicate a high energy fluvial system. At Martells Quarry the gravels are interbedded with various organic sediments, some of which are indicative of interglacial conditions and comprise more than one climatic cycle.

The coarse-grained sand and gravels of the Ardleigh Lower Gravel are up to 2 m in thickness. The gravel is overlain by sand and beds of grey clay (c.0.5 m thick) containing plant fossils which were deposited by a river under lower energy and warm climatic conditions. Pollen from the organic horizons indicates the interglacial deposits represent an early Cromerian interglacial deposit. The Upper Ardleigh Gravel overlies the organic horizon and is up to 5m in thickness and composed of coarse grained sands and gravels. Within the Upper Ardleigh Gravel is a clay bed ranging from 0.1 to 1.0 m in thickness, containing rare fossils of plants that existed during a period of cold climate (arctic). The topmost Ardleigh Gravels are enriched by a red clay deposit and are deformed. The horizon is considered to be a palaeosol, initially formed during a warm period (temperate stage), known as the Valley Farm Soil, and continuing to develop as conditions became cooler, known as the Barham Soil. Higher energy cold-climate conditions follow with the deposition of coarse-grained sediments of sand and gravel known as Martells Gravel. Up to 3.0 m of gravel was deposited during this stage.

Soil

The gravels tend to be associated with soils of the Bradfield Series but also overlap with the brickearth plateau and so include soils of the Tendring Soil Series. On slopes soils of the Wix Soil Series occur. The Wix soil series are characterised by deep sandy or sandy silt loams. Where they are formed on gravely lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The Tendring Soil Series are characterised by usually deep and stoneless loams and drain reasonably well, although it can also contain sufficient water to avoid drought in most years. These are typical soils of the plateau landscape and are high grade agricultural soils.

Topography/Geomorphology

The sediments were laid down by the Thames which is thought to have been at least 5 km wide at this time. It flowed towards the northeast and would have been confluent with the Medway, which deposited the Oakley Gravels, further east in the Oakley-Harwich area.

The sediments survive as discrete patches across a large area in the northwest and north of the District from Ardleigh towards the Oakley Ridge. The deposits flank the Ardleigh, Alresford, Ramsey and Stour Valley river systems at the head of the valleys upon the high valley slopes (c.30 m-35 mOD). Much of the area they cover is rural and partly wooded.

Human Exploitation

Limited development has occurred upon the gravel patches as their location upon the upper valley slopes would not have been preferable for settlement. Small linear settlements are found near Ardleigh, and part of the built up residential area of Ardleigh lies within the zone. Further east lies the village of Wrabness. A high proportion of the land has been quarried, also quarries within the mapped brickearth deposits reveal sand and gravels below the brickearth that are likely to be the Ardleigh gravels around the Elmstead Market and Ardleigh area.

GCA 7 Wivenhoe Gravels & Cooks Green Gravels

Summary

The Wivenhoe and Cooks Green Gravels belong to the third highest of the four Kesgrave Formations on the Tendring Plateau. The band of gravels were deposited by an earlier course of the Thames as it flowed north-eastwards across Tendring around 500,000 years ago, and represent the Thames and Thames/Medway channels respectively.

The Wivenhoe Gravels were laid down by the Thames system in the western and central areas of Tendring, under cold climate conditions. At the type-site of Wivenhoe (Colchester District) the gravels are divided by an organic silty clay that was laid down under a temperate climate (interglacial) and soils have developed upon the upper gravels which represent a further temperate stage followed by periglacial conditions (Valley Farm-Barham Soil complex). The Cooks Green Gravels were deposited by the combined Thames-Medway system beyond the confluence of the two.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warmth-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The superficial geology includes the sand and gravel deposits belonging to the Cooks Green Gravel which were deposited under cold climate conditions and includes material brought to the area from both the Thames and Medway rivers combined. The Cooks Green Gravels are visible in the cliffs at Walton where they are represented as a single gravel body. They are contemporary with the Wivenhoe Gravels which are sand and gravel deposits laid down by the Thames channel upstream of the confluence with the Medway. Investigations of the Wivenhoe Gravels at the type-site in Wivenhoe have provided information on the stratigraphy of the deposit. The Wivenhoe Gravel has two gravel bodies separated by a temperate stage deposit (interglacial/interstadial). The Lower Gravel and Upper Gravel were deposited under cold climate conditions and contain frost cracks and ice wedges indicative of periglacial conditions. At the type-site the Lower Gravels are up to *c*. 5.0m in thickness and consist of medium to coarse sandy gravel interbedded with sand. The Upper Gravels are up to 1.5m in depth and consist of bedded sand and gravel. These are separated by silty clay organic sediment with pollen, plant and beetle remains, deposited within the Cromerian Complex (pre-Anglian). This deposit is recorded with occasional pebbles and is *c.* 1.0 m thick. At the top of the Upper Gravels are possible relict features of the Valley Farm-Barham soil. This deposit of silty organic clay is up to *c.* 1.5 m thick and has been deformed by later cold-climate processes. The development of soils indicates that the river channel had migrated allowing a land surface to form and be subjected to weathering processes. The Valley Farm Soil developed under temperate climate conditions and has the Barham Soil superimposed upon it reflecting a change to periglacial conditions.

Soil

Generally the Oakley Soil Series tends to form on the Kesgrave Gravels while the Wix soil series forms upon the slopes. The Wix Soil Series are characterised by deep sandy or sandy silt loams. However, where they are formed on gravely lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. Along the southern valley the soils are classified as Tendring on the 1:250,000 map but Oakley on the Weeley 1:10000 soil sheet. Both are classified as sandy or sandy silt loams with Weeley soils generally forming on coarser grained lithologies and having higher stone contents. Towards the coast upon the lower valley slopes are soils of the Windsor Soil Series. The Windsor Soil Series are characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland.

Topography/Geomorphology

At the time the gravels were deposited the Thames River would have been at least 5 km wide, while towards the eastern coast the confluent river would have been *c.*7-8 km wide flowing west to east.

The Cooks Green Gravels survive in the southeast of the District and largely along the Holland Brook Valley. They lie at around *c*.20 mOD on the northern side of the brook and *c.*25 mOD on the southern side. The gravels survive as discrete patches upon the gentle upper slopes of the valley.

The Wivenhoe Gravels flank the higher valley slopes of the Alresford Valley system and headwaters of the Weeley, Holland and Tendring Brooks, from around 20 m to *c.*35 mOD. The high valley slopes are relatively undeveloped and largely rural in character with open fields and scattered woodland. In the west the gravels lie adjacent to the Tendring plateau and in the east the London Clay plain.

Human Exploitation

Bridgland (1994) records two flint flakes recovered from the Wivenhoe Gravels at the type-site at Wivenhoe pit. This would indicate occupation by humans *c.*500,000 years ago, pre-dating the Anglian glaciation. Recent discoveries in Suffolk have revealed that there was human presence in East Anglia before the Anglian glacial stage. There has been some historic development in the area, utilising the higher, permeable ground formed by the gravel deposits for road systems, linear settlements and prominent buildings such as churches and manorial halls. Much of the zone is rural with open field systems and farmsteads. Cropmarks over the area indicate historical field systems. The gravel areas have been subjected to extensive quarrying for sand and gravel, both recently and historically, significantly in the Elmstead Market, Alresford and Thorrington areas. There are still 5 active quarries within the area and 9 applications to extend existing quarries. A small number of historic brickworks were located within the area at Weeley and Thorrington.

GCA 8 Wigborough/ Mersea Island Gravels

Summary

These gravels were deposited by the post-diverted Thames-Medway system as part of the East Essex Gravels, following blockage of the headwaters of the Thames channel during the Anglian glaciation (Fig. 19). The Wigborough Gravel is the equivalent of the Mersea Gravels, seen at the SSSI at Cudmore Grove on Mersea Island. The Wigborough Gravel was visible in the cliffs above the Clacton Channel deposis at West Cliff, Clacton. The gravels overlie interglacial deposits dated to the Hoxnian interglacial deposits.

Geology

The bedrock of the area is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The sand and gravels belong to the Wigborough and Mersea Island Gravel, members of the East Essex Gravel, which represent the sediments laid down by the post-Anglian diverted Thames River within the Tendring District. At Cudmore Grove, the Mersea Island Gravels are exposed in the cliffs up to 4 km thick. They are composed of sands and gravels which display a variety of bedding structures and contain a clast (stone) content which precludes those typical of northern provenance. The gravels overlie organic sediments dated to the Hoxnian interglacial (MIS 11, *c.*400,000 years ago).

The Wigborough Gravels were deposited by the post-diversion Thames-Medway system following blockage upstream of the Thames channel during the Anglian glaciation. The Wigborough Gravels appear to be a continuation of the Mersea Gravels, laid down under cold climate conditions and possibly including a component of older Thames gravels reworked and introduced by the River Colne flowing from the Colchester area, occupying the former channel of the Thames. At West Cliff, Clacton the Wigborough Gravels overlie the Clacton Channel interglacial sediments dated to the Hoxnian (MIS 11, c.400,000 years ago).

Soil

Soils developed upon the gravels belong to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. Where they are formed on lithologies with a gravel component they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water.

Topography/Geomorphology

Together the gravels survive as a band along the southern fringe of the plateau running from Point Clear to Jaywick. The gravels form a low ridge running west-east across the south of the district at a height of *c.*10 mOD.

Human Exploitation

Part of the zone has been built upon with residential development at Point Clear and Jaywick. Elsewhere there is sparse settlement and the area is largely rural. The landscape is open with few trees or hedgerows and large open fields. There has been relatively little gravel extraction both historically and in recent times.

GCA 9 Waldringfield Gravel

Summary

The Waldringfield Gravels are the highest and oldest of the four Kesgrave Formations on the Tendring Plateau (Fig.19). The sands and gravels were deposited by the pre-diverted Thames, when it flowed across the north of the District around 625,000 years ago. The gravels are located upon the high valley slopes of the Stour Valley system and Ardleigh Valley system in the north and northwest.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Waldringfield Gravels are composed of sands and gravels deposited upon the bed of the pre-Anglian Thames River. There is no recorded input from the Medway River which would have been located further south. At Newney Green, Chelmsford, sands and gravel, possibly associated with the Waldringfield Gravels, are recorded in section as being up to 3.4 m thick. These are cross-stratified sands and gravels and indicate an eastwards flow. The coarse-grained gravels indicate deposition by a braided river under cold climate conditions and contain up to cobble size components some of which are of Welsh origin (Bridgland, 1994) revealing an extensive catchment area.

Soil

The soils developed upon the gravels upon the upper slopes are mapped as belonging to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. However where they are formed on lithologies with a gravel component they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. Their main land use includes cereals and other arable crops. Where the gravels are mapped as lying upon the Tendring plateau the soils belong to the Tendring Soil Series. The Tendring Soil Series are characterised by usually deep and stoneless loams and drain reasonably well, although it can also contain sufficient water to avoid drought in most years. These are typical soils of the plateau landscape and are high grade agricultural soils.

Topography/Geomorphology

The gravels lie at a surface height of c.40 mOD, running west-east along the coastal ridge and slopes in the north of the District adjacent to the Tendring plateau. The tributary valleys of the Stour are steep sided and wooded. The gravels give rise to acidic soils and thereby influence the landcover of the area with heathland developing in places. The landscape is relatively undeveloped and rural upon the higher valley slopes away from the coast.

Human Exploitation

Settlement has occurred closer to the coast at Lawford, Manningtree, Mistley and Bradfield. On the higher valley slopes the land is relatively undeveloped and sparsely settled. There are no known workings of this gravel, however a gravel pit is indicated on the historic maps on the edge of woodland in Mistley Park which was small scale and local and gravel extraction is planned at Wick Farm, north of the Ardleigh Reservoir.

GCA 10 Ardleigh Valley system

Summary

The Ardleigh Valley system is located in the northwest of the District and forms part of the catchment of the Colne to the south (Fig.19). The area covers the exposed London Clay slopes along the steep sided valleys. The reservoir at Ardleigh floods much of the northern part of the valley system.

Geology

The valley slopes have been eroded to expose the London Clay bedrock. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. In its unweathered state it is stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit.

Soil

The soils are mapped as belonging to the Wix Series. The Wix Soil Series are characterised by deep sandy or sandy silt loams. Where they are formed on lithologies with a gravel component they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes. The character of the soils may be influenced by the brickearth and gravels upon the adjacent plateau region. The vegetation indicates acidic soil conditions on the gravels.

Topography/Geomorphology

The steep sided London Clay slopes of the valley system fall from *c.*40 m -*c.*10 mOD. The Ardleigh reservoir has flooded two arms of the valley system. South of the dam the streams are fast-flowing and wooded in places, some of it ancient deciduous woodland. The Salary Brook retains a good proportion of the former wooded valley sides along its length.

Human Exploitation

Within the area settlement is sparse, largely confined to the high valley slopes . There are small fields of pasture and larger fields with irregular field boundaries suggesting a historic origin. Spring Valley Mill is a working water-mill along the Salary Brook. The reservoir dominates the area and has led to the creation of a large lake with two arms north of the dam. The reservoir is used for fishing. A small part of the area is covered by industrial units. The railway cuts across the valley on embankments and the A120 road crosses the area. There is evidence for small scale quarrying in the area with pressure for further gravel extraction.

GCA 11 Stour Estuary

Summary

The River Stour forms the Essex/Suffolk county boundary (Fig.19). It is a wide, open estuary of deep tidal waters with sandflats and mudflats emerging within the intertidal zone reaching up to the saltmarsh and low coastal cliffs. Within the cliffs and foreshore are exposures of Eocene deposits of geological significance. It is important for trade and shipping and industries relating to the resources found within the estuarine landscape.

Geology

In the foreshore areas and the low coastal cliffs between Harwich and Wrabness are exposures of the Harwich Formation and London Clay. The Harwich Formation contains layers of volcanic ash, fallout from active volcanoes in Scotland *c*.50 million years ago, forming a sequence of horizontally bedded calcareous siltstone. Over 30 separate ash layers occur throughout up to 10 m's of clay and silty clay. The Harwich Formation is superseded by the London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. The fossilisation of the plant material within the London Clay in concretions preserves a greater degree of detail for study. Faults in the London Clay record prehistoric earthquakes. In its unweathered state it is stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit.

Resting upon the London Clay are fine grained sediments deposited by the sea at high tide level within an estuarine environment. This marine alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser grained deposits reflecting periods of higher-energy such as storms. The deposits build up over time and when sea level drops salt-tolerant vegetation is able to establish and grow, creating saltmarshes. These sediments have been laid down during the Holocene and can provide a record of changing sea levels. In more sheltered areas coarser-grained sand deposits lie at the base of the low coastal cliffs forming a beach.

Soil

There has been some soil development in the area of saltmarsh growth near Ramsey and Parkeston. Upon the more mature saltmarsh these soils are of the Wallasea Soil Series. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have high groundwater table. Around Parkeston the soils developed upon the emergent saltmarsh are Saline. They are of variable texture depending upon the lithologies of the parent material. The soils can range from soft and unripened where they are subjected to regular flooding and fresh sediment input to firm and ripened on higher sites or on sandier parent materials. All variations are frequently calcareous. Small areas of saltmarsh along the coast have been mapped as having both Wix and Windsor soils developed upon them. These soils are not typical saltmarsh soils and are more likely to reflect the surrounding geology. The Wix Soil Series are characterised by deep sandy or sandy silt loams. They are fairly resistant to erosion by water. The Windsor Soil Series are characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally on valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland.

Topography/Geomorphology

The area lies between high and low tide, usually less than 5 mOD up to the low coastal cliffs. The landscape is largely intertidal mudflats, creeks, rills and open water. The shallow water bays include Jacques, Copperas and Bathside which encompass most of the intertidal flats. There are few areas of saltmarsh along the coastal edge and limited beach development.

Human Exploitation

The area is unsuitable for permanent settlement or infrastructure. The coastline has been subject to development due to the links with shipping, trade and industry, however this is largely concentrated at Harwich. It would have been an area rich in natural resources and utilised from prehistoric times. The London Clay has been utilised in the past in the copperas industry which extracted pyrite nodules for the chemical dye industry.

GCA12 Hamford Water

Summary

Hamford Water is a large and shallow embayment comprising tidal creeks, intertidal mudflats and sandflats, saltmarshes, islands, beaches and marsh grasslands.

Geology

The area is underlain by London Clay which outcrops within the basin as small islands. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine grained sediments deposited by the sea at high tide level within a sheltered estuarine environment. The sediments/marine alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser grained deposits reflecting periods of higher-energy such as storms. The deposits built up over time at the high tide limit allowing the colonisation of plants and formation of saltmarsh. As the saltmarsh develops the type of vegetation it can support increase and diversify.

Soil

The soils developed within the area belong to the Wallasea and Windsor Soil Series, reflecting the underlying geology. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high groundwater table. The Windsor Soil

Series is characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally on valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland.

Topography/Geomorphology

The morphology of the embayment is formed by a depression in the underlying London Clay and restricted landward by a ridge of rising ground. The large shallow basin is enclosed by gently shelving slopes and comprises tidal creeks, intertidal mud and sand flats, saltmarshes, islands, beaches and marsh grasslands. A shingle spit mark the seaward edge from Dovercourt to Crabknow Spit and from Walton to Stone Point. The mouth of the basin is constricted by the Naze, Horsey island, Foulton Hall Corner and Pye Sands. Part of the marshland has been drained by straight open ditches enclosed by the sea wall.

Human Exploitation

The zone would have been unsuitable for settlement, however the drainage of the marshes has allowed the expansion of urban areas and holiday camps into the former marshland area at Walton. The area has been utilised for industrial purposes since prehistoric times. A number of salterns lie along the inland fringes of the area, dating from the Iron Age/ Roman period onwards. Brickworks were situated on the edges of the zone, presumably to exploit transport routes, such as Beaumont Quay. The remains of jetties, quays and landing stages around the coastal edge are possibly also historic. Part of the saltmarsh is used for grazing as it would have been in the past, however the outer fringes of the marsh has been drained and the land improved.

GCA 13 London Clay plateau and coastal slopes around Hamford Water and Brightlingsea

Summary

The area includes the gently undulating London clay plateau across the central region of the District from Wrabness in the north to Clacton in the south and the low coastal slopes around Hamford Water and Brightlingsea. It includes two geological SSSIs at Harwich and the Naze. The diversity of fossils and form of preservation in these areas is of great significance for research.

Geology

The oldest bedrock exposed in the area are the sediments laid down in a sandy sub-tropical sea around 55 million years ago, the Eocene Harwich Formation. The Harwich Formation is notable as it preserves bands of ash derived from explosive volcanic eruptions in Scotland during this period. These ash bands have become cemented and contain veins of calcite (calcium carbonate). A prominent ash band, known as the Harwich Stone Band is exposed at Harwich. The Harwich Formation was superseded by the London Clay which represents the continuation of sedimentation within a marine environment. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. The diversity of fossils and form of preservation of these fossils in this area is of great significance for research. In its unweathered state it is a stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit. The clay can be up to 150 m deep in places.

There is a small area of Kesgrave Sand and Gravel deposits near Beaumont upon the plateau.

Around the edge of Hamford Water at the base of the London Clay slopes are unsorted coarser-grained sediments (head) which have been eroded from the adjacent hill and been transported downslope through weathering processes.

Soil

The dominant soil formed upon the plateau and slopes belongs to the Windsor Soil Series. The Windsor Soil Series are characterised by deep clayey soils mostly with brown subsoils. Their distribution therefore is generally valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. In the south of the area the soils formed upon the London Clay belong to the Wix Soil Series. The Wix Soil Series is characterised by deep sandy or sandy silt loams. Where the soils are formed on lithologies with a gravel component they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. In flatter areas particularly where the clay plateau lies adjacent to the brickearth plateau the soils belong to the Tendring Soil Series. The Tendring Soil Series is characterised by usually deep and stoneless loams which drain reasonably well, although they can also contain sufficient water to avoid drought in most years. These are typical soils of the plateau landscape and are high grade agricultural soils. The quality of agricultural land within the area is moderate to good (Grade 2/3).

Topography/Geomorphology

Much of the plateau is gently undulating and falls from below 30 m – *c*.5 mOD towards the coast. It flanks the Oakley Ridge in the north-east of the area, towards the coast south of Harwich. It is crossed by small streams and tributaries and is drained by the Holland Brook in the south. It is largely a rural landscape of improved large open fields but does contain some surviving ancient woodland including Weeleyhall Wood. Around the island of Brightlingsea the relatively gentle, low coastal slopes fall from *c*.20 m - c.5 mOD. Around the embayment of Hamford Water, the London Clay slopes represent a degraded cliff line and have moderately steep upper slopes.

Human Exploitation

Historically settlement of the inland area was of low density with scattered farmsteads and cottages, hamlets and small villages built up around greens or along roads. Towards the north this pattern has remained little affected by modern development.

The northern coastal areas were favourable areas for settlement and became more heavily developed from the Medieval period. Over time the historic settlements of Dovercourt and Harwich have expanded and amalgamated and much of the northern coastal region is developed and built upon. In the south the villages of St Osyth, Little Clacton, Weeley and Thorpe-le-Soken have all grown and the significant increase in residential development of the coastal towns at Clacton, Frinton and Walton has led to encroachment into the area. In addition residential amenities and activities associated with the urban fringe has led to an increase in parks, holiday parks and industrial areas. The A120 crosses part of the area in the north and the A133 crosses north of Clacton.

GCA14 Stour Valley system

Summary

The area includes the valleys and floodplains of the tributaries flowing from the south into the Stour River (Fig 19). Isolated patches of sands and gravels survive along the steep London Clay slopes. At the base of the slopes are head deposits bordering the marshland.

Geology

The London Clay slopes have become exposed due to weathering and erosion since the Anglian glacial period. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Discrete patches of terrace sand and gravels survive at the base of the slopes at the coast and within the floodplain formed at the head of the Estuary.

At the base of the slopes are unsorted deposits composed of clays, silts, sand and gravel (head) that are derived from sediments upslope and incorporated into a clay matrix derived from the London Clay slopes. These sediments have been transported downslope under the action of water falling as rain and slope runoff and are deposited at the base of the slope.

Soil

The soils developed upon the London Clay slopes and head deposits belong to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. The soils developed on the terrace gravels at the head of the Stour estuary are varied. Much of the area is covered by soils of the Ludford Soil Association with soils of both the Fladbury and Wallasea Soil Series at the western and eastern extremes reflecting an input from freshwater and marine fluvial systems respectively. The Ludford Soil Association are characterised by deep loams, often formed over glacial deposits and can be fine, coarse and sandy soils. Where they are developed upon gravels they can have a stony component locally. They are often well drained with a slight risk of soil erosion. The Fladbury Soil Series are deep stoneless silty clay loams or clayey soils formed on freshwater alluvial sediments. They are often calcareous. The soils are difficult to work and prone to waterlogging in flat areas such as floodplain environments. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have high groundwater table.

Topography/Geomorphology

The Stour Valley system includes the Shir Burn, Wignall Brook and brooks east and west of Bradfield and between Manningtree and Mistley as well as the smaller tributaries feeding into these larger streams and the River Stour. The streams flow northwards to the Stour, and are relatively short in length (less than 5 km long). In the west the streams flow down to a floodplain of the River Stour upstream of the estuary. The steeper slopes are often wooded with many tributary valleys feeding into the main system. The shallower valley sides are utilised for arable and pasture. Reservoirs have been constructed along some of the streams and the river channels have been modified in places. The coastal slopes are gentler and include the Stour and Copperas Wood SSSI, Mistley Place Park and Lawford Park.

Human Exploitation

The area is largely rural with scattered farms and cottages. Settlement is concentrated towards the coast to take advantage of trade and transport links. The historic port at Manningtree allowed the growth of the Medieval market town and Mistley was built in the 19th century with a quay, wharves, warehouses and a stream-mill. Part of the area has been encroached upon by the extension of the modern built-up settlement at Manningtree. The railway line crosses the zone along the coastal edge and has led to the development of small industrial areas. The London Clay has been extracted historically for the production of bricks. The lower lying areas have been drained and brought into agricultural use.

GCA 15 Ramsey Valley system

Summary

The area covers the Ramsey Creek valley system and alluvial floodplain including the drained marshes at Parkeston and Harwich town (Fig.19).

Geology

In the cliffs and foreshore at Harwich part of the succession from the Harwich Formation to London Clay is exposed (GCA 13). London Clay is exposed upon the slopes of the valley and lies below the alluvium within the floodplain. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Patches of sand and gravel lie within the system, largely on the northern side of the valley mapped as Kesgrave Formation and Lowestoft Formation. These coarse-grained deposits reflect deposition within a high energy fluvial environment and suggest mixing of sediments deposited within two separate periods and environments. They lie within an area between known Ardleigh Gravels (GCA 6) and Oakley Gravels (GCA 2), the second highest of the four Kesgrave Formations on the Tendring Plateau and may be associated with them.

Patches of freshwater alluvium survive within and at the confluences of the tributary valley and Ramsey Creek. Within the floodplain freshwater and marine alluvium has been deposited and marshland formed.

Soil

The soils formed within the valley system reflect the topography and drainage.
The Windsor Soil Series is developed upon the London Clay along the steeper valley slopes. These are characterised by deep clayey soils mostly with brown subsoils. Their distribution therefore is generally valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. In the lower reaches and floodplain areas soils of the Wallasea Soil Series develop. These are characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. Due to the parent material the soils often have organic surface horizons. They suffer from seasonal waterlogging and have high groundwater table.

Topography/Geomorphology

The Ramsey Creek is steep sided and wooded in the upper reaches with relatively shallow lower valley slopes towards the coast. Many of the tributaries on the west side of the Ramsey Creek have shallow sloping valley sides, c.30 m -5 mOD, with large, broad open catchments covering a large area compared to the narrow catchments on the east side. Issues and springs arise along the eastern valley sides. Bordering the river are pasture fields and paddocks. The Ramsey Creek becomes a gently meandering river as it reaches the flat alluvial floodplain. In the lower reaches of the floodplain fields have been drained by ditches and an arable landscape created. A small hill, from 10 m -*c.*5mOD, within the floodplain is formed by a capping of gravels upon the London Clay. The river has been altered within the floodplain.

Human Exploitation

Over much of the higher reaches of the valley system settlement is scarce with scattered farmsteads. The less steep northern valley slopes attracted linear settlements at Wix and Ramsey. The marshes would not have been suitable for settlement or development before they were drained and settlement at the coast has been concentrated at Harwich since the Medieval period. Harwich was a successful Medieval port and town that expanded with the coming of the railway and has since expanded to amalgamate with nearby Upper Dovercourt and Oakley Cross. The area was important in its natural resources and location for industry, and contains a number of brickworks, some dating from the mid 19th century, and the Harwich cement works. The manufacture of 'Roman cement' from the local 'cement stone' nodules from the Harwich cliffs was a very important local industry in the first half of the 19th century. The cement stones were recovered from the foreshore and by dredging from the sea bed. The marshes were drained for the purposes of construction of the railway and related industrial activity in the 19th century. This has led to much of the area being used for industry.

GCA 16 Holland Brook valley

Summary

The area covers the steep sided valley slopes of the Holland Brook, the alluvial floodplain and Holland Haven marshes (Fig.19).

Geology

London Clay is exposed along the slopes of the Holland Brook. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

On the valley floor the alluvial sediments were deposited by floodwaters within the floodplain of the Brook. The alluvium has been recorded and consists of stoneless grey silty alluvium over thin sandy gravel. These deposits reach up to c.1.2 m in the upper reaches of the valley and at least 1.8 m downstream. Both freshwater and estuarine alluvium is present within the floodplain at the coast.

Soil

Upon the slopes soils of both the Wix and Windsor Soil Series occur. The Wix Soil Series is characterised by deep sandy or sandy silt loams. Where the soils are formed on gravely lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. Around the Holland Brook, these soils display patterning mostly on the Tendring Soil Series which are relict features formed during the Devensian glacial stage. The Windsor Soil Series are characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally on the valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. Within the floodplain soils of the Fladbury Soil Series have developed upon the alluvium. The Fladbury Soil Series are deep stoneless silty clay loams or clayey soils formed on freshwater alluvial sediments. They are often calcareous. The soils are difficult to work and prone to waterlogging in flat areas such as floodplain environments. At the coast soils of the Wallasea Soil Series have developed upon the estuarine alluvium. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high groundwater table. The quality of agricultural land is low and soils become less workable towards the floodplain. Along the valley the landscape is largely pastoral with areas of mixed woodland, some of it ancient upon the steeper slopes and wetter areas.

Topography/Geomorphology

The Holland Brook valley system includes the Holland Brook and tributaries including Tendring Brook, Weeley Brook and Pickers Ditch. The Holland Brook is the largest stream (*c*.16 km long) in the District and divides much of the area diagonally. The Brook flows northwest-southeast into the sea at Holland Haven. Its valley is asymmetric with steeper south-western slopes falling from 25 m -5mOD. There are dry valleys on some of the steeper slopes giving rise to a gently undulating lowland landscape. The tributaries and valley is relatively constrained until it reaches down valley and towards the coast where it opens out. The narrow floodplains along the valley floor are flat and flanked by shallow slopes. At the bottom of the valley towards the coast the floodplain opens out within a marshland landscape and the river meanders widely.

Human Exploitation

Much of the area would have been unsuitable for settlement or development. Scattered farms and cottages are located upon the more shallow slopes at the head of the valley and tributary valleys along the system. Isolated cottages and small hamlets are located at or close to river crossing points. Towards the coast the small village of Great Clacton has been amalgamated within the residential development of Clacton. The London Clay upon the valley slopes was extracted for brickmaking. The remains of a kiln from a late 19th century brickworks (HER 15468) survive above ground close to Thorpe-le-Soken railway station. Towards the coast prominent buildings have utilised the septarian nodules, or ‘septaria’ from the London Clay, such as the church of St. John the Baptist at Great Clacton. The floodplain has been subjected to drainage and improvement.

GCA 17 Clacton Channel deposits along the coast between Jaywick and Clacton

Summary

The area covers a complex of channel deposits associated with the Thames-Medway system found inland and in the cliffs at Clacton, West Cliff, and the foreshore at Jaywick. The area covers three separate areas which make up the Clacton Cliffs SSSI. Within the channel deposits are highly fossiliferous interglacial sediments which have yielded Palaeolithic flint artefacts and become the type-site for the Clactonian industry.

Geology

London Clay outcrops within the area. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Exposures within the cliffs and investigations inland have revealed a stratigraphic sequence which shows finegrained freshwater and estuarine sediments occupying a channel cut into the Lower Holland Gravel and the underlying Tertiary London Clay. They have yielded abundant molluscan and mammalian fossil remains, fossil plants and pollen, most of which indicate a Hoxnian interglacial age (MIS 11) 425,000-380,000 years BP. Channel IV at Jaywick is currently thought to be infilled with sediments of Ipswichian (MIS 5e) age, c.120,000 year old. The stratigraphic sequence within the cliffs is varied (Bridgland 1994). The Holland Gravels were laid down by the combined Thames-Medway Rivers under cold climate conditions. The Lower Holland Gravel is the final terrace aggradation before the Thames diversion due to blockage of the channel upstream by the Anglian icesheet. The basal channel deposits consist of up to 7 m of clayey gravel and sand known as the Lower Freshwater Beds. Above this the sediments become finer grained with up to 4 m of loamy sands with clays (Upper Freshwater Beds). A change in the tidal influence is reflected with the deposition of the Clacton Estuarine Beds which are composed of up to 5 m of sand with shells and clays over laminated clay. The channel deposits were deposited under temperate condition within a lower energy environment. A deterioration of climatic conditions and significant change to a higher energy fluvial system is reflected by the deposition of the Wigborough Gravels which cover the channel deposits with up to 2 m of bedded sands and gravels. The Wigborough Gravel was deposited by the diverted post-Anglian Thames-Medway River, though possibly the gravel may be associated with the Colne.

A thin strip of blown sand is mapped as being exposed behind the sea wall and upon the beach. Blown sand is typically a fine-grained and well-sorted deposit.

Over much of the area Holocene marine alluvium has covered the underlying sediments. The alluvial deposits are fine-grained sediments deposited by the sea at high tide level within an estuarine environment. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarse-grained deposits reflecting periods of higher-energy such as storms. The deposits build up over time which allows the colonisation of plants and formation of saltmarsh. Subsequent flood events or rising sea level rises cover the vegetation with muds and the buried vegetation eventually breaks down to a peat deposit. These sediments can provide a record of changing sea levels. These alluvial deposits lie inland of the sea defences and have been artificially drained and improved for cultivation.

Soil

The area lies adjacent to the London Clay coastal slopes where soils of the Wix Soil Series have developed. These are characterised by deep sandy or sandy silt loams. Where they are formed on gravely lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. Where the area borders the drained marshes in the south the soils developed belong to the Wallasea Soil Series. These are characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high groundwater table.

Topography/Geomorphology

The Clacton Channel deposits are approximately 500 m wide. The separate channels reveal a river system flowing from the south with an estuarine influence. In places the channels are separated by a ridge of clay which is exposed at the surface. The cliffs reveal a natural cross-section of the gently domed St Osyth coastal ridge from Point Clear to Clacton which reaches up to 15 m in height. The deposits have been covered by Holocene alluvial deposits and the landscape indicates a former marshland with winding creeks surviving in places as drains. Further linear drains connect the former creeks. Drainage of the area behind the sea defences has created a landscape of rough grassland with small areas of mixed woodland in the surviving open areas.

Human Exploitation

Within the cliffs an undisturbed Palaeolithic occupation surface has been identified. This has revealed human occupation along the diverted Thames-Medway shortly after the Anglian glaciation during an interglacial known as the Hoxnian which began about c.425,000 until 380,000 years ago. Analysis of the finds including flint lithics and a wooden spear indicate hunting, hide processing, wood and bone working from a simple suite of tools.

Since the drainage of the marsh the landscape has been altered significantly and the area is now covered by part of the settlement at Jaywick and the residential expansion of Clacton. The open areas are largely used for recreational purposes and include a golf course. The cliffs are now obscured by sea defences and the beach is protected by a series of groynes and breakwaters.

GCA 18 Exposures of Red Crag and sediments from the Cromerian Complex

Summary

The area includes exposures of the distinctive red shelly sand known as the Red Crag, located upon the southern bank of the Oakley Ridge, Beaumont and possibly Mistley. At The Naze the Red Crag and an interglacial deposit form part of a stratigraphic sequence that is designated as a geological SSSI.

Geology

The Red Crag is underlain by London Clay, which are exposed along the gently shelving coastal slopes. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Red Crag is composed of sediments and shells deposited in the near-shore environments of the sea around 2.4 million years ago. It is found across much of north-east Essex and is exposed across the eastern coast of Tendring. At the base of the Crag phosphatic nodules form a layer or bed containing fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells. The shells have been used to reveal a cooling of climate as the sequence progresses upwards. The deposit is divisible into two main units, a lower (shelly) Red crag composed of sand with many shells and crossbedded structures representing sand dunes in a shallow sea and an upper (non-shelly) Red Crag of medium to fine-grained iron-stained crossbedded sands, possibly decalcified. The deposit can contain a small number of pebbles and major component of clay in certain areas.

At Walton fine-grained silt deposits lie within a channel that is cut into the Red Crag and underlying the Cooks Green Gravel. Originally they were mapped as Chillesford Clay (part of the Norwich Crag) but pollen recovered from the silts indicate later interglacial conditions and the stratigraphic position of the silts indicate that they were deposited shortly before the pre-Anglian gravels that cover them, therefore they are part of the Cromerian Complex. The Chillisford Clay has been dated to c. 1.9 million years.

Soil

The soils formed upon the Red Crag and Cromerian sediments are varied over the District and are likely to reflect the surrounding geologies where they are dominant in extent over an area. Typical soils recorded as forming over Red Crag sediments belong to the Beaumont Soil Series (not on 1:250,000 soil mapping) where the deposits are free of clay and iron-panning. The soils are calcareous brown earths suitable for arable agriculture and horticulture. They are easy working and freely draining soils though need more frequent watering.

Topography/Geomorphology

The patches of Red Crag are exposed largely in the east of the District around the coastal slopes of Hamford Water. Isolated exposures and ground investigation indicate that the Red Crag is found at up to 20 mOD. At Mistley a possible exposure is located within a tributary valley of the Stour upon the London Clay slopes. At The Naze (GCZ 19.2) the Red Crag is exposed in the low cliffs resting upon the London

Clay. The stratigraphic succession gives rise to landslips. The cliffs are exposed to coastal erosion.

Human Exploitation

The sediments are largely exposed upon the upper slopes and are underlain by London Clay. These areas would have been unproductive for agricultural purposes and unattractive for settlement. The expansion of many coastal towns has led to residential settlement encroaching upon the slopes. Much of the area remains rural.

3.2 Geodiversity Character Zone Descriptions

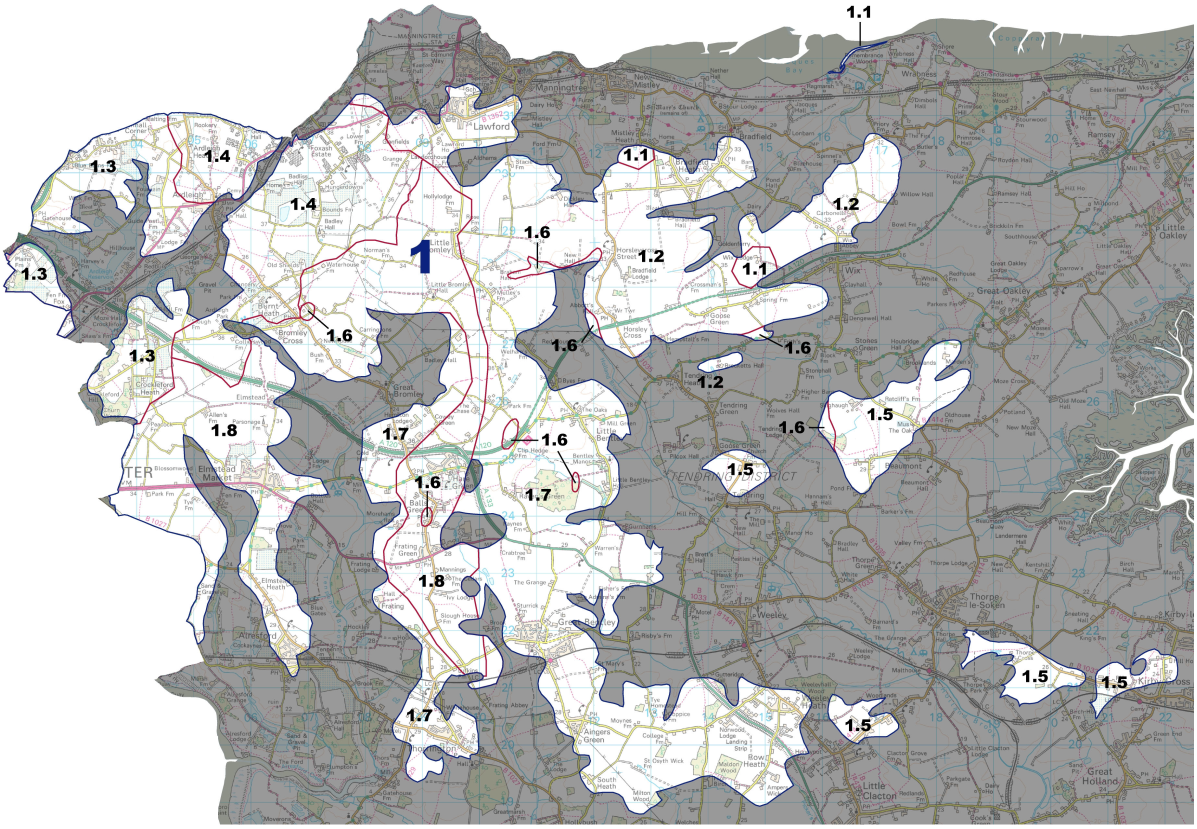


Fig. 20 Geodiviersity Character Zones (GCA 1)

GCZ 1.1 Patches of ‘fossil’ brickearth sediments along the Stour coast and northern plateau region

Summary

Fossil interglacial brickearth deposits at Wrabness and Mistley and possibly Wix Lodge mapped within the Tendring brickearth plateau. It is unusual to find vertebrae remains in plateau brickearth, making this area particularly important palaeontologically.

Geology

The bedrock of the area is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals

as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The ‘fossil’ brickearth deposits were reworked during temperate (interglacial) stages from wind-blown sediments that were deposited during preceding cold stages (glacial) (GCA 1). They are largely distinguished by their fossil content. At Wrabness the deposits are composed of fine sand, revealing some bedding with some fine gravel and broken shells and has yielded a variety of vertebrates including elephant and red deer. Vertebrate fauna has allowed correlation with those at Stutton on the north bank of the Stour which have been assigned to a temperate stage MIS 7 (c.200,000 years BP). At Stutton the freshwater ‘brickearths’ include rodents, and carnivores, including lion. Other large mammals include the straight-tusked elephant (extinct) and mammoth.

During the Second World War work on the anti-aircraft battery at Mistley Heath resulted in the discovery of elephant and rhinoceros remains in brickearth deposits. The site has not yet been re-located. There were also comparisons with a similar deposit seen at Wix Lodge. An antler of red deer has been recovered from close to Wix Lodge (HER 3050) which may be associated with the fossil brickearth deposit.

Soil

Much of soil on the plateau is of the Tendring Soil Series. The soil is usually deep and stoneless and drains reasonably well, although it can also contain sufficient water to avoid drought in most years. The land is agricultural grade 2 and 3. Along the coast the Wix Soil Series is characterised by deep loams, often formed on gravels and so has a coarse, often flinty component which makes it permeable. The soils are fairly resistant to erosion by water.

Topography/Geomorphology

The deposits at Wrabness are exposed along the southern banks of the Stour, in the low cliffs (below 5.0 mOD) north of the sluice around the headland at Wrabness Point.

The deposits at Mistley and the possible deposits around Wix Lodge are located within the main plateau brickearth deposit (GCZ 1.2) between 30 m -35 mOD and so occupy a separate topographical area from those at Wrabness.

Human Exploitation

Palaeolithic artefacts have been recorded from the Stutton fossil brickearth deposits across the Stour. As part of the Hullbridge Survey (Wilkinson & Murphy, 1988) flint flakes were recovered from around the fossil brickearth exposure but were not recovered from a secure context.

Rarity	Very few exposures or known locations	3
Cultural Association	Important Pleistocene deposits associated with interglacial periods	3
Amenity Value	Cliff exposures visible and further research required. Wrabness sluice site is recommended for a Logal Geological Site (LoGS)	3
Capacity for change	Limited capacity for change due to limited distribution and risk from coastal erosion	3

GCZ 1.2 Brickearth deposits of the Tendring plateau between Bradfield and Wix

Summary

Discrete patch of brickearth deposits between Bradfield and Wix. The majority of the brickearth was deposited under aeolian conditions during the Devensian glacial stage, 15,000-20,000 years ago, derived from the finer-grained glacial outwash deposits. However, the plateau brickearth sediments may have been laid down over a number of cold-climate (periglacial) episodes. Fossil brickearth deposits have been investigated within this area (GCZ 1.1) that suggests reworking of older, pre-Devensian sediments during temperate episodes (interglacials).

Geology

The bedrock of the area is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Both the Waldringfield Gravels (GCZ 9.3) and the Ardleigh Gravels (GCZ 6.4) are exposed at the boundary of the brickearth extent and could be expected to exist below the brickearth deposits.

The fine-grained brickearth sediments include fine sand and silts mixed with clays that were transported by the action of wind, sometimes over a considerable distance from their original positions. The original deposition of the sediments occurred under cold climate conditions within fluvial outwash sediments from glaciers. The exposed finer-grained sediments were picked up and transported by the wind and were deposited when conditions ameliorated with the sand deposited first due to its larger grain size.

Soils

The Tendring Soil Series is characterised by usually deep and stoneless loams that drain reasonably well, although they can also contain sufficient water to avoid drought in most years. Much of the zone has Grade 2 agricultural land, with some Grade 3 land at the margin of the brickearth.

Topography/Geomorphology

The brickearth lies at around 30 m - 35 mOD within a gently undulating landscape. Issues arise within the zone and along the eastern edge two streams emerge that flow towards the Stour. There are small isolated patches of woodland surviving.

Human Exploitation

Brickworks were located within the zone of brickearth, close to the adjacent London Clay providing the raw materials for the products. These were located at Bradfield (HER 15469)

The zone is largely rural with scattered farmsteads and a limited amount of settlement at Goose Green, Horsleycross Street, Bradfield Heath and part of

Bradfield. Cropmarks across the zone suggest ancient field systems. The area was heathland in the Medieval and early Post-medieval period. Today the fields are very large, open and irregular, there is cartographic evidence for drainage of the land around Bradfield Hall. Much of the land may have been within former Medieval manorial extents. The zone would have once encompassed the estates belonging to Wix Abbey, Bradfield Hall, Brocketts Hall and Abbots Hall. There are a disproportionate number of manorial halls and large estates for the area.

Rarity	The brickearth is widely distributed across the District	1
Cultural Association	There is no direct cultural association	1
Amenity Value	The Devensian cold climate brickearth deposits are of limited research potential, however fossil interglacial brickearth deposits may exist within the zone near to Wix and Mistley Heath	2
Capacity for change	Moderate capacity for change due to widespread extent but potential for mineral extraction of underlying gravels	2

GCZ 1.3 Brickearth deposits in the northwest of the Tendring plateau

Summary

Part of an extensive spread of brickearth deposits upon the Tendring plateau, this zone is located around the Ardleigh reservoir and valley slopes of the Salary Brook. The majority of the brickearth was deposited under aeolian (wind blown) conditions during the Devensian glacial stage, 15,000-20,000 years ago, from finer-grained glacial outwash deposits. However, brickearth sediments may have been laid down over a number of cold-climate (periglacial) episodes.

Geology

The bedrock of the area is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals

as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The fine-grained sediments include fine sand and silts mixed with clays that were transported by the action of wind, sometimes over a considerable distance from their original position. The original deposition of the sediments occurred under cold climates within fluvial outwash sediments from glaciers. The exposed finer-grained sediments were picked up and transported by the wind and deposited when conditions ameliorated with the sand deposited first due to its larger grain size. Both the Waldringfield and Ardleigh Gravels (GCZ 9.1, 6.1 & 6.2) are exposed at the boundary of the brickearth margin and could be expected to exist below the brickearth deposits.

Soils

The Tendring Soil Series is characterised by usually deep and stoneless loams and drain reasonably well, although it can also contain sufficient water to avoid drought in most years. At the top of the valley slopes, the Wix Soil Series is characterised by deep loams, often formed on gravels and so has a coarse, often flinty component which makes it permeable. The soils are fairly resistant to erosion by water. Much of the zone has Grade 2 agricultural land, with some Grade 3 land at the margin of the brickearth at the top of slope (Wix soils). This zone includes part of Bullock Wood SSSI.

Topography/Geomorphology

The deposits lie on the highest levels of the plateau at around 35 m - 45 mOD and down the valley slopes of the Salary Brook at Crockleford Heath to about 15 mOD. Streams run northwest-southeast in the north, feeding into the Ardleigh reservoir. The eastern slopes of the Salary Brook are relatively shallow.

Human Exploitation

Cropmark features reveal a pattern of ancient field systems and settlement. There are small rural settlements at Ardleigh Heath, west of Ardleigh and Crocklefield Heath. The land is largely agricultural with rectilinear fields and dispersed halls and farmsteads. There is some evidence for drainage. There is a higher proportion of woodland and plantation within the zone, largely along the shallow valley slopes of the Salary Brook and around Crockleford Heath. Evidence for settlement and small industrial activity is suggested by the discovery of a kiln (HER 45455) at Wick farm, Ardleigh which possibly dates from the Early Iron Age. Historic brickworks within the zone include Bacons (HER 15563) and Greensteadvale (HER 15565). Bacon's Brickworks was in operation from 1750 to the 1860s or later. Greensteadvale Brickyard dates from before 1845 to 1890 or later. This site may warrant an impact assessment to determine the location of buried structures/kilns with further intrusive works. The extensive quarrying of the Ardleigh Gravels (HER 6.1) in the Ardleigh area may in the future extend into this zone as the mapped limit of the exposed gravels has largely been exhausted. A large capacity quarry is proposed in the area of Wick Farm, Ardleigh.

Rarity	The brickearth is widely distributed across the District	1
Cultural Association	There is potential for surviving below-ground remains associated with industries utilising the brickearth	2
Amenity Value	The Devensian cold climate brickearth deposits are of limited research potential	1
Capacity for change	Gravels underlying the brickearth lie close to existing quarries and may be at risk from extensions to the quarried areas in the future and new quarries ie. Wick Farm	2

GCZ 1.4 Brickearth deposits of the Tendring plateau between Ardleigh and Lawford

Summary

Part of an extensive spread of brickearth deposits upon the Tendring plateau forming high grade agricultural land between Ardleigh and Lawford and south to Burnt Heath. The majority of the brickearth was deposited under aeolian conditions during the Devensian glacial stage, 15,000-20,000 years ago, from the finer-grained glacial outwash deposits. However, brickearth sediments may have been laid down over a number of cold-climate (periglacial) episodes.

Geology

The bedrock of the zone is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The fine-grained sediments include fine sand and silts mixed with clays that were transported by the action of wind, sometimes over a considerable distance from their original positions. The original deposition of the sediments occurred under cold climates within fluvial outwash sediments from glaciers. The exposed finer-grained sediments were picked up and transported by the wind and were deposited when conditions ameliorated with the sand deposited first due to its larger grain size.

Both the Waldringfield Gravels (GCZ 9.2, 9.3 and the Ardleigh Gravels (GCZ 6.1) are exposed at the boundary of the brickearth extent and could be expected to exist below the brickearth deposits.

Soils

The Tendring Soil Series is characterised by usually deep and stoneless loams which drain reasonably well, although it can also contain sufficient water to avoid drought in most years. The agricultural land is of the highest grade. Large greenhouses at Foxash Estate suggest intensive agriculture.

Topography/Geomorphology

The deposits lie upon the high plateau at around 35 mOD gently rising to 40 mOD in the northwest. The flatness of the zone is illustrated by the presence of a landing strip east of Ardleigh. There are large wooded areas close to Foxash Estate surrounding a landing strip and around Burnt Heath.

Human Exploitation

Brickworks existed at Great Horkesley (HER 15569) utilising the brickearth deposits, it was located at the west end of Brick Kiln Lane and operated from before 1830s to 1870s. The site of the former brickworks is now within the grounds of Kiln House, below ground evidence may survive. A potential glass-working site at Bounds Farm (HER 2410) may have been extracting the high-grade silica sand from the Ardleigh Gravels found below the brickearth. The gravels below the brickearth were extracted in the past at Badliss Hall Farm, east of Ardleigh. A small extension to Martells Quarry at Ardleigh lies within the zone, suggesting that the area may be subject to further quarrying for the underlying gravels.

Much of the land is used for agriculture with farms and large open fields, there are some nurseries. The zone has few small settlements at Burnt Heath and Ardleigh Heath and includes the modern built-up residential area of Ardleigh.

Rarity	The brickearth is widely distributed across the District	1
Cultural Association	There is potential for surviving below-ground remains associated with industries utilising the brickearth	2
Amenity Value	The Devensian cold climate brickearth deposits are of limited research potential	1
Capacity for change	The deposits are widespread in extent but overlie gravels with the potential for mineral extraction	2

GCZ 1.5 Brickearth deposits of the Tendring plateau along the Oakley Ridge and Holland Valley

Summary

The zone covers part of an extensive spread of brickearth deposits upon the lower levels of the Tendring plateau surrounding Hamford Water basin, along the crest of the Holland Brook interfluve and the Oakley Ridge. The majority of the brickearth was deposited under aeolian (wind blown) conditions during the Devensian glacial stage, 15,000-20,000 years ago, from the finer-grained glacial outwash deposits. However, brickearth sediments may have been laid down over a number of cold-climate (periglacial) episodes.

Geology

The bedrock of the area is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The fine-grained sediments include fine sand and silts mixed with clays that were transported by the action of wind, sometimes over a considerable distance from their original positios. The original deposition of the sediments occur under cold climates within fluvial outwash sediments from glaciers. The exposed finer-grained sediments were picked up and transported by the wind and were deposited when conditions ameliorated with the sand deposited first due to its larger grain size.

Both the Cooks Green Gravels/ Wivenhoe Gravels (GCZ 7.2, 7.3, 7.4), to the south of the basin, and the Oakley Gravels (GCZ 2.6), to the north, are exposed in places adjacent to the brickearth and could be expected to exist below the brickearth deposits.

Soils

Soils of the Tendring Series cover much of the zone with Wix and Windsor Series along the high valley slopes. The Tendring Soil Series is characterised by usually deep and stoneless loams which drain reasonably well, although it can also contain sufficient water to avoid drought in most years. The land becomes less workable and less productive on the valley slopes

Topography/Geomorphology

The deposits lie at or above 25 mOD along the crest of the northwest-southeast flowing Holland Brook interfluve and along the southern margin of the southwest-northeast running Oakley Ridge. A number of issues arise within the zone, expected due to the topographical location, which feed into the Holland Brook. Around the Holland Brook the soils often illustrate patterned ground features which are relict features formed during the Devensian glacial stage.

Human Exploitation

The area is largely rural with small linear settlements at Kirby Cross, north of Little Clacton and north of Tendring. Some of the large, open fields have been drained. In the past small-scale quarrying has occurred along the edge of the brickearth deposits and the underlying (GCZ 7.2) Cooks Green Gravel at Rose farm, Thorpe-le-Soken.

Rarity	The brickearth is widely distributed across the District	1
Cultural Association	No known cultural association	1
Amenity Value	Possible patterned ground features survive which are visibly distinctive and reflect particular cold climate soil processes	2
Capacity for change	Discrete patches of brickearth may be vulnerable due to extraction of underlying gravel deposits	2

GCZ 1.6 Patches of gravels exposed within the brickearth spread of the Tendring plateau

Summary

These small, discrete patches of gravels are part of the Kesgrave Gravels. They are exposed within an extensive spread of brickearth deposits upon the Tendring plateau and along the high valley slopes of the Holland Brook.

Geology

The bedrock of the area is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The deposits are composed of sands and gravels and although mapped as undifferentiated Kesgrave and Lowestoft Formation on the 1:50k BGS digital mapping they are considered to be solely Kesgrave Sands and Gravels. The gravels were deposited by the Thames when it flowed north-eastwards across the plateau. Those found at higher levels may belong to the Ardleigh/Oakley Gravel group, at lower elevations the gravels may belong to the Wivenhoe/Cooks Green gravels.

The adjacent brickearth sediments include fine sand and silts mixed with clays that were transported by the action of wind, sometimes over a considerable distance from their original position.

Soils

The small discrete patches of gravel are mapped within the larger extent of soils belonging to the Tendring and Wix Soil Series. The Tendring Soil Series are characterised by usually deep and stoneless loams which drain reasonably well, although it can also contain sufficient water to avoid drought in most years. The Wix Soil Series is characterised by deep loams, often formed on gravels and so have a coarse, often flinty component which makes it permeable. The soils are fairly resistant to erosion by water. The land is of varied agricultural grades.

Topography/Geomorphology

The discrete patches of gravels lie at around 30-35 mOD within the plateau and at 25 mOD to above 35 mOD around the higher valley slopes of the Holland Brook. Where the gravels are exposed at the boundaries of the underlying clay and overlying brickearth along the slopes of the Holland Brook these areas tend to be associated with springs and woods.

Human Exploitation

There is very little settlement within the zone apart from at Bulls Green and Bromley Cross. Much of the zone is undeveloped and includes small areas around Monkey Street, Burnt Heath, Little Bentleyhall Wood, Horsley Cross Street, Goose Green and Tendring Green.

Rarity	The gravels are exposed in discrete patches within the brickearth but their distribution is likely to be more extensive below the brickearth.	1
Cultural Association	No known cultural association	1
Amenity Value	Gravels are of mixed origin and source and have limited research potential	1
Capacity for change	Potential risk from future mineral extraction	2

GCZ 1.7 Brickearth deposits in the central area of the Tendring plateau from the Stour to Alresford Creek

Summary

Part of an extensive spread of brickearth deposits upon the Tendring plateau, this zone extends in a north-south band from the Stour to Alresford Creek. The majority of the brickearth was deposited under aeolian conditions during the Devensian glacial stage, 15,000-20,000 years ago, from the finer-grained glacial outwash deposits. However, brickearth sediments have been laid down over a number of cold-climate (periglacial) episodes.

Geology

The bedrock of the area is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The fine-grained sediments include fine sand and silts mixed with clays that were transported by the action of wind, sometimes over a considerable distance from their original positions. The original deposition of the sediments occurred under cold climates within fluvial outwash sediments from glaciers. The exposed finer-grained sediments were picked up and transported by the wind and were deposited when conditions amelioratd with the sand deposited first due to its larger grain size.

Along the northern limits of the brickearth both the oldest Kesgrave Member within the Tendring Plateau, the Waldringfield Gravels (GCZ 9.2, 9.3, 9.4), and the second oldest, the Ardleigh Gravels (GCZ 6.3, 6.4), are exposed at the boundary of the brickearth extent and could be expected to exist below the brickearth deposits.

In the south the brickearth overlies a later Kesgrave deposit, the Wivenhoe Gravels/Cooks Green Gravels (GCZ 7.3, 7.4, 7.6)

Soils

Much of the zone is covered by the Tendring Soil Series. This is characterised by usually deep and stoneless soils and drains reasonably well, although it can also contain sufficient water to avoid drought in most years. These soils are typically high grade agricultural land. At the headwaters of the Holland brook the Windsor Soil Series are mapped. These are characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. These soils are often of poorer quality agricultural land.

Topography/Geomorphology

The deposits lie on the high levels of the plateau at around 35 m - 45 mOD and further south along the bluffs between the eastern slopes of the Tenpenny Brook and Bentley Brook and the western slopes of the Holland Brook. The landscape is rural with large open fields and scattered farmsteads. There are small woods, more concentrated in the south upon the poorer soils, associated with issues and small reservoirs.

Human Exploitation

There are scattered small settlements at Little Bentley, Mill Green, Aingers Green, Row Heath and Weeley Heath with part of the larger built-up residential area of Lawford, in the north and Great Bentley in the south. Cropmarks indicate historical field systems, possibly prehistoric. Quarrying has taken place on the edge of the brickearth deposits at Thorrington, into the underlying Wivenhoe Gravels (GCZ 7.6), and at Gutteridge Hall (GCZ 7.4). New quarries are proposed in the area of

Thorrington Hall farm, Thorrington and Admirals Farm and Gurnhams, Great Bentley and Frating Hall Farm .

Rarity	The brickearth is widely distributed across the District	1
Cultural Association	No known cultural association	1
Amenity Value	The Devensian cold climate brickearth deposits are of limited research potential	1
Capacity for change	Areas of brickearth may be vulnerable due to the extraction of underlying gravel deposits	2

GCZ 1.8 Brickearth deposits in the north and west of the Tendring plateau

Summary

Part of an extensive spread of brickearth deposits upon the Tendring plateau, this zone extends in a north-south band from Alresford to Little Bromley in the north. The majority of the brickearth was deposited under aeolian conditions during the Devensian glacial stage, 15,000-20,000 years ago, from the finer-grained glacial outwash deposits. However, brickearth sediments have been laid down over a number of cold-climate (periglacial) episodes.

Geology

The bedrock of the area is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The fine-grained sediments include fine sand and silts mixed with clays that were transported by the action of wind, sometimes over a considerable distance from their original positions. The original deposition of the sediments occurred under cold climates within fluvial outwash sediments from glaciers. The exposed finer-grained sediments were picked up and transported by the wind and were deposited when conditions ameliorated with the sand deposited first due to its larger grain size.

Along the northern limits of the brickearth both the second oldest Kesgrave Member within the Tendring Plateau, the Ardleigh Gravels (GCZ 6.3), and, in the south, the third oldest Kesgrave deposit, the Wivenhoe Gravels (GCZ 7.5), are exposed at the boundary of the brickearth extent and could be expected to exist below the brickearth deposits.

Soils

The zone is characterised by the Tendring Soil Series and high quality agricultural land. Cropmarks indicate a long history of field systems and evidence for ridge and furrow (HER 2581) at Elmstead reveals continuing agricultural use into marginal areas. The very regular fields in the south may indicate their historic landuse. The Tendring Soil Series is characterised by usually deep and stoneless and drains reasonably well, although it can also contain sufficient water to avoid drought in most years. Small woods, plantations and small groves are dispersed within the zone.

Topography/Geomorphology

The deposits lie at around 25-35 mOD at the headwaters of the north-south flowing brooks on a relatively level plateau and southwards along the bluffs between the slopes of the Sixpenny, Bromley and Tenpenny Brook. Issues emerge along the boundary of the brickearth and gravels deposits.

Human Exploitation

The zone is largely rural but does have a larger settlement at Alresford with smaller settlements at Little Bromley and Elmstead market as well as the villages of Balls Green, Hare Green and Frating Green. A Palaeolithic handaxe (HER 2472) was recovered west of Little Bromley which may have come from the underlying Ardleigh Gravel. Extraction of the underlying gravels has occurred in the past (HER 17559), possibly from pre-Medieval times (HER 17562). Extensive modern quarrying has occurred within the brickearth areas along the valley slopes at Wivenhoe and Elmstead Market where the Wivenhoe Gravel may be closer to the surface. Further quarrying is anticipated within these areas, a quarry is proposed at Frating Hall farm, Frating. Within the higher plateau area quarrying has occurred in the past for the underlying Ardleigh gravels.

Rarity	The brickearth is widely distributed across the District	1
Cultural Association	No direct cultural association to brickearth	1
Amenity Value	The Devensian cold climate brickearth deposits are of limited research potential	1
Capacity for change	Areas of brickearth may be vulnerable due to extraction of underlying gravel deposits (Frating Hall farm)	2

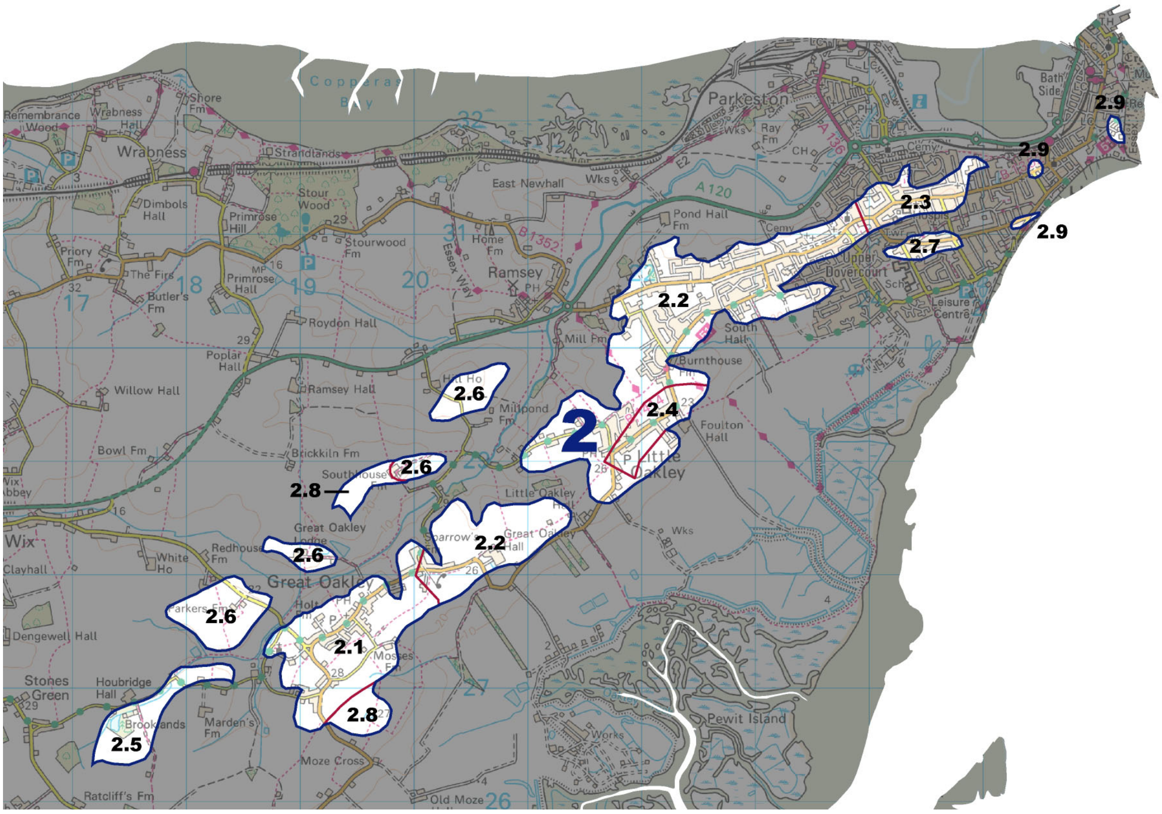


Fig.21 Geodiviersity Character Zones (GCA 2)

GCZ 2.1 Area of Oakley Gravels around Great Oakley village

Summary

The Oakley Gravels were deposited by the pre-diversion Thames c.575,000 years ago, when it flowed across the north of the district. The Oakley Gravel is thought to be contemporary with the Ardleigh Gravel (GCA 6). The Oakley/Ardleigh gravels belong to the second highest of the four Kesgrave Formations on the Tendring Plateau. The zone is located at the southern end of the ridge now occupied by the settlement of Great Oakley.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals

as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The superficial geology of the zone is the sand and gravel sediments that belong to the Oakley Gravels. The coarse-grained deposits were laid down under cold-climate conditions by a former course of the Thames when it flowed across Essex towards Suffolk, possibly with an input from the early Medway also.

Soil

The soil that has developed upon the gravels within the zone belong to the Tendring Soil Series. The Tendring Soil Series are palaeo-argillic brown earths soils that are is characterised by deep often stoneless coarse loamy soils. The soils drain reasonably well, although they can also contain sufficient water to avoid drought in most years. They are often highly fertile soils, however on the ridge the land is classified as less workable.

Topography/Geomorphology

The deposits lie at the southern end of the ridge at heights of between 20 m and 35 mOD. The ridge forms a dominant topographical feature. The landscape is rural with the village of Great Oakley along the ridge. The smaller scale and irregular boundaries of the field pattern surrounding Great Oakley suggests a historic origin. The fields are crossed by tracks and have intermittent hedgerows as field boundaries. A small portion of the fields are used for recreation associated with the village, most are under arable cultivation.

Human Exploitation

The zone has been subject to historic ridge-top settlement. The village of Great Oakley has expanded along the main road (B1414) which follows the line of the ridge north to Little Oakley. Much of the surrounding land is undeveloped and used for agriculture.

Rarity	The ridge is the only known location the gravels survive.	3

Cultural Association	Palaeolithic flints (pre-Anglian) have been recorded from the gravels outside of this zone	3
Amenity Value	There are areas of open ground where the gravels could be exposed	2
Capacity for change	Moderate capacity for change from further development.	2

GCZ 2.2 Oakley Gravels along mid-Oakley Ridge

Summary

The Oakley Gravels were deposited by the pre-diversion Thames c.575,000 years ago, when it flowed across the north of the district. The Oakley Gravel is thought to be contemporary with the Ardleigh Gravel (GCA 6) with a possible input from the early Medway. The Oakley/Ardleigh Gravels belong to the second highest of the four Kesgrave Members on the Tendring Plateau. The zone comprises a large area of the gravel ridge from the edge of Great Oakley to Upper Dovercourt. Upon the southern slopes of the Oakley ridge the gravels overlie exposures of Red Crag

Geology

The gravels rest upon exposures of Red Crag which overlies the London Clay. The Red Crag is composed of sands and shells deposited in the near-shore environments of the sea. At the base of the Crag phosphatic nodules form a layer or bed, this deposit contains fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells.

The Little Oakley interglacial Channel deposits (GCZ 2.5) have been revealed within close proximity to the gravels and may extend into this zone.

The sediments that form the flat topped ridge are Oakley Gravels, part of the Kesgrave Sands and Gravels which represent the bed of the former course of the Thames when it flowed across Essex towards Suffolk. The coarse-grained sand and gravels were deposited under cold-climate conditions.

Soil

The gravels lie within an area predominantly characterised by soils of the Wix Series which are argillic brown earths. The Wix Soil Series are characterised by deep loams, often formed on gravels and so has a coarse, often flinty component which makes it permeable. The soils are fairly resistant to erosion by water. The land is of good agricultural quality.

Topography/Geomorphology

The zone is located along the central ridge at heights above 20 mOD. The north-western and south-eastern slopes are significantly steeper than the gentle northeast-southwest trending slopes of the ridge. Gentle rises up to c.25 mOD create slight hills along the flattened ridge where prominent buildings have been sited. Along the southwest facing slopes of the main ridge small 'spurs' of gravel have survived where the gravel overlying the exposed Red Crag is divided by small streams which have exposed the London Clay slopes.

Human Exploitation

The area has been subject to expansion of the settlement at Upper Dovercourt and become amalgamated with the village of Little Oakley. The urban areas are largely residential and built-up, becoming less so away from Upper Dovercourt heading southwest. Great Oakley Hall has been sited upon an elevated position along the ridge. The area around the Hall and village of Little Oakley has remained undeveloped with open spaces and fields.

Rarity	The ridge is the only known location the gravels survive.	3
Cultural Association	No known cultural association	1
Amenity Value	Provides the potential for a fuller stratigraphic sequence	3
Capacity for change	Residential expansion and development may disturb the gravel deposits which are a limited resource.	2

GCZ 2.3 Oakley Gravels and later gravels at the site of Gants Pit within Upper Dovercourt

Summary

The Oakley Gravels were deposited by the pre-diversion Thames c.575,000 years ago, when it flowed across the north of the district. The Oakley Gravel is thought to be contemporary with the Ardleigh Gravel (GCA 6). The Oakley/Ardleigh gravels belong to the second highest of the four Kesgrave Formations on the Tendring plateau. Within later sands and gravels is the former Gants Pit quarry which has yielded the largest number of handaxes of Palaeolithic date and various species of Pleistocene fauna in Essex.

Geology

The ridge is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The sediments that form the flat topped ridge are Oakley Gravels, part of the Kesgrave Sands and Gravels which represent the bed of the former course of the Thames when it flowed across Essex towards Suffolk. The sands and gravels were deposited under cold-climate and high energy conditions.

Cut into the north side of the ridge is a channel infilled with post-Anglian sand and gravel which has yielded the largest number of handaxes of Palaeolithic date and various species of Pleistocene fauna.

Soil

This zone is predominantly characterised by soils of the Wix Series which are argillic brown earths. The Wix Soil Series is characterised by deep loams, often formed on gravels and so have a coarse, often flinty component which makes it permeable. They are fairly resistant to erosion by water.

Topography/Geomorphology

The deposits survive at the northern end of the ridge at c.20 mOD and along the gentle north-east facing slope above 15 mOD.

Human Exploitation

The area has been subject to urban settlement and is wholly urban in character with few open recreational areas. The little open area that survives is largely used for recreational purposes, such as playing fields and allotments. Small scale quarrying has taken place in the past. A former quarry, Gants Farm Pit (also known as Pound Farm Pit), was the richest site for Palaeolithic hand-axes in Essex. The first discoveries were made in 1908 and the pit ceased working in the 1920s. Over 200 hand-axes came from this pit together with numerous mammal bones including beaver, rhino, fallow deer, red deer, ox and straight-tusked elephants. The site is now levelled and occupied by Spring Meadow Primary School and playing field. In recent investigations at the school (HER 46179) Palaeolithic flints have been recovered *in situ.* The area reveals that the small open spaces within the built-up urban area may still preserve a significant Palaeolithic and Pleistocene resource.

Rarity	Only known location of Oakley Gravels with later gravels bearing Palaeolithic implements	3
Cultural Association	Significant post-Anglian Palaeolithic finds and Pleistocene remains at Gants Pit.	3
Amenity Value	The association of the gravel bodies needs to be investigated. Gants Pit is recommended as a LoGS.	3
Capacity for change	Limited capacity for change as few surviving deposits which are vulnerable to encroaching development	3

GCZ 2.4 Little Oakley interglacial channel deposits

Summary

The zone covers an area where a channel with probable Cromerian interglacial sediments is cut within the Oakley Gravels and Red Crag along the southern edge of the Oakley Ridge. The Oakley Gravels were deposited by the pre-diversion Thames c.575,000 years ago, when it flowed across the north of the district. The Oakley Gravel is thought to be contemporary with the Ardleigh Gravel (GCA 6). The Oakley/Ardleigh Gravels belong to the second highest of the four Kesgrave Formations on the Tendring Plateau.

Geology

The area is underlain by London Clay with exposed remnants of Red Crag. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Red Crag overlies the London Clay and is composed of sediments and shells deposited in the near-shore environments of the sea. At the base of the Crag phosphatic nodules form a layer or bed, this deposit contains fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells.

The Oakley Gravels comprise sands and gravels that were deposited on the bed of the pre-diversion Thames c.575,000 years ago, under cold climate conditions. They represent a high-energy fluvial regime that covered a large area of possible braided channels.

Cutting through the Oakley Gravels in a WSW-ENE trending single channel are fine-grained deposits representing deposition by a low energy fluvial system under temperate conditions. The channel is estimated to have been between 150m and 175m wide. The sediments are highly fossiliferous, including pollen, molluscs, ostracods, mammals and fish within a deposit of fine sand with silt, clay and occasional pebbles. The Little Oakley channel has provided one of very few stratified early Middle Pleistocene vertebrate faunas from the British Isles. Mammals include taxa indicative of both woodland and more open areas. Pollen analysis of sediment samples have provided evidence of contemporary vegetational development in a temperate period. The initial late-glacial taxa being replaced by pioneer pre-temperate woodland vegetation and later the development of fully temperate deciduous forest. The latter may have been maintained by alluvial aggradation and large vertebrate activity. The deposit is up to 4 m in thickness and has been buried by up to 3 m of colluvium in places. The sediments are thought to be the only recognised deposits representing an interglacial period c.575,000 years ago within the Cromerian Complex.

Soil

The soils formed upon the gravel belong to the Wix Soil Series. This is characterised by deep loams, often formed on gravels and so have a coarse, often flinty component which makes them permeable. They are fairly resistant to erosion by water.

Topography/Geomorphology

The superficial Oakley Gravel deposits lie above 20 mOD upon a gentle gradient on the eastern facing slope of the ridge. A spring emerges in the south which drains into artificial cuts towards the North Sea.

Human Exploitation

The north-south running Harwich Road passes through the zone with houses to the west and fields to the east. Foulton Hall lies at the southern point. The land is open and forms part of an agricultural field that lies adjacent to the road running through Little Oakley.

This zone has been extended beyond the initial discovery of the channel on the basis of later excavations at Foulton Hall, Little Oakley which identified similar channel deposits and shelly Crag.

Rarity	Only known location for the channel deposits	3
Cultural Association	Palaeolithic flints (pre-Anglian) have been recorded from the gravels outside of this zone	3
Amenity Value	Provides significant stratigraphic succession for a pre-Anglian interglacial stage	3
Capacity for change	The full extent of the channel deposits is unknown and may be less deeply buried elsewhere and so have a limited capacity for change	3

GCZ 2.5 Discrete patch of Oakley Gravels upon the southern extent of the ridge

Summary

The Oakley Gravels were deposited by the pre-diversion Thames c.575,000 years ago, when it flowed across the north of the district. The Oakley Gravel is thought to be contemporary with the Ardleigh Gravel (GCA 6). The Oakley/Ardleigh Gravels belong to the second highest of the four Kesgrave Formations on the Tendring Plateau. The zone includes a discrete patch of sands and gravels located at the southern end of the Oakley Ridge adjacent to brickearth deposits around Brooklands farm.

Geology

The ridge is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The sediments that form the flat-topped ridge are Oakley Gravels, part of the Kesgrave Sands and Gravels which represent the bed of the former course of the Thames when it flowed across Essex towards Suffolk. The coarse sediments represent a high energy fluvial regime, laid down under cold-climate conditions.

The gravels lie adjacent to a large spread of brickearth deposits, forming a continuation of the ridge and can be expected to survive below the brickearth.

Soil

The small patch of gravels is isolated from the main ridge and the soils reflect the influence of the adjacent brickearth deposits. The Tendring Soil Series is characterised by usually deep and stoneless soils and drains reasonably well, although it can also contain sufficient water to avoid drought in most years. The land is of good quality agricultural grade.

Topography/Geomorphology

The majority of the deposits lie between 20 m - 25 mOD within the headwaters of the Ramsey Valley and separated from the main ridge by the tributary valleys of the Ramsey Valley system. A stream rises in the southwest at the junction between the gravels and London Clay slopes. A body of open water with a jetty lies along the stream which appears to be a lake surrounded by the gardens at Brooklands.

Human Exploitation

The gravels survive in a largely rural area with large scale arable fields around Brooklands farm. A large lake at Brooklands may indicate small scale quarrying and historic quarrying is indicated on the 1st edition OS map.

Rarity	The ridge is the only known location the gravels survive.	2
Cultural Association	Palaeolithic flints (pre-Anglian) have been recorded from the gravels outside of this zone	3
Amenity Value	Potential for further research into the gravels in undisturbed area	2
Capacity for change	Moderate capacity for change due to limited distribution	2

GCZ 2.6 Discrete patches of Oakley Gravels on the northern side of Ramsey Valley

Summary

The Oakley Gravels were deposited by the pre-diversion Thames c.575,000 years ago, when it flowed across the north of the district. The Oakley Gravels are thought to be contemporary with the Ardleigh Gravel (GCA 6). The Oakley/Ardleigh Gravels belong to the second highest of the four Kesgrave Members on the Tendring Plateau. The patches of sands and gravels are remnants of the Oakley Gravels upon the northern side of the Ramsey Valley.

Geology

The area is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The sediments within the zone are sands and gravels known as Oakley Gravels, part of the Kesgrave Sands and Gravels which represent the bed of the former course of the Thames when it flowed across Essex towards Suffolk. The coarse-grained sediments indicate a high energy fluvial regime deposited under cold climate conditions.

Soil

The soils formed upon the patches of gravels reflect the surrounding geology upon the slopes of the valley. The Windsor Soil Series is characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. The land is of lower-level mixed agricultural grades.

Topography/Geomorphology

The majority of the deposits lie between 15 m - 20 mOD along the northern upper slopes of the Ramsey Valley system. The Oakley Gravels are more limited and discrete in their distribution on this side of the valley, separated by tributary streams which have cut into the London Clay. The south-eastern facing slopes on which they survive have a gentler gradient than their counterparts south of the Valley. There is a reservoir around Great Oakley Lodge.

Human Exploitation

The landscape is rural with scattered farmsteads and large open fields separated by drainage channels. Great Oakley Lodge is located upon one discrete patch of gravel, possibly due to the prominent position afforded by the survival of the gravel upon the London Clay slopes.

Rarity	Small surviving areas of gravels across the valley from the ridge	2
Cultural Association	Palaeolithic flints (pre-Anglian) have been recorded from the gravels outside of this zone	3
Amenity Value	Limited potential for significant research	1
Capacity for change	Moderate capacity for change due to limited distribution	2

GCZ 2.7 Discrete patch of Oakley Gravels on southern side of Oakley Ridge

Summary

The Oakley Gravels were deposited by the pre-diverted Thames c.575,000 years ago, when it flowed across the north of the district. The Oakley Gravel is thought to be contemporary with the Ardleigh Gravel (GCA 6). The Oakley/Ardleigh Gravels belong to the second highest of the four Kesgrave Members on the Tendring Plateau. The discrete patch of sands and gravels are remnants of the Oakley Gravels south of the Oakley Ridge at Dovercourt.

Geology

The ridge is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The discrete patch of sand and gravels belong to the Oakley Gravels, part of the Kesgrave Sands and Gravels which represent the bed of the former course of the Thames when it flowed across Essex towards Suffolk. The sediments indicate deposition within a high energy fluvial regime under cold climate conditions.

Soil

The soils developed upon the gravels belong to the Wix Soil Series. This is characterised by deep loams, often formed on gravels and so have a coarse, often flinty component which makes them permeable. They are fairly resistant to erosion by water.

Topography/Geomorphology

The patch of gravels forms an undulating landscape upon the south-facing slope of the Oakley Ridge, rising from above 15 m to 20 mOD.

Human Exploitation

The area has been subject to urban development and is largely built up. There are small patches of open areas in school playing fields.

Rarity	Small surviving areas of gravels separated from the ridge	2
Cultural Association	Palaeolithic flints (pre-Anglian) have been recorded from the gravels outside of this zone	3
Amenity Value	The area is built-up with few open areas	1
Capacity for change	The area has been developed and built upon, small open areas survive which will have limited capacity for change	2

GCZ 2.8 Brickearth deposits along Oakley Ridge

Summary

The zone covers small discrete patches of brickearth deposits at the southern end of the Oakley Ridge, south and north of Great Oakley

Geology

The ridge is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The brickearth lies adjacent to and is likely to overlie the Oakley Gravels, part of the Kesgrave Sands and Gravels which represent the bed of the former course of the Thames when it flowed across Essex towards Suffolk.

The fine-grained brickearth sediments include fine sand and silts mixed with clays that were transported by the action of wind, sometimes over a considerable distance from their original positions. The original deposition of the sediments occurred under cold climates within fluvial outwash sediments from glaciers. The exposed finer-grained sediments were picked up and transported by the wind and were deposited when conditions ameliorated with the sand deposited first due to its larger grain size.

Soil

Soils developed upon the small patches of brickearth are likely to reflect the surrounding geology where this is dominant. Upon the ridge the soils developed belong to the Tendring Soil Series. These are characterised by usually deep and stoneless and drains reasonably well, although it can also contain sufficient water to avoid drought in most years. North of the ridge at the head of the London Clay slopes the soils developed belong to the Windsor Soil Series. These are characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. Upon both soil types the land is classified as being of good agricultural quality which may suggest drainage and soil improvement upon the Windsor soils.

Topography/Geomorphology

The discrete patches of brickearth lie between 20 m to above 25 mOD either side of the Oakley Ridge running northeast-southwest. They lie adjacent to Oakley Gravels at the crest of the London Clay slopes and are likely to overlie the Oakley Gravels within the zone.

Human Exploitation

The area is undeveloped and rural with large open fields, situated around Southhouse Farm to the north and east of Cabbage Row to the south of Great Oakley.

Rarity	Brickearth deposits probably overlie Oakley Gravels	2
Cultural Association	Possible limited use of brickearth for industrial purposes historically	1
Amenity Value	Possible gravels deposits below brickearth warrant further research	1
Capacity for change	Moderate capacity for change due to accessibility of underlying gravels	2

GCZ 2.9 Undifferentiated Kesgrave Gravels along the Oakley Ridge

Summary

These are discrete patches of gravels overlying Red Crag and London Clay in the Harwich-Dovercourt area associated with the early Thames drainage system and are likely to be part of the Oakley Gravels. The Oakley Gravels were deposited by the pre-diversion Thames c.575,000 years ago, when it flowed across the north of the district. The Oakley Gravel is thought to be contemporary with the Ardleigh Gravel

(GCA 6). The Oakley/Ardleigh Gravels belong to the second highest of the four Kesgrave Members on the Tendring Plateau.

Geology

In the north of Dovercourt the patches of gravel are underlain by London clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Near Dovercourt Bay the gravels rest upon the Red Crag. The Red Crag is composed of sediments and shells deposited in the near-shore environments of the sea around 2.4 million years ago. At the base of the Crag phosphatic nodules form a layer or bed, this deposit contains fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells. The shells demonstrate a cooling of climate as the sequence progresses upwards.

The superficial geology is composed of undifferentiated sands and gravels of the Kesgrave Formation. These coarse-grained sediments would have been originally deposited by the former course of the Thames when it flowed across Essex towards Suffolk. They are likely to form part of the Oakley Gravels but their sedimentological characteristics have been modified by cold climate processes occurring since their original deposition.

Soil

The patches of gravel lie upon the upper slopes of the Oakley Ridge where London Clay is exposed. The soils developed upon the slopes belong to the Windsor Soil Series. These are characterised by deep and clayey soils mostly with brown subsoils formed upon London Clay. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils.

Topography/Geomorphology

The majority of the deposits lie between 5 -10 mOD just beyond the northern tip of the ridge running northeast-southwest along the London Clay coastal slopes towards the peninsula at Harwich. The coastal slopes are shallow and have been subject to residential urban development. Towards the coast small areas of playing fields and open land survive.

Human Exploitation

The gravel patches lie in areas that are now built-up and urban in character.

Rarity	Possible association with the Oakley Gravels	2
Cultural Association	Post-Anglian Palaeolithic finds have been recovered from nearby Gants Pit	2
Amenity Value	Limited opportunity for further research within developed area	1
Capacity for change	Land is heavily developed	1

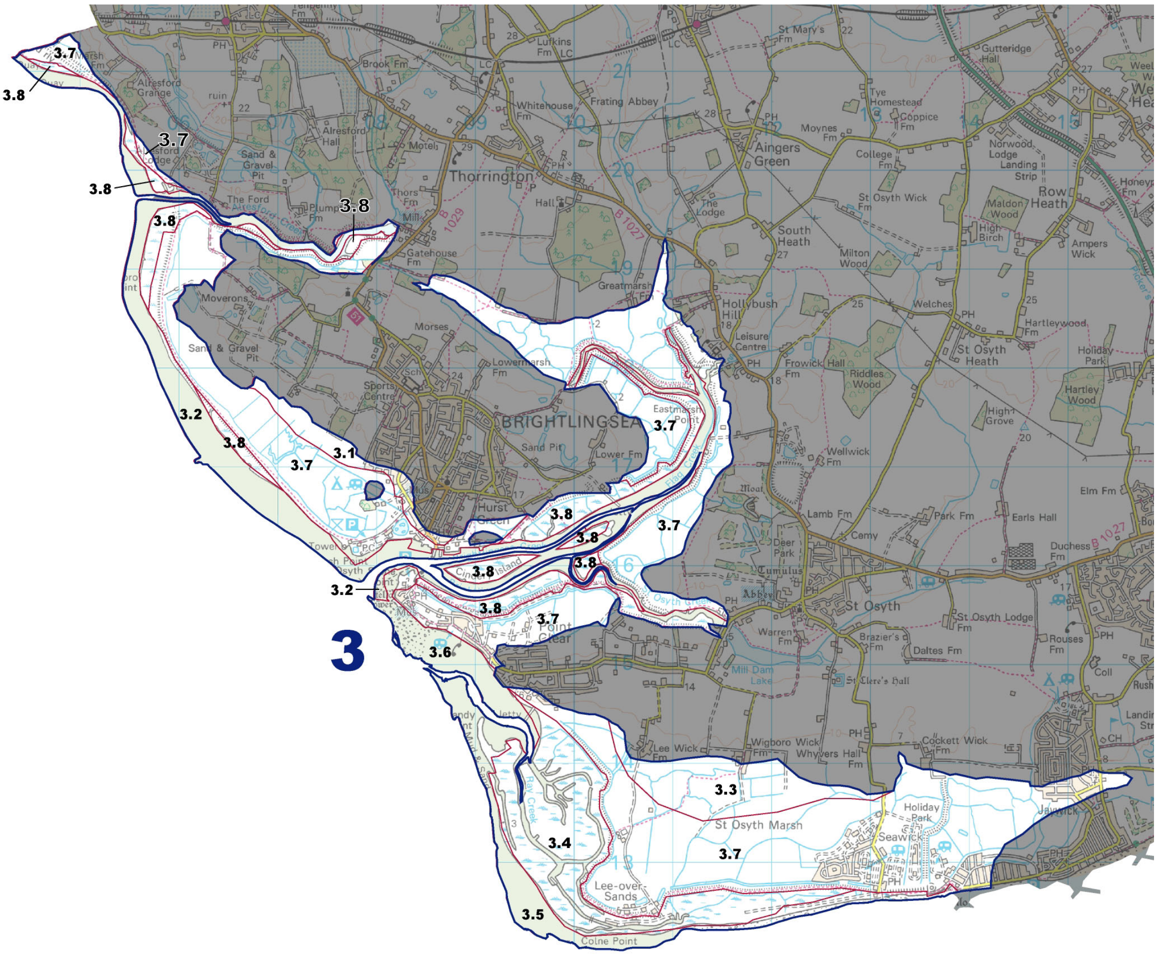


Fig 22 Geodiviersity Character Zones (GCA 3)

GCZ 3.1 Historical industrial area on edge of intertidal zone near Brightlingsea

Summary

This small zone spans the southeastern fringe of Brightlingsea Island and lies at the edge of the alluvial deposits at the base of the coastal slopes. The zone incorporates areas of drained saltmarsh that would have been at the limit of the intertidal zone, thereby making it accessible for small industrial activities in the past such as the copperas industry, salterns and brickworks.

Geology

The fine-grained sediments of the London Clay which form the bedrock of the zone represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine-grained sediments deposited by the sea at high tide level within an estuarine environment. The marine alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher energy such as storms. The deposits built up over time and in sheltered areas which allows the colonisation of plants and formation of saltmarsh. These sediments were laid down during the Holocene and can provide a record of changing sea levels. These alluvial deposits lie more than 0.5 m above the present mean high tide mark and have been artificially drained and improved for cultivation.

Soil

Much of the zone is covered by soils of the Wix Series which are argillic brown earths. The Wix Soil Series is characterised by deep sandy or sandy silt loams. The soils are often formed on slopes and generally have a coarse component. However, artificial drainage of the former saltmarsh has led to soil improvement and cultivation over time which would have altered the initial character of the alluvial soils. The zone comprises land that is of poorer agricultural grade than the plateau, however cultivation techniques have meant that these soils can be used for some arable use or grassland. A small area of the more typical marshland soil survives within the zone. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high ground-water table.

Topography/Geomorphology

The zone is situated at the base of the gentle coastal slopes. The land is flat and low lying, below the 5 mOD contour. The zone would have formed part of the upper saltmarsh zone bordering the River Colne. Regular, linear ditches and drains channel the water into the Colne and a sea wall along the coast prevent any risk of tidal flooding.

Human Exploitation

The zone is notable for the high proportion of industrially related features. There is evidence for industrial activity from the Late Iron Age period onwards with remains of salterns upon the former marsh (HER 2163, 2164). Others may be older or Medieval in date (HER 2242, 2673). The salterns would have been placed to exploit the tides for the production of salt. In addition, a brickworks (HER15702) was located west of Brightlingsea town presumably to utilise the transport links offered by the nearby river. The site has been redeveloped and no archaeological remains are expected to have survived. Within Brightlingsea, copperas was manufactured as early as 1542. The copperas industry involved gathering of pyrite nodules (known as 'copperas stones') from beaches, where they had been washed out of the London Clay, and converting them to ferrous sulphate (green vitriol) which was an essential chemical for making dyes, ink, and several industrial chemicals such as sulphuric acid. In 1674 the famous Essex naturalist John Ray published an account of refining metals and minerals in England and in this book he describes the technical aspects of copperas manufacture at Brightlingsea. Philip Morant, in 1768, refers to a copperas works at Brightlingsea and a 'copperas house' is marked on the 1777 Chapman and Andre map. The copperas works at Brightlingsea is commemorated by the road name Copperas Road. The southern half of the zone has been built-up with residential and amenity development.

Rarity	Areas of drained saltmarsh are limited in distribution to the coastal zone inland of the sea wall	2
Cultural Association	High proportion of historical industrial remains	3
Amenity Value	Remains of early industrial sites visible within the landscape ie.salterns and accessible for further investigation	3
Capacity for change	Limited capacity for change including increasing development and agricultural intensification	3

GCZ 3.2 Intertidal mudflats of the Colne Estuary surrounding Brightlingsea

Summary

This is zone of fine-grained estuarine alluvial sediments, mudflats that were deposited within the intertidal zone. It encompasses the area from west of Alresford, around Brightlingsea Island and up to the head of the estuary at Brightlingsea Reach.

Geology

The fine-grained sediments of the London Clay which form the bedrock of the zone represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The superficial geology of the area is dominated by alluvial fine-grained estuarine sediments. The sediments form a narrow intertidal zone predominantly composed of flats of fine silt and mud. Regular flooding would replenish the muds resulting in soft, homogeneous clays.

Soil

Due to daily flooding there is no soil development in the zone.

Topography/Geomorphology

The mudflats form between high and low tide, within the intertidal zone, and are generally gently sloping towards the river channels, mostly below 2 mOD. The flats border the saltmarsh or sea walls along the coast and include the tidal inlet channels of Alresford Creek up to Mill Dam, Brightlingsea Creek, Flag Creek, Thorrington and St Osyth Creek. The mudflats surround the larger Cindery Island and the smaller Pincushion Island.

Human Exploitation

The zone is unsuitable for settlement and so is largely undeveloped. Small jetties, wharves and landing stages cross the mudflats to gain access to the water channel.

There is a ford across an inlet channel of Alresford Creek. A dam has been created at the mouth of Tenpenny Brook where it discharges into Alresford Creek.

Rarity	Mudflats are located within the intertidal zone along the estuaries	2
Cultural Association	Limited cultural finds or features within zone	2
Amenity Value	Restricted access but possible research potential	2
Capacity for change	Moderate capacity for change, specifically environmental changes	2

GCZ 3.3 Historical industrial area on St Osyth Marsh west of Jaywick

Summary

The zone is characterised by historic industrial activity within the former St Osyth saltmarsh. The zone incorporates areas of drained saltmarsh that would have been at the limit of the intertidal zone, thereby making it accessible for small industrial activities in the past such as the salterns at Lee Wick.

Geology

The fine-grained sediments of the London Clay which form the bedrock of the zone represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine-grained sediments deposited by the sea at high tide level within an estuarine environment. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher energy such as storms. The deposits built up over time and in sheltered areas which allows the colonisation of plants and formation of saltmarsh. Subsequent flood events or rising sea-level cover the vegetation with muds and the buried vegetation eventually breaks down to a peat deposit. These sediments were laid down during the Holocene and can provide a record of changing sea-levels. These alluvial deposits lie inland of the seawall and have been artificially drained and improved for cultivation.

Soil

The zone is covered by soils of the Wallasea Series. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high groundwater table.

Topography/Geomorphology

The zone is situated at the base of the gentle coastal slopes. The land is flat and low-lying, below 5 mOD and above 2 mOD. The zone would have formed part of the upper saltmarsh zone bordering the River Colne. The area is now inland of the seawall preventing any further risk of tidal flooding; drains dissect the zone in the former marsh area, some following the historic creeks others linear.

Human Exploitation

The zone is notable for the high proportion of industrially related features. There is evidence for industrial activity from the Roman period onwards with remains of salterns upon the former marsh (HER 2819, 7395). Others may be older or Medieval in date (HER 2819, 2838, 7394, 17055, 17060). The salterns would have been placed to exploit the tides for the production of salt. The saltmarshes themselves would have provided valuable grazing areas for sheep. Cheese-making was a profitable industry and evidence for this is recorded in the names of the nearby farms of Wigborough Wick Farm and Lee Wick farm. The drainage of the saltmarshes would have followed the construction of the sea wall. The zone would have been unsuitable for settlement and has remained undeveloped.

Rarity	Areas of drained saltmarsh are limited in distribution to the coastal zone inland of the sea wall	2
Cultural Association	High proportion of historical industrial remains	3

Amenity Value	Remains of early industrial sites often visible within the landscape i.e. salterns and accessible for further investigation	2
Capacity for change	Limited capacity for change including increasing development and agricultural intensification	3

GCZ 3.4 Saltmarsh around the mouth of the Colne Estuary at Brightlingsea Reach.

Summary

This extensive zone of saltpans and saltmarsh morphology extends from Point Clear, around the coast to Lee-over-Sands, near St Osyth.

Geology

The alluvium is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine-grained sediments deposited by the sea at high tide level within an estuarine environment. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher energy such as storms. At St Osyth the surface sediment within the saltmarsh has been recorded and the sediment composition was clay (52%) and silt (43%) with 5% sand (Wilkinson & Murphy, 1995). The deposits built up over time and in sheltered areas which allowed the colonisation of plants and the formation of saltmarsh. Subsequent flood events or sea-level rise cover the vegetation with muds and the buried vegetation eventually breaks down to a peat deposit. A seam of peat has been dated at St Osyth to around 4,300 years BP. These sediments were laid down during the Holocene and provide a record of changing sea-levels. Along the southern coast the sediments include a coarser-grained component due to the more exposed coastline.

Soil

Within areas of saltmarsh, soils formed upon the marine alluvium are referred to as Saline. They are of variable texture depending upon the lithologies of the parent material. The soils can range from soft and unripened where they are subjected to regular flooding and fresh sediment input to firm and ripened on higher sites or on sandier parent materials. All variations are frequently calcareous. The soils can be utilised for some summer grazing.

Topography/Geomorphology

Along the coast of the estuary the zone is a low lying, flat landscape bisected by sinuous branching tidal inlets, winding creeks and channels. There are areas of open water, mudflats, saltpans and saltmarsh cliff. The assemblage of features reflects the maturity of the marsh system that has developed here. Saltpans are an important morphological feature of much of this saltmarsh. Their shape and size vary greatly, some are sub-circular and others are linear features with similar shapes to creeks. The high salinity of the hollows or creeks makes them unsuitable for the colonization of plants. The saltmarsh has formed in the lee of the sandy spit that forms the northern extension of the shingle and sand ridges that stretch from St Osyth beach to Colne Point (GCZ 3.5). Longshore drift moves sediment along the beach towards the estuary in the direction of the prevailing current. The saltmarsh extends c.3 km westwards from St Osyth to Colne Point, where the shoreline turns north-northwest for a further c.2 km. Much of the marsh at St Osyth is emergent, except near the mouth of the tidal creek where it is degrading. The surface of the emergent marsh lies at 2.30 m OD +/- 0.15 and is covered by about 99 tides per annum (Wilkinson & Murphy, 1995). St. Osyth Marsh is an important site for documenting the changes in saltmarsh growth, and is one of a few marsh areas in Britain to have been dated. The age of the marsh is about 4,300 years, the date provided by the analysis of a peat seam preserved in grey-black clay at the site. The character of the saltmarsh differs along the southern coast where the coastline is more open and tidal processes more active than those within the sheltered reaches. This stretch of coastline includes a transitional zone from saltmarsh to sand-dune and is protected seaward by a barrier beach.

Human Exploitation

The saltmarsh habitat is unsuitable for settlement and so has remained undeveloped. The saltmarsh is seaward of the seawall and so is subject to flooding. Grazing was traditionally carried out upon the saltmarshes. There are a few jetties and landing stages to gain access to the water. The area at Brightlingsea Creek is now a national nature reserve.

Rarity	Emergent saltmarsh unimpeded by drainage or development	3
Cultural Association	Saltmarsh areas would have been used for activities and at times of lower sea-level a stable landsurface for human occupation or activities	2
Amenity Value	The area is protected as a SSSI and has a high nature conservation value	3
Capacity for change	Areas of the saltmarsh are degrading and the system has a low capacity for change including development and sea-level change	3

GCZ 3.5 Sand and shingle ridge surrounding Colne Point

Summary

The zone covers the sand-dunes and shingle ridges from St Osyth to the spit at Colne Point and is one of the few dune systems in Essex.

Geology

The sediments are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The coarser-grained sediments of the shingle ridge and beaches comprise sands and gravels (shingle), derived from cliff erosion and reworking of earlier beaches.

These are topped with finer sand forming the dunes. The sand and shingle ridges are mixed with clay within the intertidal zone.

Soil

Much of the area is subjected to regular flooding and there is no soil development. In some areas on higher ground Saline soils have formed upon the marine alluvium. They are of variable texture depending upon the lithologies of the parent material.

Topography/Geomorphology

The landscape along the coastal edge is one of sandflats, beaches and beach ridges formed above mean high tide level. The narrow beach forms a barrier on the seaward facing edge of the saltmarsh (GCZ 3.4). Sandy mudflats and tidal ponds border the beach above low mean tide level. Neal et al (2003) have shown that the beach ridges are not true cheniers. From St Osyth a narrow beach extends some 3 km westwards from St Osyth to Colne Point, where the shoreline turns north-northwest for a further 2.3 km. During periods of higher wave energy the coarse-grained beach material is transported along the coast in the direction of the prevailing current (longshore drift). The force of the waves decreases as they move into the sheltered mouth of the estuary towards Colne Point and the sediment is deposited, with the coarser-grained sediments deposited first. Over time the build up of the coarse-grained sediment forms ridges and sand-dunes. Finer-grained sediments are transported further along the coast towards the distal end of the ridge to form a small, narrow barrier spit. At Colne Point the spit shows a historical pattern of extension and shortening as well as destruction and reworking at the landward end of two older beach ridges that are thought to have been formed over a thousand years ago.

Human Exploitation

The beach ridge has been subjected to gravel extraction in the past. The site is now protected as it lies within the Colne Estuary SSSI and is a an Essex Wildlife Trust reserve

Rarity	One of the few beach ridge and dune systems in Essex	3

Cultural Association	Possible prehistoric or historic associations with human activity	2
Amenity Value	Part of the Colne Estuary SSSI and of high nature conservation value	3
Capacity for change	Low capacity for change including man made and environmental changes	3

GCZ 3.6 Estuarine alluvial sediments at Point Clear Bay to St Osyth Stone Point

Summary

The zone contains estuarine alluvial sediments of mud and sand at Point Clear Bay and around St Osyth Stone Point. The zone is separated by Ray Creek from the shingle spit at Colne Point.

Geology

The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The superficial sediments are composed of fine-grained alluvial clays and coarser-grained sands deposited by the sea.

Soil

The area is subjected to tidal flooding and no soil development has occurred.

Topography/Geomorphology

The sediments are located within the sheltered reaches of the Colne Estuary. They are separated from the sand ridges and shingle spit at Colne Point by Ray Creek. They form a large open flat landscape up to the sea wall.

Human Exploitation

The landscape is unsuitable for settlement or industry. A number of landing stages project from the land to gain access into the waterway at high tide, one hard-landing stage has been constructed across a narrow stretch to gain access into Ray Creek.

Rarity	There is an association of these sediments to geomorphological landforms rare within Essex	2
Cultural Association	No known cultural association	1
Amenity Value	Not suitable for access	1
Capacity for change	Moderate capacity for change, threats from environmental change	2

GCZ 3.7 Drained saltmarsh around Brightlingsea and St Osyth.

Summary

The zone contains two large separate areas of drained saltmarsh, including Brightlingsea Marshes and, to the south, St Osyth Marsh.

Geology

The alluvial sediments are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine-grained sediments deposited by the sea at high tide level within an estuarine environment. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher energy such as storms. The deposits built up over time and in sheltered areas allowed the colonisation of plants and the formation of saltmarsh. Subsequent flood events or rising sea-level rises cover the vegetation with muds and the buried vegetation eventually broke down to a peat deposit. These sediments were laid down during the Holocene and provide a record of changing sea-levels. These alluvial deposits below the saltmarsh vegetation lie inland of the seawall and have been artificially drained and improved for cultivation.

Soil

The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high groundwater table.

Topography/Geomorphology

The saltmarsh landscape is a typically flat open area between the low coastal slopes and high tide mark (below 5 mOD) along the Colne Estuary and Brightlingsea Reach and around the coast to St Osyth. It lies adjacent to a number of tidal creeks including Thorrington, Brightlingsea, St Osyth, and Flag Creek. The drained saltmarsh no longer receives any input of sediment or water from mean high tides due to the construction of the sea wall, however an extensive area between Colne Point and Clacton-on-Sea is vulnerable to flooding during storms and high tides. Drainage has occurred by maintaining existing, natural channels that meander through the saltmarsh and the addition of regular linear drains across the landscape towards the sea. Many of the former creeks have silted up but are identifiable by depressions within the fields. There are a number of open water bodies and ponds.

Human Exploitation

The saltmarshes have been utilised for grazing and industry historically. Few parts of the marsh are still grazed, such as at Howlands Marsh and Jaywick. Some of the drained marshland around Brightlingsea is used for grazing, much of the saltmarsh has been converted to open grassland and agricultural fields. There is scattered evidence for the former industrial uses of the marsh; red hills at Howlands, and concentrations of historical industrial activity have been identified near Brightlingsea (GCZ 3.1) and St Osyth Marsh (GCZ 3.3). A post-Roman kiln lies within the zone, possibly for drying of grain before transport by sea. Excavations along the channel and land at St Osyth revealed the remains of a wharf dating to the late 15th/early 16th century. The construction of the sea defences allowed the saltmarsh inland of the defences to be drained. A branch railway line was built between Wivenhoe and Brightlingsea along the western edge of the drained marsh, this has now been dismantled but suggests that the marshland industries were profitable at this time. There were two brickworks at Great Bentley along Thorrington Creek. Evidence for the former recreational uses of the saltmarsh in the 19^{th} century survives in the form of a decoy pond. During the Second World War anti-glider ditches were dug on the marshes, some of these are still evident as cropmarks.

The site of a Roman villa within this zone west of Brightlingsea reveals that some areas within the zone were habitable during Roman times. Before the marshes were drained they would have been unsuitable for settlement; however the modern development of coastal holiday settlements such as Jaywick and Seawick has led to residential and recreational development within the zone including caravan parks, holiday complexes, car parks and golf courses at Westmarsh Point and Point Clear

Rarity	Areas of drained saltmarsh are limited in distribution to the coastal zone inland of the sea wall	3
Cultural Association	High proportion of prehistoric and historic activity and historical industrial remains	3
Amenity Value	Remains of early industrial sites visible within the landscape ie.salterns and accessible for further investigation	3
Capacity for change	Limited capacity for change including increasing development and agricultural intensification	3

GCZ 3.8 Saltmarsh along the River Colne and tidal creeks

Summary

The zone covers the surviving remnants of saltmarsh along the coastal fringes, largely seaward of the sea wall, along the River Colne and tidal inlets.

Geology

The fine-grained sediments of the London Clay which form the bedrock of the zone represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine-grained sediments deposited by the sea at high tide level within an estuarine environment. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher energy such as storms. The deposits built up over time and in sheltered areas which allows the colonisation of plants and formation of saltmarsh. Investigation of an exposed sequence on the saltmarsh edge (Wilkinson & Murphy, 1995) has shown the estuarine clay to be c.1.4m in depth. The clays are grey, mottled and contain fibrous roots and other plant debris

Soil

With areas of saltmarsh, soils formed upon the marine alluvium are referred to as Saline. They are of variable texture depending upon the lithologies of the parent material. The soils can range from soft and unripened where they are subjected to regular flooding and fresh sediment input to firm and ripened on higher sites or on sandier parent materials. All variations are frequently calcareous. The soils can be utilised for some summer grazing.

Topography/Geomorphology

The zone comprises discrete patches of active/emergent saltmarsh areas. These are generally low-lying, flat landscapes dissected by sinuous branching tidal inlets and channels and areas of open water. The saltmarsh is found along part of the River Colne channel and along Alresford Creek, Brightlingsea Creek including Cindery Island, Flag Creek and St Osyth Creek. The growth of the saltmarsh vegetation provides a more stable environment beyond the influence of daily tidal inundation while the creeks allow tidal waters into the saltmarsh landscape. The saltmarsh continues to develop above mean high water through the vegetational succession of salt-tolerant plants. The saltmarshes are bordered by the intertidal mudflats seaward and in many places bounded by the sea wall landward.

Human Exploitation

The zone would have been unsuitable for settlement but were a vital resource for fisheries and farming. The cheese-making and woollen industry relied on the saltmarsh for summer grazing land. Cindery Island is littered with oyster pits, evidence of a profitable industry in the past. These are now disused. Channels were enlarged or cut to gain greater access to the land as at Church Dock, north of Brightlingsea Hall. A regular series of interlinked pits have been cut into the saltmarsh north of Point Clear with inlets to the water. Investigation of saltmarsh deposits carried out during the Hullbridge Survey (Wilkinson & Murphy, 1995) found a series of wooden structures along 130 m of the foreshore south of Alresford which they proposed to be a sea-wall revetment dating from the 11th century. The saltmash is bounded by the current sea-wall, preventing inland growth. Drains and sluices have been cut though the saltmarsh in places to aid drainage from inland of the sea wall.

Rarity	Emergent saltmarsh is limited in extent around the coast and estuaries	3
Cultural Association	Some evidence for prehistoric and historic activity	2
Amenity Value	Difficult access but some research potential for sea-level change and archaeology	2
Capacity for change	Low capacity for change, significantly environmental change	3

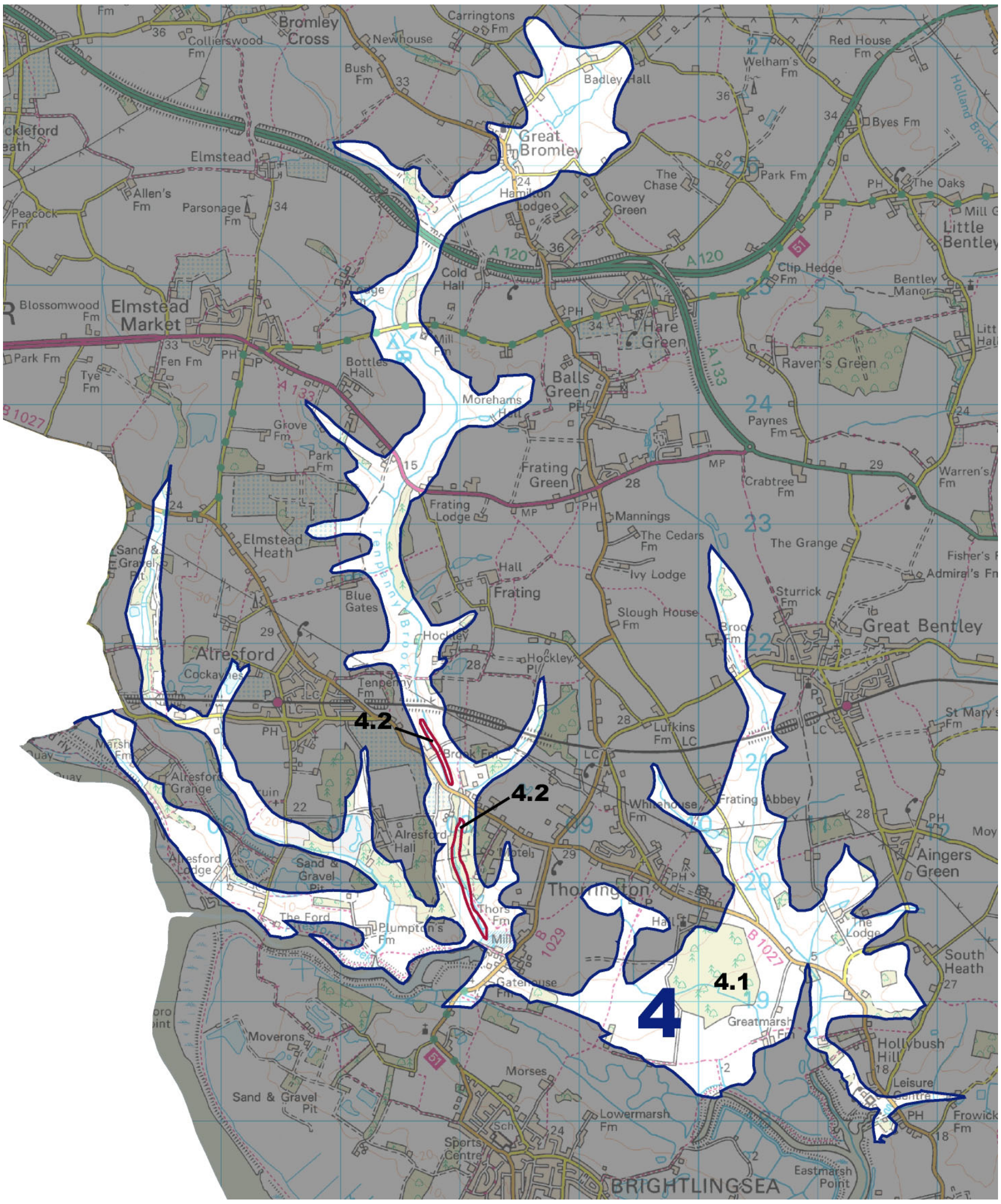


Fig 23 Geodiviersity Character Zones (GCA 4)

GCZ 4.1 Alresford valley system

Summary

The zone comprises the brooks, tributaries and London Clay slopes of the Alresford Valley system, part of the Colne catchment

Geology

The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The London Clay slopes have become exposed due to erosion of the overlying sediments by water, in places the upper valley slopes are capped by Wivenhoe Gravels (GCZ 7.6) and Ardleigh Gravels (GCZ 6.3) and brickearth.

Soil

The soils developed on the valley slopes belong to the Wix Soil Series. These are often formed on head/solifluction deposits over London Clay on gentle slopes and can be deep sandy or sandy silt loams. They are fairly resistant to erosion by water. The soils give rise to fairly productive agricultural land, which is of better quality (Grade 2) on the western slopes (east-facing) and less steep basal slopes.

Topography/Geomorphology

The valley system flows north-south and the main tributaries include the Bentley Brook, Tenpenny Brook, and Sixpenny Brook flowing into the Alresford and Thorrington Creeks which feed into the River Colne. The slopes are relatively steep-sided in the headwaters, from c.20 m to 10 mOD. The valleys are asymmetrical with steeper west-facing slopes. The lower slopes (c.5 m -10 mOD) become markedly less steep nearer to the creeks, around Alresford and Thorrington Creeks. There is a high proportion of woodland cover upon the slopes, much of it deciduous and some of it ancient. Thorringtonhall Wood is located on the less steep basal valley slopes (c.20 m- 5 mOD). Along Tenpenny Brook the less well drained areas support unimproved grasslands and meadows, elsewhere slight drainage improvements have resulted in small fields of pasture and on the lower slopes large-scale arable fields. There are small reservoirs along the brooks and the remains of historic fish ponds along the Bentley Brook at Great Bentley

Human Exploitation

The zone is largely rural in character. Historically there has been sparse development and limited settlement consisting of scattered cottages and isolated farms. There is a small village at Great Bromley and some recent holiday homes near

Thorrington Creek. The zone contains three recorded historic brickworks at Great Bentley (HER 15366), Thornington Mill (HER 15495) and Mill Hill, Great Bentley (HER 15517). The railway cuts across the high reaches of the valley on embankments running east-west.

Rarity	One of a number of valley systems with London Clay slopes within the District	1
Cultural Association	Some historical industrial related activities	2
Amenity Value	Low potential for research and difficult access	1
Capacity for change	Moderate capacity to change due to the natural balence of valley systems	2

GCZ 4.2 Tenpenny Brook alluvial deposits

Summary

The zone includes the freshwater fluvial flood deposits (alluvium) found along the Tenpenny Brook upstream of the confluence with the Alresford Creek

Geology

The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The freshwater alluvial deposits consist of fine-grained deposits, largely silts laid down under flood conditions adjacent to the main channel of the brook.

Soil

Soils formed upon the alluvial deposits are mapped as the Wix Soil Series. These are characterised by deep sandy silt loams. They are fairly resistant to erosion by water. Upon the alluvial deposits they are of poorer quality agricultural land and lying adjacent to the main channel may suffer from waterlogging.

Topography/Geomorphology

The Tenpenny Brook is the middle tributary of the Alresford Valley system with the most northerly headwaters. The alluvial deposits lie at a height of c.5 mOD at the base of the lower valley slopes within the narrow floodplain. They are found immediately upstream of the Tenpenny Bridge east of Alresford and between the bridge and Mill Dam which feeds into Alresford Creek. Their deposition may relate to the function of the dam holding back waters from the Creek.

Human Exploitation

There is no settlement or development within the zone of the alluvial deposits however the construction of Mill Dam at the confluence of Tenpenny Brook and Alresford Creek may relate to their deposition.

Rarity	Limited distribution within valley system and District	3
Cultural Association	No known cultural association	1
Amenity Value	Potential for palaeoenvironmental evidence	2
Capacity for change	Limited capacity for change, including development and environmental change	3

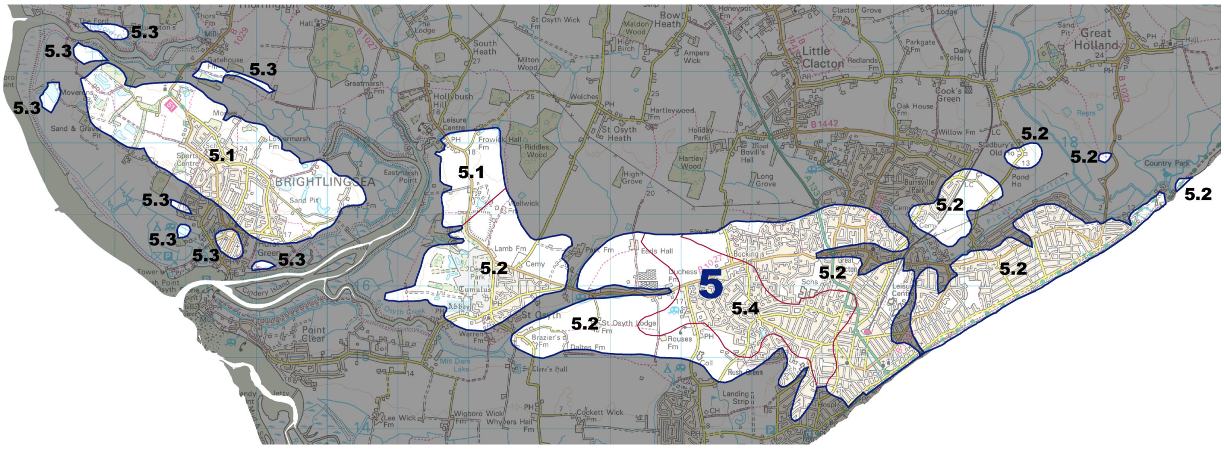


Fig 24 Geodiviersity Character Zones (GCA 5)

GCZ 5.1 St Osyth Gravels around Brightlingsea

Summary

The St Osyth Gravels belong to the fourth highest of the four Kesgrave Formations on the Tendring Plateau. The St Osyth Gravels were deposited along an earlier course of the Thames and are contemporaneous with the Holland Gravels which were laid downstream of the Thames/Medway confluence. The stratigraphy of the gravels records the change from sediments deposited by a pre-Anglian river to those deposited as Anglian glacial outwash around 450,000 years ago.

Geology

The gravels cut though older Kesgrave deposits and are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

At St Osyth gravel pit the Lower St Osyth Gravels are up to 10 m in depth, their coarse-grained gravel component reflects an input from the pre-Anglian Thames catchment with a directional flow to the south-east. These are overlain by up to 3 m of gravelly sand, the Upper St Osyth Gravels, which have a wider range of lithologies. The reduction in clast size between the Lower and Upper gravels indicate a decrease in energy due to a blockage by ice leading to a more restricted flow of water and the wider ranging lithologies indicating glacially derived material entering the river system upstream. The deposits reveal just how rapidly the Thames suddenly ceased to flow through central Essex as a result of being blocked upstream in Hertfordshire and Essex by the Anglian ice sheet

Soil

The soils developed upon the gravels are of the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The majority of the zone has Grade 2 agricultural land.

Topography/Geomorphology

The gravels survive at around 10 - 20 mOD across the flat topped ‘island’ of Brightlingsea. The distribution of the gravels indicates a river system with a more restricted channel, c.2-3 km wide, representing a significant change in the dynamics of the system caused through blockage by the Anglian ice-sheet higher up in the catchment. The gravels are underlain by London Clay which is exposed along the relatively steep coastal slopes.

Human Exploitation

The flat topped ridge of the ‘island’ would have been attractive for settlement from prehistoric times. Small scattered areas of mixed deciduous woodland survive and linear plantations. The field pattern is irregular and only a small proportion of the zone is used for agriculture. The historic settlement of Brightlingsea has grown over the years and now covers a large proportion of the zone. The landscape is marked by a history of quarrying with open areas of disused workings, open areas of water and reservoirs. The zone has been substantially quarried around Brightlingsea and St Osyth and contains one active quarry at Moverons Pit. There are applications for further quarrying within the zone. The location of the gravels adjacent to the London Clay slopes would have been advantageous for brickmaking. A brick field kiln is shown on the 1st Edition OS map on the southeast coast of Brightlingsea.

Rarity	Gravels form part of a wide band across the District	2
Cultural Association	Current re-evaluation of possible cultural association	2
Amenity Value	The St.Osyth Gravel Pit SSSI is a now overgrown and no sand and gravel is visible. It would be of great value if a section of sand and gravel could be created in the vicinity	2
Capacity for change	Limited capacity for change, including quarrying activities currently and in the future	3

GCZ 5.2 Holland Gravels east of Brightlingsea to Clacton on Sea

Summary

The Holland Gravels correlate with the lowest of the four Kesgrave formations on the Tendring Plateau. The band of gravels was deposited by an earlier course of the Thames downstream of the confluence with the Medway system. They are contemporaneous with the St Osyth Gravels laid down by the Thames. The gravel body records the change from sediments deposited by a pre-Anglian river to those having an input of Anglian glacial outwash. These gravels cross the southern part of the District trending west-east towards the southeast coast.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Lower Holland Gravel is recognised as the final terrace aggradation by the Medway-Thames before the diversion of the latter river and includes a small but significant contribution from the contemporary River Medway. In the cliffs at Holland-on-Sea the Lower Holland Gravel is up to 5 m in thickness overlain by sands. This is overlain by a fine-grained sandy gravel deposit, the Upper Holland Gravel, which has a different composition of lithologies indicating that it is largely a Medway deposit, although with a proportion of glacial outwash material. The gravel indicates a cessation of input from the Thames due to blockage by ice further up in the catchment.

Soil

The soils developed upon the gravels are of the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The majority of the zone has Grade 3 agricultural land.

Topography/Geomorphology

The deposits are located generally between 10 -15 mOD in a wide band across the lower central part of the District running west-east and widening in distribution at the coast. The combined Thames-Medway river systems would have formed a channel c.4-5 km wide. The gravels have been eroded by a north-south flowing stream at St Osyth but otherwise form a largely flattened ridge of elevated ground towards the coast at Clacton-on-Sea.

Human Exploitation

The zone would have provided a prominent position within the surrounding landscape and has been subjected to settlement and activity from prehistoric times as revealed by cropmarks and excavation around St Osyth. The zone contains the historic St Osyth's Priory, part of which was built from the surrounding natural stones or 'septaria' from the London Clay. Few farms and scattered cottages indicate the former rural nature of the zone. There are few large open agricultural fields north of St Osyth. There are open recreational areas surrounding the town at St Osyth including St Osyth Park, surrounding the Priory, which contains open-water bodies, evidence for past mineral extraction. There has been some recent quarrying in the zone at St Osyth and east of Brightlingsea. There is still one active quarry within the zone with an application for extension. Two brickworks operated in the early 20th century at Coopers Lane (HER 15501) and Valley Road (HER 15503), both are now built over by the modern development at Clacton-on-Sea.

The gravels are considered to be of low potential for artefacts/faunal remains of Palaeolithic age. However recent re-evaluation of existing flint artefact collections suggest that pre-Anglian flints may have been derived from the Holland Gravel (Wenban-Smith, 2007).

Rarity	Gravels form part of a wide band across the District	2
Cultural Association	Current re-evaluation of possible cultural association	2
Amenity Value	The Holland cliff section represents a stratigraphic site of considerable importance.	3
Capacity for change	Limited capacity for change, including development and environmental change	3

GCZ 5.3 Undifferentiated river terrace gravels around Brightlingsea

Summary

The discrete patches of undifferentiated river terrace gravels are located around the island of Brightlingsea. It is likely that they were deposited by an earlier course of the Thames and are contemporaneous with the St Osyth and Holland Gravels.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The deposits consist of fluvial sand and gravels. Clast lithological analysis would help determine if these gravels belong to the St Osyth or Holland deposits or possibly Colne terrace deposits.

Soil

The soils developed upon the gravels are soils of the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water.

Topography/Geomorphology

The discrete patches of gravels (less than c.0.5 km in length) are located at the base of the exposed London Clay slopes and within flat open saltmarsh, on or below the 5 mOD contour line. The majority of the gravels form isolated 'islands' within the adjoining low-lying area of saltmarsh. One 'patch' is identified as 'Furze Hill' on 1st edition OS and indicates that it was previously wooded.

Human Exploitation

The modern built-up development at Brightlingsea covers one of the larger gravel patches. The historic settlement seems to have extended from the main centre along one of the gravel 'islands' towards the southwest coast and industrial area. Other discrete patches are within the drained marsh area and are part of the large open arable field system. There has been some quarrying, both historic and recent.

Rarity	River terrace gravels of unknown origin within a larger band of fluvial gravels	1
Cultural Association	No known cultural association	1
Amenity Value	Limited distribution and of low research potential	1
Capacity for change	Moderate capacity for change, threats from increasing development	2

GCZ 5.4 Brickearth deposits at Clacton-on-Sea

Summary

A discrete patch of brickearth covers the western area of Clacton. The deposit lies within the projected channel of the Thames/Medway river systems immediately prior to the Anglian glaciation. It is surrounded by Holland Gravel and so is likely to be overlying Holland Gravels.

Geology

The bedrock of the zone is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The superficial geology is brickearth. Brickearth deposits include fine sand and silts mixed with clays that are transported by the action of wind, sometimes over a considerable distance from their original position. The original deposition of the sediments occurs under cold climates within fluvial outwash sediments from glaciers. The exposed finer-grained sediments were picked up and transported by the wind and deposited when conditions ameliorated with the sand deposited first due to its larger grain size.

The Holland Gravels (GCZ 5.2) surround the discrete patch of brickearth and can be expected to exist below the brickearth deposits.

Soil

The soils developed on the brickearth are the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The brickearth and probably underlying gravels provide relatively good agricultural land (Grade 2/3).

Geomorphology

The brickearth covers an area of around 3 km x 1 km in extent, forming an irregular discrete patch upon a flattened ridge lying at c.10-15 mOD overlooking the Holland Brook valley.

Human Exploitation

The western and southern limits of the sediments correlate with the urban settlement situated upon it. The zone is largely covered by the built-up residential settlement at Clacton-on-Sea and its suburbs with recreational grounds and allotment plots forming the few open areas within the town. Few open areas survive with large open fields and a small wood in the extreme west. The zone contained a relatively dense concentration of historic brickworks, (HER 15499, 15500, 15501, 15502), operating around the end of the 19th century/early 20th century. One of the brickworks was powered by steam and was located close to a lake within the urban district which may have been associated with the works.

Rarity	Brickearth is widespread in extent over the District	1
Cultural Association	Dense concentration of historical industrial sites with limited potential for below ground remains	2
Amenity Value	Covers stratigraphically important sediments of the Holland Gravels	2
Capacity for change	Much of the area is heavily developed with little open area at risk from residential expansion	2

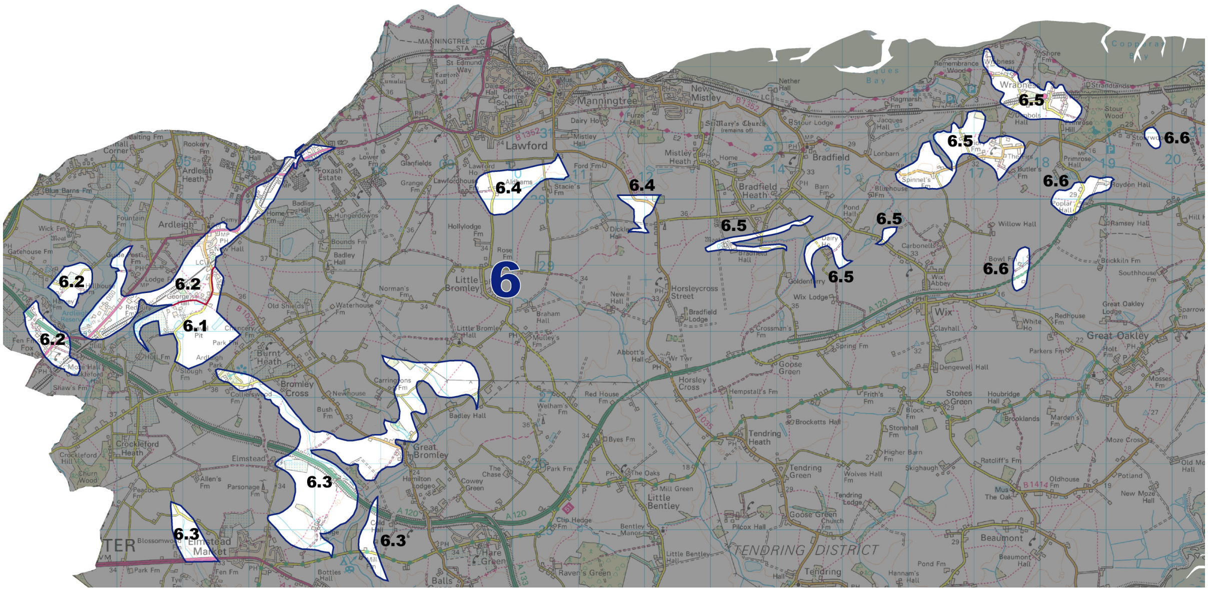


Fig 25 Geodiviersity Character Zones (GCA 6)

GCZ 6.1 Ardleigh Gravels at Martells Quarry

Summary

The Ardleigh Gravels belong to the second highest of the four Kesgrave Formations on the Tendring Plateau. They were deposited by the pre-diversion Thames c.550,000 years ago, when it flowed across the north of the district. They are thought to be contemporary with the Oakley Gravels (GCA 2). The zone covers an area of sands and gravels, overlain in part by brickearth, in the north-western corner of the district where the gravels have been exposed through quarrying and the stratigraphy recorded. The gravels represent two separate cold climate periods and are separated by interglacial deposits. These are capped by a complex buried soil above which is a further local gravel, the Martell's Gravel.

Geology

At Martells Quarry the gravel sequence is underlain by London Clay, borehole records suggest the surface of London Clay lies between 6.5 and 12 m below natural ground levels (22-26 mOD). The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The gravels are capped by brickearth (GCZ 1.4) which has been removed in order to extract the Ardleigh Gravels. At this site three separate gravel bodies are recognised; Martells Gravel, Ardleigh Upper Gravel and Ardleigh Lower Gravel. Quarrying has revealed the combined thicknesses of the gravels to be between 8 and 10.5 m.

The basal coarse-grained sand and gravels belonging to the Ardleigh Lower Gravel are up to 2.0 m in thickness. This gravel is overlain by sand and beds of fine-grained organic grey clay (c.0.5 m thick) containing plant fossils which were deposited by a river under lower energy conditions in a warm climatic environment. Pollen samples from the organic horizons have been dated to an early part of the Cromerian Complex deposit otherwise unknown within Britain. The Ardleigh Upper Gravel overlie the interglacial deposit and represents a return to cold climate conditions; they are up to 5m in thickness and composed of coarse-grained sands and gravels. Within the Ardleigh Upper Gravels is a clay bed ranging from 0.1 to 1.0 m in thickness, containing rare fossils of plants that existed during a period of cold climate (arctic) conditions. The deposition of the clay reflects very low energy conditions within the river channel, possibly overbank flood deposits. The Ardleigh Upper Gravels (Martells Gravel) are enriched by a red clay deposit and are deformed. The enriched horizon is considered to be a palaeosol, initially formed during a warm period (temperate stage), known as the Valley Farm Soil, and continued to develop and deform as conditions became cooler, known as the Barham soil. Continued higher energy cold conditions are indicated by the deposition of coarse-grained sediments of sand and gravel known as Martells Gravel. Up to 3.0 m of gravel was deposited during this stage.

Soil

Due to the superficial brickearth covering over the gravels within this zone the soils developed belong to the Tendring Soil Series. The Tendring Soil Series are palaeo-argillic brown earths and are characterised by deep often stoneless coarse loamy soils. They are highly fertile soils but can be prone to some seasonal waterlogging.

Topography/Geomorphology

The sediments are located on relatively flat ground, above c.35 mOD at the top of the southern bank of the Salary Brook in the headwater region with springs to the north and south. A thin arm of the gravels to the south of the zone is wooded, however the area has been extensively modified due to quarrying.

Human Exploitation

The majority of the zone has been extensively quarried due to the very high quality silica content of the sand component. Martells Quarry is the only silica sand quarry in Essex. There are further quarries that are likely to be extracting the Ardleigh gravels around the Elmstead Market and Ardleigh area. The history of quarrying can be traced back to post-medieval times (HER 17657), possibly small scale extraction linked to the only house in the area at the time, Martells Hall.

Rarity	Exposures of the full stratigraphic sequence are rare	3
Cultural Association	Association with the Oakley Gravels (see GCA 2)	2
Amenity Value	SSSI site, good access and high potential for further research	3
Capacity for change	Limited capacity for change, especially further quarrying	3

GCZ 6.2 Ardleigh Gravels around Ardleigh reservoir.

Summary

The Ardleigh Gravels belong to the second highest of the four Kesgrave Formations on the Tendring Plateau. They were deposited by the pre-diversion Thames c.550,000 years ago, when it flowed across the north of the district.They are thought to be contemporary with the Oakley Gravels (GCA 2). The zone includes the deposits of sands and gravels which are located along the higher slopes of the Salary Brook.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface sediments are Ardleigh Gravels, part of the Kesgrave Sands and Gravels which represent the coarse-grained sediments laid down on the river bed under cold-climate conditions. The full stratigraphy of the gravels has been investigated at Martells Quarry (GCZ 6.1) where three separate gravel bodies have been identified separated by fine-grained organic interglacial and cold climate sediments.

Soil

The slopes are covered by Wix soils. The Wix Soil Series are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The land is of good agricultural grade (Grade 2/3).

Topography/Geomorphology

The gravels are located along the top of the slopes of the headwaters of the Salary Brook and around the Ardleigh Reservoir at heights of c.30-35 mOD. Part of the zone lies adjacent to Martells Quarry.

Human Exploitation

The area remains largely rural with scattered farms and small linear settlements. It includes the waterworks for the reservoir and lies adjacent to Martells Quarry. It is possible the gravels were extracted during works for the Ardleigh reservoir. The railway line crosses the zone north to south and the A12 crosses the southern part of the zone east-west. In the northernmost zone the Foxash Industrial Estate has built up.

There are two reported findspots of Palaeolithic flints (HER 2543, 2567) from within the zone in the Ardleigh area which, if contemporary with the gravels would date them to c.700,000 years old. However these flints have not been recovered from the gravels directly.

Rarity	Part of discrete and discontinuous band of gravels in the northwest of the District	2
Cultural Association	Association with the Oakley Gravels (see GCA 2)	2
Amenity Value	Areas adjacent to exposures of full stratigraphic sequence merit further investigation	2
Capacity for change	Moderate capacity for change, especially quarrying	2

GCZ 6.3 Ardleigh Gravels around Great Bromley.

Summary

The Ardleigh Gravels belong to the second highest of the four Kesgrave Formations on the Tendring Plateau. They were deposited by the pre-diversion Thames c.550,000 years ago, when it flowed across the north of the district.They are thought to be contemporary with the Oakley Gravels (GCA 2). The zone includes deposits of sands and gravels in the upper reaches of the Bromley Brook and Tenpenny Brook.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface sediments are Ardleigh Gravels, part of the Kesgrave Sands and Gravels which represent the coarse-grained sediments laid down on the river bed under cold-climate conditions. The full stratigraphy of the gravels has been investigated at Martells Quarry (GCZ 6.1) where three separate gravel bodies have been identified separated by fine-grained organic interglacial and cold climate sediments.

Soil

The soils developed upon the gravels belong to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams, however where they are formed on gravelly lithologies the soils can have a moderate to strong, stony component which makes them permeable. They are fairly resistant to erosion by water. The zone covers areas of lower grade agricultural land. At Slough Farm potatoes, sugar beet, cereals and oilseed rape are grown. There is often a need for irrigation due to unreliability of water sources recently.

Topography/Geomorphology

The sediments survive along the top of the slopes of the headwaters of the Salary Brook and the high valley slopes of the Sixpenny, Bromley and Tenpenny Brooks at heights of c.30-35 mOD. The zone is crossed by numerous streams often with smaller springs arising from within patches of woodland. Much of the land is rural surrounding the villages of Elmstead Market and Great Bromley.

Human Exploitation

There is a small amount of quarrying within the zone at Hall Farm, Great Bromley with an application for further quarrying at Blue Gate farm, north-west of Great Bromley. Part of the zone is crossed by the A12, however much of the land is undeveloped and natural in places.

Rarity	Part of discrete and discontinuous band of gravels in the northwest of the District	2
Cultural Association	Association with the Oakley Gravels (see GCA 2)	2
Amenity Value	Good access and location for potential further investigation	2
Capacity for change	Moderate capacity for change, especially quarrying	2

GCZ 6.4 Ardleigh Gravels within the Stour valley system south of Mistley.

Summary

The Ardleigh Gravels belong to the second highest of the four Kesgrave Formations on the Tendring plateau. They were deposited by the pre-diversion Thames c.550,000 years ago, when it flowed across the north of the district. They are thought to be contemporary with the Oakley Gravels (GCA 2). The zone includes the deposits of sands and gravels which are located along the higher slopes of the tributary valley of the Stour.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface sediments are Ardleigh Gravels, part of the Kesgrave Sands and Gravels which represent the coarse-grained sediments laid down on the river bed under cold-climate conditions. The full stratigraphy of the gravels has been investigated at Martells Quarry (GCZ 6.1) where three separate gravel bodies have been identified separated by fine-grained organic interglacial and cold climate sediments.

Soil

The small patches of gravel are exposed along the margins of the Tendring plateau and the soils developed in this area are of the Tendring Soil Series. These are characterised by usually deep and stoneless loams and drain reasonably well, although it can also contain sufficient water to avoid drought in most years. The gravels are likely to influence the soils locally and would result in a higher stone content than typical Tendring soils. The land is of good quality agricultural grade (Grade 2/3).

Topography/Geomorphology

The discrete patches of surviving gravels are located on level ground (c.30-35 mOD) along the high valley slopes, near the issues of the southwest-northeast running valley of the tributary flowing towards Mistley. They have become exposed through erosion by the streams and are likely to survive below the adjacent brickearth deposits (GCZ 1.2 and 1.7). The land is crossed by small streams and there is a small reservoir along the stream south of Lawford.

Human Exploitation

The small zone is undeveloped and largely rural with large, open arable fields, few cottages and a farmstead.

Rarity	Part of a discrete and discontinuous band of gravels in the north-west of the District	2
Cultural Association	Association with the Oakley Gravels (see GCA 2)	2
Amenity Value	Gravels lie within close proximity of the oldest Kesgrave Members within the District and their relationship has potential research value.	2
Capacity for change	Moderate capacity for change, especially quarrying	2

GCZ 6.5 Ardleigh Gravels within Stour Valley system around Wrabness.

Summary

The Ardleigh Gravels belong to the second highest of the four Kesgrave Formations on the Tendring Plateau. They were deposited by the pre-diversion Thames c.550,000 years ago, when it flowed across the north of the district.They are thought to be contemporary with the Oakley Gravels (GCA 2). The zone includes the deposits of sands and gravels which are located along the higher slopes of the tributary valley of the Stour.

Geology

The gravels are underlain by Red Crag in places as seen in a cutting east of Wrabness Station. The gravels were reported to be over 1 m in thickness with a pebble bed of phosphatic nodules at the base. The Red Crag was deposited in a sandy sea c.700,000 years ago and once covered much of north Essex.

The Red Crag rests upon the London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface sediments are Ardleigh Gravels, part of the Kesgrave Sands and Gravels which represent the coarse-grained sediments laid down on the river bed under cold-climate conditions. The full stratigraphy of the gravels has been investigated at Martells Quarry (GCZ 6.1) where three separate gravel bodies have been identified separated by fine-grained organic interglacial and cold climate sediments.

Soil

The slopes are covered by Wix soils. The Wix Soil Series are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The land is of good agricultural grade (Grade 2/3). Part of the zone surrounds Dairyhouse Farm which could suggest use of the lower quality land for grazing

Topography/Geomorphology

The gravels survive as discrete patches along the high valley slopes (c.25-30 mOD) and southern slopes of the south-north running tributary valley flowing towards Wrabness. The gravels lie adjacent to the brickearth deposits (GCZ 1.2) and are likely to survive below these deposits. The land is largely rural with large open fields. Springs and streams cross the zone feeding into the main valley. Small areas of woodland and groves survive. Areas of open water exist as a moat and ponds around Bradfield Hall which lies at the head of a spring.

Human Exploitation

The zone has little development and limited settlement with scattered farms and cottages, the small hamlet south of Wrabness and village at Wrabness. The railway crosses part of the northern extent of the zone at Wrabness. The zone includes the historic moated site of Bradfield Hall where extraction of gravels is indicated by the presence of large ponds.

Rarity	Part of discrete and discontinuous band of gravels in the northwest of the District	2
Cultural Association	Association with the Oakley Gravels (see GCA 2)	2
Amenity Value	Some areas have good access and potential for further research. Wrabness cutting is recommended as a LoGS.	3
Capacity for change	Moderate capacity for change, including development and quarrying	2

GCZ 6.6 Ardleigh Gravels upon the London Clay plain.

Summary

The Ardleigh Gravels belong to the second highest of the four Kesgrave Formations on the Tendring Plateau. They were deposited by the pre-diversion Thames c.550,000 years ago, when it flowed across the north of the district. They are thought to be contemporary with the Oakley Gravels (GCA 2). The zone includes the discrete patches of sands and gravels within the London Clay plain and along the higher valley slopes of the tributaries of the Ramsey valley system.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface sediments are Ardleigh Gravels, part of the Kesgrave Sands and Gravels which represent the coarse-grained sediments laid down on the river bed under cold-climate conditions. The full stratigraphy of the gravels has been investigated at Martells Quarry (GCZ 6.1) where three separate gravel bodies have been identified separated by fine-grained organic interglacial and cold climate sediments.

Soil

The small patches of gravel lie upon the London Clay slopes and are mapped within an area of soils belonging to the Windsor Soil Series and Tendring Soil Series. The Windsor Soil Series are characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally valley slopes and the undulating lowlands. The land is of lower quality agricultural grade (Grade 1/2). The Tendring Soil Series are characterised by usually deep and stoneless loams and drain reasonably well, although it can also contain sufficient water to avoid drought in most years. The gravels are likely to influence both soil types locally and would result in a higher stone content and better drainage than typical Tendring and Windsor soils.

Topography/Geomorphology

The gravels survive as discrete patches upon the high valley slopes (above 25 mOD) north of the western tributaries of the Ramsey Valley system. They form a broken band trending southwest-northeast towards the Stour Estuary. The small patches of gravels are located within an open landscape within the London Clay plain.

Human Exploitation

The zone forms part of a largely rural landscape with few scattered farmsteads and includes Roydon Hall, Poplar Hall and Wickham lodge.

Rarity	Part of discrete and discontinuous band of gravels in the northwest of the District	2
Cultural Association	Association with the Oakley Gravels (see GCA 2)	2
Amenity Value	Discrete patches upon London Clay provide	1

	limited potential for further investigation	
Capacity for change	The discrete patches have moderate capacity for change due to their limited extent	2

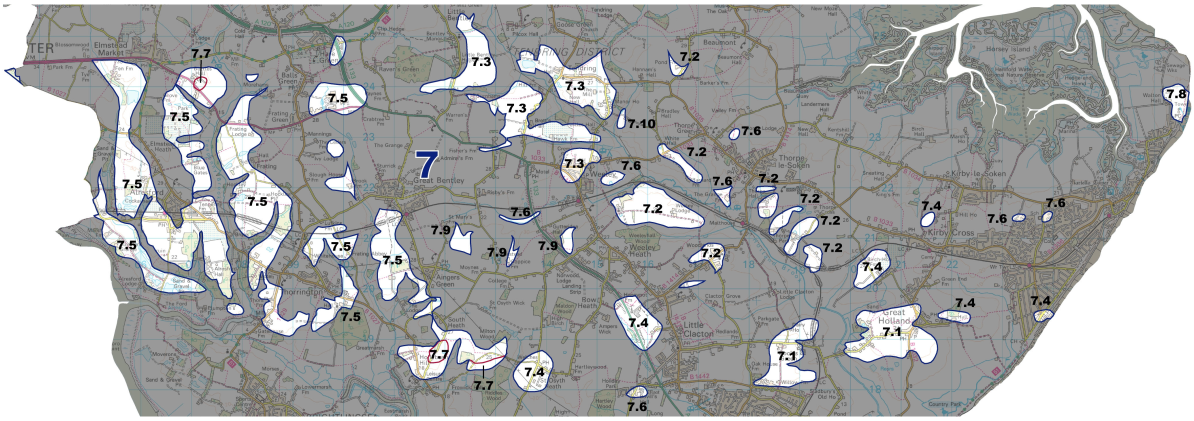


Fig 26 Geodiviersity Character Zones (GCA 7)

GCZ 7.1 Deposits of Cooks Green Gravels along the valley sides of the Holland Brook

Summary

The Cooks Green Gravels correlate with the third highest of the four Kesgrave Members on the Tendring plateau and are contemporary with the Wivenhoe Gravel. The Cooks Green Gravels represent course-grained sediments deposited beyond the confluence of an earlier course of the Thames and Medway rivers. These gravels are thought to have been deposited under cold climate conditions around 500,000 years ago. The zone covers the gravels along the valley sides of the Holland Brook.

Geology

The gravel overlies London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The superficial deposits are composed of sand and gravel. The stone content of the Cooks Green Gravels reveal that the material was being derived from two separate sources, the Thames River and Medway River. The stratigraphy of these gravels can be seen in the cliffs at Walton (GCZ 7.8)

Soils

The distribution of the gravel deposits correlate with the overlying Wix soils. The Wix Soil Series is characterised by deep loams, often formed on gravels and so have a coarse, frequently flinty component which makes them permeable. They are fairly resistant to erosion by water. Around the Holland Brook, these soils display patterned ground features which are relict features formed during the Devensian glacial stage. The land is classified as Grade 3 agricultural land. Much of the land is open fields.

Topography/Geomorphology

At the time the gravels were deposited the width of the combined Thames and Medway rivers was likely to have been around 7-8 km. The gravels lie at heights of between 10-20 mOD, their distribution following the contours, along the edge of the Tendring plateau. They form two discrete ‘islands’ along the upper slopes of the Holland Brook towards the mouth of the valley. A spring emerges from within one patch to join the Holland Brook, much of the land is flat with large open fields.

Human Exploitation

Much of the zone is rural with large open fields and few farmsteads. The zone has some linear development along the road at Cooks Green and also includes the edge of the Great Holland village.

Quarrying for the sand and gravel resource has occurred at Great Holland Pits and Hodgnells Farm. At Great Holland Pits the quarry has been restored and is now a nature reserve. Great Holland Pits no longer contain any visible exposures of the stratigraphy, however cobbles and boulders left after the quarrying operation reveal the wide variety of stones that make up the gravels.

Rarity	Part of a discontinuous spread of gravels across the central area of the District	2
Cultural Association	Association with Wivenhoe Gravels (GCA 7) from which Palaeolithic flints have been recovered	2
Amenity Value	Great Holland Pits recommended for consideration as a Local Geological Site (LoGS)	3
Capacity for change	Low capacity for change, especially further quarrying	2

GCZ 7.2 Deposits of Cooks Green Gravels along the mid valley slopes of the Holland Brook, south of Thorpe-le-Soken.

Summary

The Cooks Green Gravels correlate with the third highest of the four Kesgrave Members on the Tendring plateau and are contemporary with the Wivenhoe Gravel. The Cooks Green Gravels represent course grained sediments deposited beyond the confluence of an earlier course of the Thames and Medway rivers. These gravels are thought to have been deposited under cold climate conditions around 500,000 years ago. The zone covers the gravels along the mid valley slopes of the Holland Brook, south of Thorpe-le-Soken.

Geology

The gravel overlies London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface deposits are composed of sand and gravel. The stone content of the Cooks Green Gravels reveals that the material was being derived from two separate sources, the Thames River and Medway River. The stratigraphy of these gravels can be seen in the cliffs at Walton (GCZ 7.8)

Soils

The upper slopes have both Wix and Tendring soils developed upon them. Downslope the soils change to the Windsor Series. The Wix Soil Series is characterised by deep loams, often formed on gravels and so have a coarse, often flinty component which makes it permeable. The soils are fairly resistant to erosion by water. The Tendring Soil Series is usually deep and stoneless and drains reasonably well, although it can also contain sufficient water to avoid drought in most years. Around the Holland Brook, these soils display patterned ground features which are relict features formed during the Devensian glacial stage. The Windsor Soil Series is characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. The varied soil types within this zone are reflected in the mixture of woodland close by at Weeley Hall Wood (SSSI). The agricultural land classification is Grade 2-3, but is largely the poorer land type.

Topography/Geomorphology

At the time the gravels were deposited the width of the combined Thames and Medway rivers was likely to have been around 7-8 km. The deposits lie along the upper, relatively steep slopes of the mid-valley of the Holland Brook at heights of 15-25 mOD. They are located in discrete patches to the north, west and south of Thorpe-le-Soken, and on the southern side of the valley at Pig Street and Weeley Lodge. The extent of the gravels is masked by a covering of brickearth on the higher ground (GCZ 1.5) and the gravels are mainly exposed at the surface along the valley slopes. Springs issue along the boundary of the gravels and adjacent London Clay slopes. Woodland covers parts of the zone and there is place-name evidence that suggests more of this zone was covered by woodland in the past reflecting the base-poor, acidic nature of the soils.

Human Exploitation

There are findspots of Palaeolithic material surrounding the zone, including material identified as Clactonian (HER 3018), and a chert hand axe (HER 3018), which, if they were derived from the gravels, would make them pre-Anglian in age. However, recent investigation of some of the gravels mapped as Cooks Green (GCZ 7.10) around Thorpe-le-Soken suggests that the gravels may be a post-Anglian deposit of the nearby Holland Brook.

The land is generally rural with large open fields. The gravels have been quarried in a limited capacity in the past at Rose Farm, Thorpe-le-Soken. Weeley Lodge and Thorpe Hall are both located upon the gravel ‘islands’, presumably utilising the relatively prominent location within the landscape to reflect their high status. A mill house, west of Thorpe Green, indicates that these patches of gravel provided prominent locations for windmills as well.

Rarity	Part of a discontinuous spread of gravels across the central area of the District	2
Cultural Association	Association with Wivenhoe Gravels (GCA 7) from which Palaeolithic flints have been recovered at the type-site	2
Amenity Value	Discontinuous in extent and limited potential for further research	1
Capacity for change	Moderate capacity for change as gravels limited in extent and distribution	2

GCZ 7.3 Wivenhoe Gravels along the headwaters of the Holland and Weeley Brooks

Summary

The Wivenhoe Gravels belong to the third highest of the four Kesgrave Members on the Tendring Plateau and are contemporary with the Cooks Green Gravels. The Wivenhoe Gravels represent course-grained sediments deposited by an earlier course of the Thames. These gravels are thought to have been deposited under cold climate conditions around 500,000 years ago. At the type site of the Wivenhoe Gravels the cold-climate deposits are separated by sediments laid down in temperate conditions that are dated to the Cromerian Complex. The gravels are topped by possible relict features of the Valley Farm-Barham Soil (GCA 7). The zone covers the gravels located along the headwaters of the Holland and Weeley Brooks.

Geology

The gravel is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface geology is the sands and gravels of the Wivenhoe Gravels. At the type site (Wivenhoe) the Lower Gravels and Upper Gravels contain periglacial structures such as frost cracks and ice wedges. The gravels are separated by a temperate stage deposit (interglacial/interstadial) and the Upper Gravel has evidence for soil formation under temperate and succeeding periglacial conditions (GCA 7).

Soils

The soils developed upon the gravels are generally soils of the Wix series. The Wix Soil Series is characterised by deep loams, often formed on gravels and so have a coarse, often flinty component which makes it permeable. The soils are fairly resistant to erosion by water. Around the Holland Brook, these soils display patterned ground features which are relict features formed during the Devensian glacial stage. The land is of moderate to good agricultural grade land.

Topography/Geomorphology

At the time the gravels were deposited upon the river bed the width of the Thames River channel may have been around 5 km wide. The gravels are exposed at around 20-25 mOD along the top of the slopes of the Holland Brook and a tributary valley. Around the headwaters of the Weeley Brook they are exposed in smaller discrete patches, however around the headwaters of the Holland Brook they cover a larger, more continuous area. The adjacent brickearth deposits (GCZ 1.7) probably mask the extent of the gravels over a greater area. The springs that feed the tributaries emerge at the intersection of the gravels and the underlying London Clay and expose the gravels.

Human Exploitation

Palaeolithic material has been recovered from within (HER 3353, 3086) and just outside (HER 3352) the mapped distribution of gravels. Their provenance is unclear and the records are insufficient to make judgement. However flint flakes have been recovered from the Wivenhoe Gravels at the type-site and at the nearby Dakings pit (GCZ 7.10), however recent investigations of the gravels from Dakings Pit suggest that they may be younger than the Wivenhoe Gravels. The zone is covered by the villages of Weeley and Tendring but is largely rural with scattered farmsteads and large, open fields. The presence of numerous reservoirs indicates small scale extraction in the past. Extraction of the gravels has occurred at Weeley and Hall Farm and is currently ongoing at Hill Farm, Little Bentley. A new extraction site is proposed at Gurnhams, Little Bentley. A brickworks and kiln (HER 15506) were located on the edge of the gravel at Weeley, presumably exploiting the adjacent London Clay and utilising the prominent position upon the gravels. Carter's and White's Brickworks, was located north-east of Brickhouse Farm and operated from c.1906 to c.1946.

Rarity	Part of a discontinuous spread of gravels across the central area of the District	2
Cultural Association	Palaeolithic flints have been recovered at the type-site (Wivenhoe)	3
Amenity Value	Further investigation into cultural associations required	2
Capacity for change	Limited capacity for change due to further quarrying (proposed quarry at Gurnhams, Little Bentley)	3

GCZ 7.4 Deposits of Cooks Green Gravel running west-east from Little Clacton to the coast at Frinton

Summary

The Cooks Green Gravels correlate with the third highest of the four Kesgrave Members on the Tendring plateau and are contemporary with the Wivenhoe Gravels. The Cooks Green gravels represent course grained sediments deposited beyond the confluence of an earlier course of the Thames and Medway rivers. These gravels are thought to have been deposited under cold climate conditions around 500,000 years ago. The zone covers discrete patches of gravels from Little Clacton to the coast at Frinton.

Geology

The gravel overlies London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface deposits are composed of sand and gravel. The lithological composition of the Cooks Green Gravels reveals that the material is being derived from two separate sources, the Thames River and Medway River. The stratigraphy of these gravels can be seen in the cliffs at Walton (GCZ 7.8)

Soils

The Windsor Soil Series is characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. The land is classed largely as Grade 3 land with some grade 2. There are fruit farms and nurseries.

Topography/Geomorphology

At the time the gravels were deposited the width of the combined Thames and Medway rivers was likely to have been around 7-8 km. The discrete patches of gravel lie in a west-east band across the south-east of the district upon the high ground (c.20-25 mOD) between the Bentley and Holland Brooks and continue eastwards towards the coast. The land is covered by large open fields and woodland. There are small woodland areas which probably extended over a larger portion of this zone, including Holland Wood. Ancient woodland is sited nearby at Riddles Wood (SSSI).

Human Exploitation

The zone is largely rural with some settlement, including St Osyth Heath in the west of the zone, the edge of Great Holland in the east and part of the modern built-up settlement at Frinton. The church at Frinton and Great Holland Hall were both built upon the gravel 'islands' suggesting that they utilised these prominent positions.

Rarity	Part of a discontinuous spread of gravels across the central area of the District	2
Cultural Association	Association with Wivenhoe Gravels (GCA 7) from which Palaeolithic flints have been recovered at the type-site	2
Amenity Value	Limited amenity value due to extent and location of gravels	1
Capacity for change	High capacity for change	1

GCZ 7.5 Band of Wivenhoe Gravels along the Alresford Valley to the Alresford Creek

Summary

The Wivenhoe Gravels belong to the third highest of the four Kesgrave Members on the Tendring Plateau and are contemporary with the Cooks Green Gravels. The Wivenhoe Gravels represent course-grained sediments deposited by an earlier course of the Thames. These gravels are thought to have been deposited under cold climate conditions around 500,000 years ago. At the type-site of the Wivenhoe Gravels the cold-climate deposits are separated by sediments laid down in temperate conditions that are dated to the Cromerian Complex. The gravels are topped by possible relict features of the Valley Farm-Barham soils (GCA 7). The zone covers the gravels along the Alresford Valley to the Alresford Creek.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals

as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The surface geology is the sands and gravels of the Wivenhoe Gravels. At the type site (Wivenhoe) the Lower Gravels and Upper Gravels contain periglacial structures such as frost cracks and ice wedges. The gravels are separated by a temperate stage deposit (interglacial/interstadial) and the Upper Gravel has evidence for soil formation under temperate and succeeding periglacial conditions (GCA 7).

Soils

The zone is largely covered by soils of the Wix series. Wix Soil Series is characterised by deep loams, often formed on gravels and so has a coarse, often flinty, component which makes it permeable. They are fairly resistant to erosion by water. The Tendring Soil Series is characterised by usually deep and stoneless and drains reasonably well, although it can also contain sufficient water to avoid drought in most years. Around the Holland Brook, these soils display patterned ground features which are relict features formed during the Devensian glacial stage. The land is of mixed agricultural grade quality. The poorer soil types are suited to woodland although the zone contains rural farmsteads and fields.

Topography/Geomorphology

At the time the gravels were deposited upon the river bed the width of the Thames River channel may have been around 5 km wide. The gravels lie along the valley sides of the Sixpenny, Tenpenny and Bentley Brooks from the headwaters to the Alresford Creek. The valleys are asymmetrical with steeper west-facing slopes. The gravels range in height from around 20 to above 30 mOD. Ponds and small reservoirs occur throughout the zone. Plantations and woodland cover a portion of the zone, including part of Hockley Wood, Mill Wood, Crestland Wood and Stable Wood.

Human Exploitation

The zone includes the built-up residential areas of Alresford and smaller settlements at Thorrington, Thorrington Cross as well as the dispersed settlement of Frating and an industrial area. The gravels in this area are close to the type site for the Wivenhoe

Gravels and can be expected to contain very similar statigraphies. The zone has been subjected to large-scale quarrying, both historically and currently at Alresford, Thorrington and Elmstead Market. A number of mineral applications for further quarrying is proposed at Thorrington Hall Farm, Frating Hall Farm, Church farm, Arlesford, Sunnymead, Elmstead and Heath Farm, Arlesford. Industrial activity relating to the extraction of adjacent clay or brickearth deposits has occurred within the zone including a brickworks at Tenpenny Heath (HER 15494) and un undated pottery kiln (HER 2440). The brickworks operated from c.1860 to c.1906. The site appears to be undeveloped and below ground deposits of former buildings and structures may survive.

Rarity	Part of a discontinuous spread of gravels across the central area of the District	2
Cultural Association	Palaeolithic material found within the type site sequence at Wivenhoe but not within the District	3
Amenity Value	Further investigation required to determine cultural association	2
Capacity for change	High proportion of extraction occurred with probability for further quarrying at a number of locations	3

GCZ 7.6 Scattered discrete patches of undifferentiated Kesgrave Gravels around Holland Brook

Summary

The zone contains undifferentiated gravel sediments which are mapped as Kesgrave and Lowestoft Formation. The small discrete patches of gravels are located in the south-east of the District around the Holland Brook valley system and towards the coast at Walton and are likely to belong to either the Cooks Green or Wivenhoe Gravels.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The sediments are composed of sands and gravels and are likely to belong to either the Cooks Green or Wivenhoe Gravel groups of the third highest of the four Kesgrave Members on the Tendring Plateau. It is possible that they have become mixed or reworked with later finer-grained sediments deposited some time after the diversion of the Thames during the Devensian.

Soils

The gravels survive as discrete patches upon the London Clay plain and the soils developed upon them have been mapped as Windsor Soil Series (1:250 000 NATMAP soil data) due to the over-riding influence of the London Clay. The Windsor Soil Series are characterised by deep clayey soils mostly with brown subsoils. The soils are likely to be influenced by the higher gravel content and so drainage may be improved. The land is of mixed agricultural grade with the better land on the north side of the Brook towards Hamford Water.

Topography/Geomorphology

The gravels are exposed on slopes between 15 and 25 mOD either side of the Holland Brook and towards the coast. They form discrete patches within the London Clay plain in the southeast of the District. There are a few open water bodies, including a moat.

Human Exploitation

There is little settlement within the zone apart from towards the coast where the modern built-up residential area of Frinton has extended. Much of the land is rural with large open fields and some mixed deciduous woodland. The moated site of Bovill’s Hall is located upon one of the patches of gravel. The gravels have been quarried in the past at Gutteridge Hall Farm, Weeley and Bovill’s Hall, Little Clacton.

Rarity	Part of a discontinuous spread of gravels across the central area of the District	2
Cultural Association	No direct cultural association	1
Amenity Value	Of limited extent or research potential	1
Capacity for change	High capacity for change	1

GCZ 7.7 Discrete patches of brickearth deposits capping Kesgrave Gravels along the Alresford Valley

Summary

Small discrete and dispersed patches of brickearth which probably cap the Wivenhoe Gravels on the high valley slopes of the Tenpenny Brook and lower slopes towards Flag Creek.

Geology

The bedrock of the area is London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The brickearth is likely to overlie Wivenhoe Gravels laid down by the Thames around 500,000 years ago (GCZ 7.5).

The brickearth is a cold-climate aeolian deposit that covers much of the plateau (GCA 1). The fine-grained sediments include fine sand and silts mixed with clays that are transported by the action of wind, sometimes over a considerable distance from their original position. The original deposition of the sediments occurred under cold climates within fluvial outwash from glaciers. The exposed finer-grained sediments were picked up and transported by the wind and were deposited when conditions ameliorated with the sand deposited first due to its larger grain size.

Soils

An indication that the brickearth overlies Kesgrave Gravel deposits is supported by the soil mapping which indicates that the soils of the zone belong to the Wix Soil Series. These are characterised by deep loams, often formed on gravels and so have a coarse, often flinty, component which makes them permeable. They are fairly resistant to erosion by water. Around the Holland Brook, these soils display patterned ground features which are relict features formed during the Devensian glacial stage. The land is of fair to good agricultural quality.

Topography/Geomorphology

The brickearth lies above 20 to 30 mOD. It survives on the high slopes of the Tenpenny Brook in the headwaters area and on the high slopes above Thorrington Creek. The survival of the sediments is probably due to the shallow nature of the slopes at the crest of the hills which become markedly steeper down the valley sides. It occurs also near South Heath and St Osyth Heath and at Bottles Hall, Elmstead. The zone is largely rural with small woods.

Human Exploitation

The patches of brickearth have not been exploited in their own right and form part of a largely rural landscape with little development apart from small roads connecting the dispersed settlements.

Rarity	Widespread deposits	1
Cultural Association	Lies above Wivenhoe Gravels (GCA 7) from which Palaeolithic flints have been recovered at the type-site	2
Amenity Value	Of value for study of underlying gravels	1
Capacity for change	High capacity for change	1

GCZ 7.8 Cooks Green Gravels at Walton-on-the-Naze

Summary

The Cooks Green Gravels correlate with the third highest of the four Kesgrave Members on the Tendring plateau, the Wivenhoe Gravel. The Cooks Green Gravels represent coarse-grained sediments deposited beyond the confluence of an earlier course of the Thames and Medway rivers. These gravels are thought to have been deposited under cold climate conditions around 500,000 years ago. The stratigraphy of the gravels above the Red Crag outcrop at The Naze can be seen in the cliffs.

Geology

The bedrock of the area is London Clay (GCZ 13.2) and Red Crag (GCZ 18.2). The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. The Red Crag is composed of sands and shells deposited in the near-shore environments of the sea around 2.4 million years ago. At the base of the Crag phosphatic nodules form a layer or bed, this deposit contains fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells. The shells have been used to reveal a cooling of climate as the sequence progresses upwards. At The Naze the earliest (Waltonian) sub-division of the Pleistocene Red Crag survives which is rich in marine Mollusca and vertebrate fossils (GCZ 18.2).

Lying within a channel cut into the Red Crag are fine-grained silt deposits. (GCZ 18.2). The sediments have been mapped as Chillesford Clay (part of the Norwich Crag) but pollen recovered from the silts indicate interglacial conditions and the stratigraphic position of the sediments suggest that they represent a later temperate period, within the Cromerian Complex. These are overlain by Cooks Green Gravels

The surface deposits are composed of sand and gravel belonging to the Cooks Green Gravel. The single gravel body contain a gravel component that reveal the material is being derived from two separate sources, the Thames River and Medway River.

Soils

The soils developed upon the gravels are classified as the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. However, where they are formed on gravelly sediments they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water.

Topography/Geomorphology

At the time the gravels were deposited the width of the combined Thames and Medway rivers was likely to have been around 7-8 km. The sediments lie at a height of c.20 m and are seen in the cliffs. The gravels and underlying sediments form a small flat-topped hill at the coast which falls away to marsh inland. The cliffs are subject to landslips and are actively eroding. The zone is largely covered by acid heath woodland and grassland.

Human Exploitation

The zone covers the recreational area at East Cliffs, Walton, including the car-park area, open grassed area around The Naze Tower and an acid heath woodland.

Rarity	Part of a discontinuous spread of gravels across the central area of the District	2
Cultural Association	Association with Wivenhoe Gravels (GCA 7) from which Palaeolithic flints have been recovered at the type-site	2
Amenity Value	Sediments visible within cliff exposures	3
Capacity for change	The cliffs are actively eroding and have a limited capacity for change	3

GCZ 7.9 Temperate-stage gravels along the Weeley Heath bypass

Summary

At Weeley Heath possible temperate stage gravels and organic sediments have been identified in an area mapped as Wivenhoe Gravels. The zone includes the immediate area in which these sediments were investigated and further discrete patches of gravels within the surrounding area which may have a similar origin.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Investigation of exposures at Weeley Heath revealed a sequence of gravels separated by an organic deposit. The gravel deposits above and below the organic deposit were largely fine-grained and contained a significantly different stone content from Wivenhoe Gravels. This would indicate that the deposits were not deposited within the main Thames or Medway river channels but by a slower flowing separate channel of the River Medway upstream of the confluence with the Thames. The stone content reveals that the gravels had not traveled far and would not survive under high energy conditions. It is suggested that the gravels were deposited under temperate conditions and the fine-grained organic sediments containing plant fossils and pollen indicate a possible interglacial origin.

The surrounding discrete patches of gravel are mapped as belonging to the Wivenhoe Gravels and their identity or association to the temperate-stage gravels is unclear. At the type site (Wivenhoe) the Lower Gravels and Upper Gravels contain periglacial structures such as frost cracks and ice wedges. The gravels are separated by a temperate stage deposit (interglacial/interstadial) and the Upper Gravel has evidence for soil formation under temperate and succeeding periglacial conditions (GCA 7).

Soils

The soils developed upon the small patches of gravels have been classified as Tendring soils upon the plateau and Windsor soils on the London Clay slopes which is likely to reflect the dominant geology of the area surrounding the patches of gravels. The Tendring Soil Series is characterised by usually deep and stoneless soils which drain reasonably well, although they can also contain sufficient water to avoid drought in most years. The Windsor Soil Series is characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. They are often woodland soils. The land is of mixed agricultural quality (Grade 2/3) reflecting the soils and topography.

Topography/Geomorphology

The discrete patches of gravel have become exposed in the vicinity of south-north flowing springs. The waters flow northwards down relatively gentle slopes into the Weeley Brook which joins the Holland Brook.

Human Exploitation

The land around the springs would be unsuitable for development or settlement and the land remains open and largely rural.

Rarity	Only one recorded location	3
Cultural Association	Human occupation during temperate episodes is likely but no cultural association has been identified	2
Amenity Value	Needs further investigation.	3
Capacity for change	Extent as yet unknown	3

GCZ 7.10 Kesgrave Gravels around Dakings Pit, southeast of Tendring village.

Summary

The zone contains gravels of disputed origin that contain evidence for human occupation. The gravels lie between the Wivenhoe and Cooks Green Gravels

deposits which accord with the third highest of the four Kesgrave Formations within the District.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The gravels have been variously mapped as both of glacial and fluvial origin. The BGS do not differentiate between the Kesgrave Gravels and Lowestoft Formation and they lie between Bridgland's (1994) mapped deposits of the Cooks Green and Wivenhoe Gravels. At an exposure within the zone the deposits were described as loose, sandy, bedded gravel up to c.1 m deep and overlain by hard yellow sand with some sedimentary structures. This was overlain by reddish-brown sand with small stones. At the time of the investigation it was suggested that the gravel may be a post-Anglian deposit of the nearby Holland Brook (Wymer, 1985).

Soils

The soils of the zone belong to the Windsor Soil Series and are likely to reflect the dominant geology of the area, London Clay. The Windsor Soil Series are characterised by deep clayey soils mostly with brown subsoils. They would be affected locally by the high gravel content.

Topography/Geomorphology

The sediments lie within a discrete patch between 10 -20 mOD along the north-west facing slopes of the Tendring Brook and towards the confluence of a tributary of the Holland Brook. The valley sides are steep and wooded. The gravels lie adjacent to Wivenhoe Gravels (GCZ 7.3), Cooks Green Gravels (GCZ 7.2) and undifferentiated Kesgrave Gravels (GCZ 7.6).

Human Exploitation

A rich assemblage of Palaeolithic artefacts has been recovered from the pit in which the gravels were recorded. Finds include chopper cores, core shatter pieces, proto hand-axes, hand-axes, primary flakes, and flakes with secondary working, some of which have been found in situ. The flint appears to be of both Clactonian and Acheulian derived industries (HER 3352). On investigation Wymer (1985) described the flints as slightly rolled or rolled and noted that there was an apparent vertical distribution of finds within the gravel with a higher proportion at depth. There are also records of flakes from pits on the other side of the valley near Weeley. The gravel is described as being of the same type as that at Daking's Pit.

Rarity	Only known recording	3
Cultural Association	More than one Palaeolithic flint industry represented	3
Amenity Value	Further investigation needed into the association with surrounding gravels. Dakings Pit is recommended as a LoGS	3
Capacity for change	Unknown distribution of sediments	3

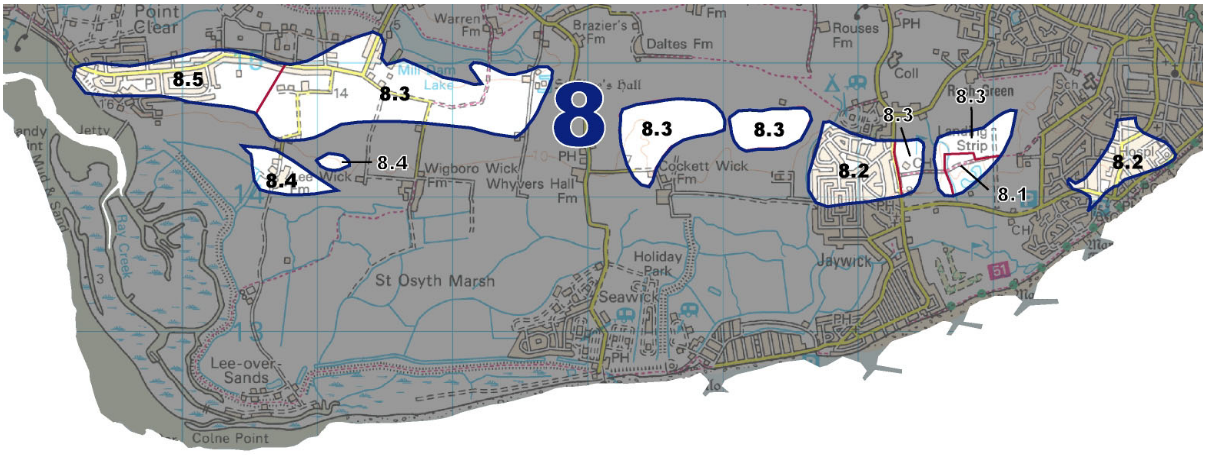


Fig 27 Geodiviersity Character Zones (GCA 8)

GCZ 8.1 Wigborough Gravels around Clacton-on-Sea

Summary

The zone covers a heavily quarried portion of the mapped distribution of the Wigborough Gravels. The Wigborough Gravels were deposited by the post-diversion Thames-Medway system following blockage upstream of the Thames channel during the Anglian glaciation. The Wigborough Gravels are the equivalent of the Mersea Gravels found in the west of the District. The gravels overlie interglacial deposits dated to the Hoxnian interglacial.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Wigborough Gravels were deposited by the post-diversion Thames-Medway system following blockage upstream of the Thames channel during the Anglian glaciation. The Wigborough Gravels appear to be a continuation of the Mersea Gravels, laid down under cold climate conditions and possibly including a component of older Thames gravels reworked and introduced by the River Colne flowing from the Colchester area, occupying the former channel of the Thames. At West Cliff, Clacton the Wigborough Gravels overlie the Clacton Channel interglacial sediments (GCZ 17.1) dated to the Hoxnian (MIS 11, c.400,000 years ago).

Soil

The zone has been quarried and hard landscaped.

Topography/Geomorphology

The gravels lie at a height of between 10 and 15 mOD. The zone has been subjected to extensive quarrying.

Human Exploitation

There has been gravel extraction at Alton Park and north of Cockett Wick since before c.1880. The area has been extensively quarried and is now covered by Clacton Airfield.

Rarity	Of limited extent forming a west-east running band across the south of the District	2
Cultural Association	No known cultural association	1
Amenity Value	No visible exposures and limited accessibility	1
Capacity for change	Quarried and heavily developed	1

GCZ 8.2 Wigborough Gravels at Jaywick and Clacton

Summary

The gravels were deposited by the post-diversion Thames-Medway system following blockage of the headwaters of the Thames channel during the Anglian glaciation. The Wigborough Gravel is the equivalent of the Mersea Gravels. The gravels overlie interglacial deposits dated to the Hoxnian interglacial. The zone is covered by the urban built-up settlements at Jaywick and Clacton.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Wigborough Gravels were deposited by the post-diversion Thames-Medway system following blockage upstream of the Thames channel during the Anglian glaciation. The Wigborough Gravels appear to be a continuation of the Mersea Gravels, laid down under cold climate conditions and possibly including a component of older Thames gravels reworked and introduced by the River Colne flowing from the Colchester area, occupying the former channel of the Thames. At West Cliff, Clacton the Wigborough Gravels overlie the Clacton Channel interglacial sediments (GCZ 17.1) dated to the Hoxnian (MIS 11, c.400,000 years ago).

Soil

The soils developed upon the gravels have been mapped as belonging to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. However, where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water.

Topography/Geomorphology

The gravels run west-east across the south of the district towards the coast at a height above 5m and below 15 mOD. The gently sloping landscape has few open areas which are used recreationally.

Human Exploitation

The zone has been covered by dense modern settlement.

Rarity	Of limited extent forming a west-east running band across the south of the District	2
Cultural Association	No known cultural association	1

Amenity Value	No visible exposures and limited accessibility	1
Capacity for change	Heavily developed	1

GCZ 8.3 Wigborough Gravels south of St Osyth

Summary

The gravels were deposited by the post-diversion Thames-Medway system following blockage of the Thames during the Anglian glaciation. The Wigborough Gravel is the equivalent of the Mersea Gravels. The gravels overlie interglacial deposits dated to the Hoxnian interglacial. The zone covers the undeveloped areas of gravels between Point Clear and Clacton.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Wigborough Gravels were deposited by the post-diversion Thames-Medway system following blockage upstream of the Thames channel during the Anglian glaciation. The Wigborough Gravels appear to be a continuation of the Mersea Gravels, laid down under cold climate conditions and possibly including a component of older Thames gravels reworked and introduced by the River Colne flowing from the Colchester area, occupying the former channel of the Thames. At West Cliff, Clacton the Wigborough Gravels overlie the Clacton Channel interglacial sediments (GCZ 17.1) dated to the Hoxnian (MIS 11, c.400,000 years ago).

Soil

The soils developed upon the gravels have been mapped as belonging to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. However, where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water.

Topography/Geomorphology

The gravels form a low ridge running west-east across the south of the district at a height of c.10 mOD. The landscape is flat and open with one small area of woodland.

Human Exploitation

The zone contains limited development with only minor roads and tracks crossing the zone, there is sparse settlement and large arable fields over much of the zone. St Cleres Hall is located within the zone. There is currently one application for a quarry west of Cockett Wick Farm' otherwise the area has remained free of gravel extraction.

Rarity	Of limited extent forming a west-east running band across the south of the District	1
Cultural Association	No known cultural association	1
Amenity Value	Undeveloped areas available for further investigation	3
Capacity for change	Limited capacity for change due to encroachment of extraction sites in similar areas of gravels.	3

GCZ 8.4 Unassigned river terrace gravels south of Point Clear

Summary

The small zone contains discrete patches of unassigned river terrace gravels located south of the Mersea/Wigborough Gravels.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals

as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The sediments are composed of sand and gravels identified as river terrace gravels and are possibly associated with the Wigborough Gravels (GCA 8).

Soil

The soils developed upon the gravels have been mapped as belonging to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. However, where they are formed on lithologies with a gravel component they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. Their main land use includes cereals and other arable crops.

Topography/Geomorphology

The gravels form isolated patches on the low coastal slopes at a height of 5 - 10 mOD. They are located on the fringes of the former coastal marsh.

Human Exploitation

Lee Wick Farm is located upon one of the slight hills utilising the higher ground on the fringes of the low lying coastal marsh area

Rarity	Unassigned gravel deposits of unknown distribution	1
Cultural Association	No known cultural association	1
Amenity Value	Possible association with Wigborough Gravels could be determined	1
Capacity for change	High capacity for change	1

GCZ 8.5 Mersea Island Gravels at Point Clear

Summary

The gravels were deposited by the post-diverted Thames-Medway system following blockage of the Thames during the Anglian glaciation. The Mersea Island Gravel is the equivalent of the Wigborough Gravels. At Cudmore Grove the Mersea Island Gravels overlie interglacial deposits dated to the Hoxnian interglacial.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The sands and gravels were deposited by the combined Thames/Medway Rivers after the Thames had been diverted into its modern channel and joined the Medway in the south of the district. At Cudmore Grove the Mersea Island Gravels, part of the East Essex Gravels, are exposed in the cliffs up to 4km thick. They are composed of sands and gravels which display a variety of bedding structures and contain a clast content which precludes those typical of northern provenance. At Cudmore Grove exposures reveal that the gravels overlie organic sediments dated to the Hoxnian interglacial (MIS 11, c.400,000 years ago).

Soils

The soils developed upon the gravels have been mapped as belonging to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. However, where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The land is of poorer grade agricultural quality.

Topography/Geomorphology

The deposit is exposed along the ridge at c.5 m -10 mOD and is visible in the cliffs at Point Clear. There is little open ground and the patch of gravels is surrounded by marshland.

Human Exploitation

The small area of exposed gravels is largely covered by modern built-up residential development with few open areas.

Rarity	Limited distribution within the District	3
Cultural Association	No known cultural association	1
Amenity Value	Possible cliff exposure of value for research	3
Capacity for change	Largely developed zone with exposures which have a limited capacity for change	2

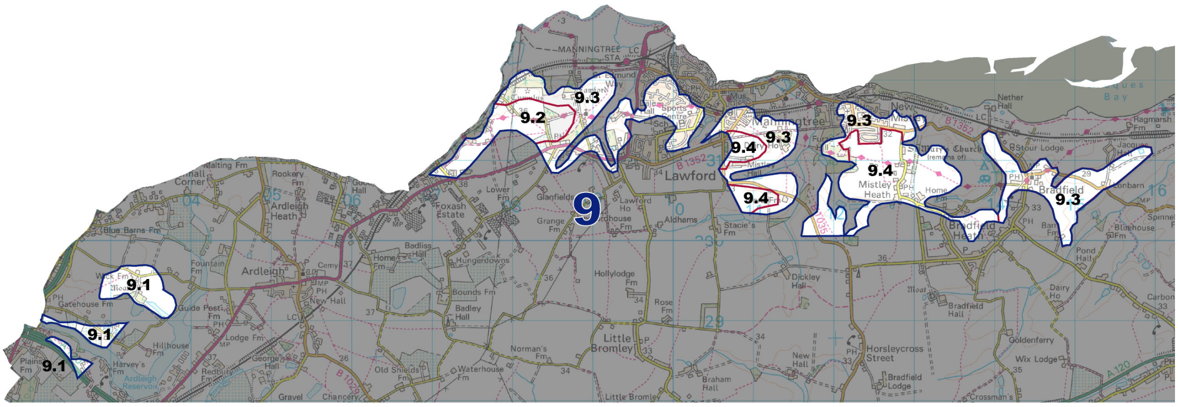


Fig.28 Geodiviersity Character Zones (GCA 9)

GCZ 9.1 Waldringfield Gravels around the Ardleigh reservoir.

Summary

The Waldringfield Gravels are the highest and oldest of the four Kesgrave Members on the Tendring plateau, deposited c.550,000 years ago. The ridge of sands and gravels is located in the north-west corner of the district. The sands and gravels were deposited by the pre-diversion Thames, when it flowed across the north of the District. The zone contains discrete patches of gravel surrounding the Ardleigh reservoir in the north-west of the District.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

There are no recorded sections of the Waldringfield Gravels in Tendring. However at Newney Green, Chelmsford, gravel possibly associated with the Waldringfield Gravels, is recorded in section as being up to 3.4 m thick. The stone content has been correlated with a sample of Waldringfield Gravel from Mistley Heath. These are cross-stratified sands and gravels and indicate an eastwards flow. The coarse-grained gravels indicate deposition by a braided river under cold climate conditions and contain up to cobble size components, some of Welsh origin (Bridgland, 1994), revealing an extensive catchment area.

Soil

The soils developed upon the gravels are mapped as belonging to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. However where they are formed on lithologies with a gravel component they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The agricultural land quality is fair to good and some of the zone is under arable cultivation. There is also a vineyard and piggeries.

Topography/Geomorphology

The gravels survive on the crest of the valley slopes at c.35 m - 40 mOD. The gravels flank two of the ‘arms’ of the Ardleigh reservoir and occupy a distinct and separate topographical area to the main body of gravel within the District. The land is largely used for agricultural purposes with arable fields, horticulture and animal husbandry. There are small areas of open water suggestive of past extraction and small springs feed into the reservoir.

Human Exploitation

The small patches of gravel surround the reservoir and so lie in a landscape altered through human intervention. The area is largely rural with a few farmsteads. There is a moat at Wick Farm which suggests a high status medieval house once occupied the area. The area is likely to have been altered in the creation of the reservoir. Possible extraction of the sands and gravels has occurred near Wick Farm and a large new site is planned for the near future.

Rarity	Part of a small band of exposed surviving deposits in the north and northwest of the District	2
Cultural Association	No known human occupation associated with the gravels	1
Amenity Value	No known exposures have been investigated	2
Capacity for change	Limited capacity for change due to previous and	3

	potential future extraction. New site planned at Wick Farm	

GCZ 9.2 Waldringfield Gravels along the Shir Burn Valley and edge of Plateau

Summary

The Waldringfield Gravels are the highest and oldest of the four Kesgrave Members on the Tendring plateau, deposited c.550,000 years ago. The ridge of sands and gravels is located in the north-west corner of the district. The sands and gravels were deposited by the pre-diversion Thames, when it flowed across the north of the District. The zone contains discrete patches of gravel along the plateau and high valley slopes of the Shir Burn Valley.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

There are no recorded sections of the Waldringfield gravel in Tendring. However at Newney Green, Chelmsford, gravel possibly associated with the Waldringfield Gravel, is recorded in section as being up to 3.4 m thick. The stone content has been correlated with a sample from Mistley Heath. The sands and gravels are cross-stratified and indicate an eastwards flow. The coarse-grained gravels indicate deposition by a braided river under cold climate conditions and contain up to cobble size components, some of Welsh origin (Bridgland, 1994), revealing an extensive catchment area.

Soil

The soils developed upon the gravels are within an area covered by the Tendring Soil Series. These are characterised by usually deep and stoneless loams and drain reasonably well, although it can also contain sufficient water to avoid drought in most years. The underlying gravels are likely to influence the stone content of these soils locally. The agricultural land quality is fair to good and much of the zone is largely under arable cultivation.

Topography/Geomorphology

The sediments flank the gentle sloping crest of the Tendring plateau and high, steep valley sides of the Shir Burn which flows south-north towards the head of the Stour estuary at Judas Gap. They lie at heights of between 25 m to over 35 mOD. The gravels lie on the upper southern slopes of the valley in a landscape that includes part of Lawford Park, a small grove and large open fields.

Human Exploitation

Part of the zone may have been landscaped in the creation of Lawford Park, however much of the zone is rural and undeveloped.

Rarity	Part of a small band of exposed surviving deposits in the north and northwest of the District	2
Cultural Association	No known human occupation associated with the gravels	1
Amenity Value	No known exposures have been investigated	2
Capacity for change	Moderate capacity for change including expanding development	2

GCZ 9.3 Waldringfield Gravels along the valley slopes of the Stour valley system

Summary

The Waldringfield Gravels are the highest and oldest of the four Kesgrave Members on the Tendring plateau, deposited c.550,000 years ago. The ridge of sands and gravels is located in the north-west corner of the district. The sands and gravels were deposited by the pre-diversion Thames, when it flowed across the north of the District. The zone contains discrete patches of gravel along the valley slopes of the Stour valley system.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

There are no recorded sections of the Waldringfield gravel in Tendring. However at Newney Green, Chelmsford, gravel possibly associated with the Waldringfield Gravel, is recorded in section as being up to 3.4 m thick. The stone content has been correlated with a sample from Mistley Heath. The sands and gravels are cross-stratified and indicate an eastwards flow. The coarse-grained gravels indicate deposition by a braided river under cold climate conditions and contain up to cobble size components, some of Welsh origin (Bridgland, 1994), revealing an extensive catchment area.

Soil

The soils developed upon the gravels are mapped as belonging to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. However where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The agricultural land quality is fair to poor.

Topography/Geomorphology

The gravels flank the steep valley sides of the south-north flowing tributaries of the Stour at heights of between c.20 and 30 mOD and the less steep coastal slopes of the Stour down to c.15 mOD. The steeper valley sides are wooded with remnants of small woods upon the less steep slopes and at Lawford Park.

Human Exploitation

The zone includes the fringes of residential settlement at Lawford, Manningtree and Mistley along the more gentle coastal slopes and the small settlement at Bradfield. Much of the land is rural with large open fields, scattered farms and cottages.

Rarity	Part of a small band of exposed surviving deposits in the north and northwest of the District	2
Cultural Association	No known human occupation associated with the gravels	1
Amenity Value	Limited access for potential exposures	1
Capacity for change	Moderate capacity for change including expanding development	2

GCZ 9.4 Waldringfield Gravels around Mistley Heath

Summary

The Waldringfield Gravels are the highest and oldest of the four Kesgrave Members on the Tendring plateau, deposited c.550,000 years ago. The ridge of sands and gravels is located in the north-west corner of the district. The sands and gravels were deposited by the pre-diversion Thames, when it flowed across the north of the DistrictThe zone contains discrete patches of gravel around Mistley Heath and includes a possible past exposure of the gravel at Mistley Heath.

Geology

The gravels are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

There are no recorded sections of the Waldringfield gravel in Tendring. However at Newney Green, Chelmsford, gravel possibly associated with the Waldringfield Gravel, is recorded in section as being up to 3.4 m thick. The stone content has been correlated with a sample from Mistley Heath. The sands and gravels are cross-stratified and indicate an eastwards flow. The coarse-grained gravels indicate deposition by a braided river under cold climate conditions and contain up to cobble size components, some of Welsh origin (Bridgland, 1994), revealing an extensive catchment area.

Soil

The soils developed upon the gravels are mapped as belonging to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. However where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. The agricultural land quality is fair to poor.

Topography/Geomorphology

The gravels lie on the high ground and crest of the tributary valleys of the Stour around Mistley, at heights of above 30 mOD. The land is relatively flat and open with few trees.

Human Exploitation

The zone is largely rural with large open fields and would have been part of the former heathland. It has very little development or settlement apart from the small village at Mistley Heath. The Ordnance Survey map of 1897 shows a gravel pit on the edge of woodland in Mistley Park, south-east of Furze Hill which may have worked the Waldringfield Gravel.

Rarity	Part of a small band of exposed surviving deposits in the north and northwest of the District	2
Cultural Association	No known human occupation associated with the gravels	1
Amenity Value	A possible exposure of the Mistley Heath gravel on the edge of woodland in Mistley park.	3
Capacity for change	Limited capacity for change due to historical and potential future commercial extraction or development	3

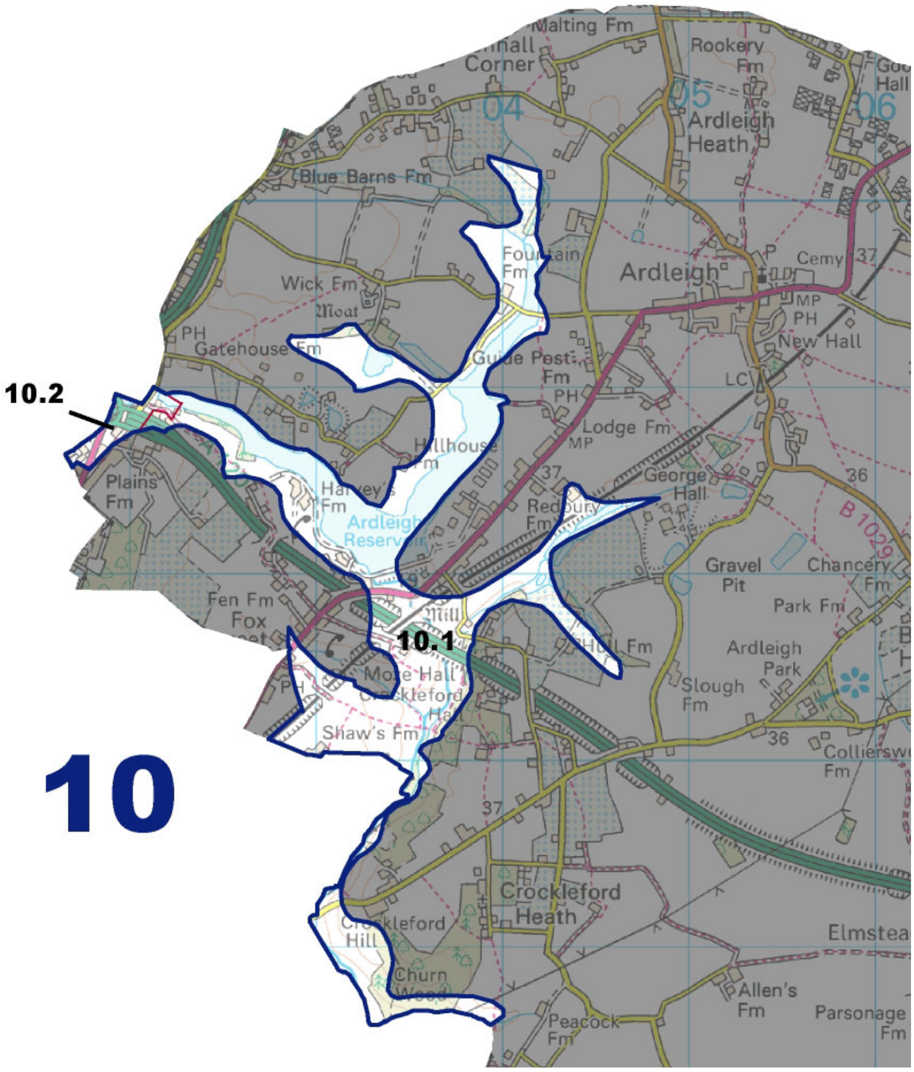


Fig 29 Geodiviersity Character Zones (GCA 10)

GCZ 10.1 London Clay slopes of the Ardleigh Valley system

Summary

The zone covers the exposed London Clay slopes of the Ardleigh Valley around the Ardleigh Reservoir and Salary Brook.

Geology

The valley slopes have been eroded to expose the London Clay bedrock. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. In its unweathered state it is a stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit.

Soil

The soils are mapped as belonging to the Wix series. The Wix Soil Series are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes. The character of the soils may be influenced by the brickearth and gravels upon the adjacent plateau region. This is indicated by the vegetation which indicates acidic soil conditions.

Topography/Geomorphology

The London Clay slopes along the valley of the Salary Brook to Ardleigh reservoir are steep sided, falling from around 35 to below 10 mOD. The Salary Brook is a fast flowing stream with small tributaries flowing into the system. Many of the tributaries and the slopes of the Brook are wooded along their lengths including Churn Wood, Broomhangings Wood and Walls Wood. A series of open water bodies along a tributary of the Salary Brook could suggest previous extraction. The reservoir has flooded the valley system north of the dam and a large lake has been created.

Human Exploitation

There are small pasture fields along the valley and in flatter areas larger fields with irregular kinking field boundaries suggest a historic origin to the field system. The reservoir dominates the zone and its creation has altered much of the valley system north of the dam. The reservoir is also used for recreational purposes. Spring Valley Mill is situated along the Salary Brook and is the only remaining example of a watermill within the District. The railway line and A120 road cross the zone in the area around Fox Street. There is evidence for quarrying north of the dam and along a tributary of the Salary Brook. The proximity of these to Martells Pit suggests a connection with the extraction of the Ardleigh Gravels in this area. Despite this the zone remains largely undeveloped with little settlement and is largely rural in character.

Rarity	Exposures of London Clay throughout the District	1
Cultural Association	Possible past extraction for industrial-related purposes	1
Amenity Value	Of limited potential for further research	1
Capacity for change	The valley has suffered from development and may be affected by future developments linked to extraction of the adjacent gravel deposits	2

GCZ 10.2 Developed area at the western arm of the Ardleigh reservoir

Summary

The zone covers a heavily developed area at the western arm of the Ardleigh reservoir where the Salary Brook flows into the reservoir.

Geology

The valley slopes have been eroded to expose the London Clay bedrock. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. In its unweathered state it is a stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit.

Soil

The soils are mapped as belonging to the Wix series. The Wix Soil Series are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes. The character of the soils may be influenced by the brickearth and gravels upon the adjacent plateau region.

Topography/Geomorphology

The small zone lies upon the London Clay slopes at heights of between 35- 40 mOD at the top of one of the flooded arms of the Salary Brook. The natural course of the brook flows into the flooded valley from the west. The zone includes the area south of the flooded arm which has a gentler gradient.

Human Exploitation

The zone is largely built upon with transport routes and industrial areas (Seedbed Centre). Prior to the valley being flooded it included the small linear settlement of Cock Common with a Union Chapel and small domestic industries, including a kiln and brick field.

Rarity	Exposures of London Clay throughout the District	1
Cultural Association	Possible past extraction for industrial-related purposes	1
Amenity Value	Of limited potential for further research	1
Capacity for change	Area been heavily developed and gravels extracted.	1

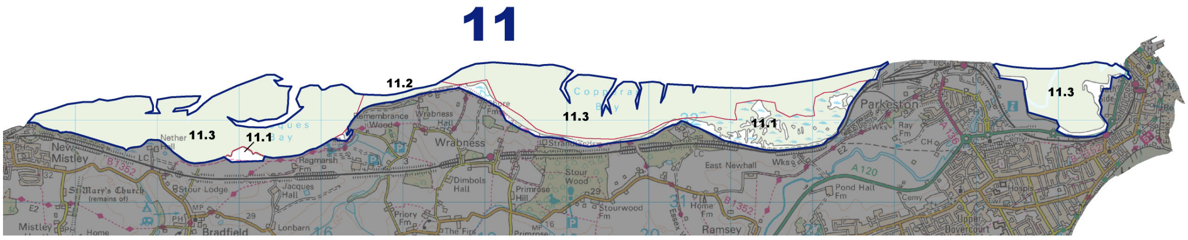


Fig 30 Geodiviersity Character Zones (GCA 11)

GCZ 11.1 Saltmarsh along the Stour Estuary coast

Summary

The zone covers a narrow strip of emergent saltmarsh along the Stour estuary, between Wrabness and Parkeston.

Geology

In the foreshore areas and the low coastal cliffs between Harwich (GCZ 15.4) and Wrabness (GCZ 11.1) the alluvium rests upon and against exposures of the Harwich Formation and London Clay. The Harwich Formation contains layers of volcanic ash, fallout from active volcanoes in Scotland c.60Ma, forming a sequence of horizontally bedded calcareous siltstone. The Harwich Formation is superseded by the London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine-grained sediments deposited by the sea at high tide level within an estuarine environment. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher energy such as storms. The deposits build up over time and salt-tolerant vegetation is able to establish and grow. The saltmarsh develops upon the marine alluvium in more sheltered areas.

Soil

Above the mean high tide limit there has been some soil development on the saltmarsh. Within Copperas Bay the soils developed upon the less mature saltmarsh belong to the Saline Soil Series and upon the higher saltmarsh elements, Wallasea. The Saline soils are of variable texture depending upon the lithologies of the parent material. The soils can range from soft and unripened where they are subjected to regular flooding and fresh sediment input, to firm and ripened on higher sites or on sandier parent materials. All variations are frequently calcareous. The soils can be utilised for some summer grazing. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high ground-water table.

Small, discrete areas of saltmarsh around the Wrabness region are mapped as belonging to the Wix Soil Series, however this is more likely to reflect the soils developed on the more dominant superficial geological sediments inland of the area which are gravels over London Clay. Towards Parkeston soils of the Windsor series are mapped along the coastal fringe reflecting the soils developed inland upon the former marshland

Topography/Geomorphology

The saltmarshes of the Stour Estuary are formed by the build up of sediment in the more sheltered areas along the coast deposited at or above mean high tide. As the deposits build up they become less susceptible to inundation by the sea and salt-tolerant vegetation has time to colonise the muds and establish communities which stabilize the underlying sediments. Around Wrabness the saltmarsh has developed in small discrete areas along the coast. The higher saltmarsh is dominated by grasses and other salt-tolerant plants. East of Wrabness to Parkeston, within Copperas Bay, is a largely continuous narrow stretch of saltmarsh up to the low coastal cliffs. Further east within the bay the saltmarsh system is more extensive and contains a series of branching creeks and tidal inlets.

Human Exploitation

The saltmarsh is unsuitable for settlement or infrastructure and no development has taken place upon them. Along much of the coast where the saltmarsh survives where there is an absence of sea defences. The saltmarshes have been utilised historically for grazing. On the 1st Edition OS map the zone is identified as saltings and were more extensive than they are today.

Rarity	Limited in extent along the Stour Estuary	3
Cultural Association	Possible buried landsurfaces suitable for industrial-related or coastal activities and palaeoenvironmental evidence	2
Amenity Value	Accessible and of potential research value	2
Capacity for change	Vulnerable to environmental change or human influence	3

GCZ 11.2 Wrabness cliffs

Summary

The cliffs at Wrabness provide the best onshore exposure of the Eocene Harwich Formation which consists of volcanic deposits and highly fossiliferous London Clay sediments.

Geology

The cliffs at Wrabness provide the best onshore exposure of the upper part of Eocene Harwich Formation and the lower few metres of the Walton Member of the London Clay. The Harwich Formation contains layers of volcanic ash, fallout from active volcanoes in Scotland c.55 million years ago, forming a sequence of horizontally bedded calcareous siltstone. Over 30 separate ash layers occur throughout up to 10 m's of clay and silty clay within the lower London Clay deposit. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. Although the fossil fruit and seed flora from Wrabness are limited by comparison with some other sites, the importance of the Wrabness flora is in its mode of preservation. Here, some of the fruit and seeds are preserved in concretions as opposed to the carbonaceous preservation or preservation in iron pyrite that occurs elsewhere within the London Clay. This form of preservation is particularly important, as much detail has been retained which would otherwise have been obscured by the growth of pyrite. The preservation of these plant fossils in concretions has also protected them from the distortion that would have occurred as a result of shrinkage or through compression on burial. Faults in the London Clay have been recorded in the cliffs and provide a record of prehistoric earthquakes. The geological sequence has been traced in the foreshore areas and the low coastal cliffs between Harwich (GCZ 15.4) and Wrabness. In its unweathered state it is stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a yellow-brown, non-calcareous deposit.

The foreshore area forms a narrow beach formed of coarse-grained alluvial sediments including sand and gravel, some of which may have been eroded from the cliffs.

Soil

Soils developed upon the sediments at the top of the low cliffs belong to the Wix Soil Series. The Wix Soil Series are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. Their main land use includes cereals and other arable crops. They are often formed on gentle valley slopes and undulating lowlands.

Topography/Geomorphology

The exposures are visible in the low coastal cliffs and foreshore. The cliffs are less than 5 mOD and wooded at the surface. At the base of the cliffs is a narrow sandy beach.

Human Exploitation

The area is unsuitable for settlement or development and is largely used for recreational purposes. It lies within the Stour Estuary SSSI.

Rarity	Contains the most complete succession of volcanic ashes in southern England.	3
Cultural Association	No cultural association	1
Amenity Value	The cliffs have a SSSI status (Stour Estuary)	3
Capacity for change	Limited capacity for change including environmental change and erosion	3

GCZ 11.3 Stour Estuary intertidal muds and creeks

Summary

The zone comprises the intertidal muds, creeks and channels around Jacques Bay and Copperas Bay which lie within the intertidal zone of the Stour Estuary.

Geology

In the foreshore areas and the low coastal cliffs between Harwich (GCZ 15.4) and Wrabness (GCZ 11.1) the alluvium rests upon and against exposures of the Harwich Formation and London Clay. The Harwich Formation contains layers of volcanic ash, fallout from active volcanoes in Scotland c.50Ma, forming a sequence of horizontally bedded calcareous siltstone. The Harwich Formation is superseded by the London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The marine alluvium is largely composed of silts and clays forming soft muds which are subjected to regular flooding and fresh sediment input.

Soil

There is no recorded soil development upon the mudflats due to regular flooding.

Topography/Geomorphology

The main bays, Jacques, Copperas and Bathside, encompass most of the intertidal flats. The muds exposed at low tide reveal rills, creeks and channels cut into the muds trending northeast-southwest. Much of the area is flooded by high tides, crossed by a system of creeks and tidal inlets and remains largely as unvegetated mudflats grading into a sandy narrow beach. The fringe the saltmarsh area along the coast and border open water.

Human Exploitation

The area would have been unsuitable for settlement and used in association with activities relating to the coast and river. Areas of hardstanding were laid to gain access to the deeper channels within the intertidal zone, and some channels may have been maintained to keep this access open.

Rarity	Distribution confined to the estuarine coastal areas of the District	2
Cultural Association	No known cultural associations. Very deeply buried peat (-12m) recorded within the alluvial silts	1
Amenity Value	Inaccessible for periods and of limited research potential	1
Capacity for change	Moderate capacity for change including environmental change and erosion	2

GCZ 11.4 The Cattawade Marshes

Summary

An area of saltmarsh at Cattawade in the north-west of the District forming part of the floodplain of the River Stour.

Geology

The alluvium is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals

as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine-grained alluvial sediments laid down within a floodplain formed between the freshwater and tidal channels of the River Stour. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher-energy. The deposits build up over time and within the sheltered areas of the floodplain which allows the colonisation of plants and formation of saltmarsh.

Soil

The soils formed upon the alluvium belong to the Wallasea Soil Series. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high ground-water table.

Topography/Geomorphology

The marshes form part of the floodplain between the freshwater and tidal channels of the River Stour. Much of the ground is below 5 mOD, generally flat and subject to flooding. The north part of the zone is a mixture of grasslands, marshland and open water. Some field boundaries follow the sinuous path of the silted up creeks.

Human Exploitation

A flood bank has been built along the southern river channel allowing an area to be drained and converted to grassland. A single farmhouse/farm is located within the zone.

Rarity	Distinct geomorphological area within the District	3
Cultural Association	Historical associations with landuse and possible palaeoenvironmental information	2
Amenity Value	Accessible landscape with visible relict channels and possible buried landsurfaces of research value	3
Capacity for change	Limited capacity for change including environmental change and erosion	3

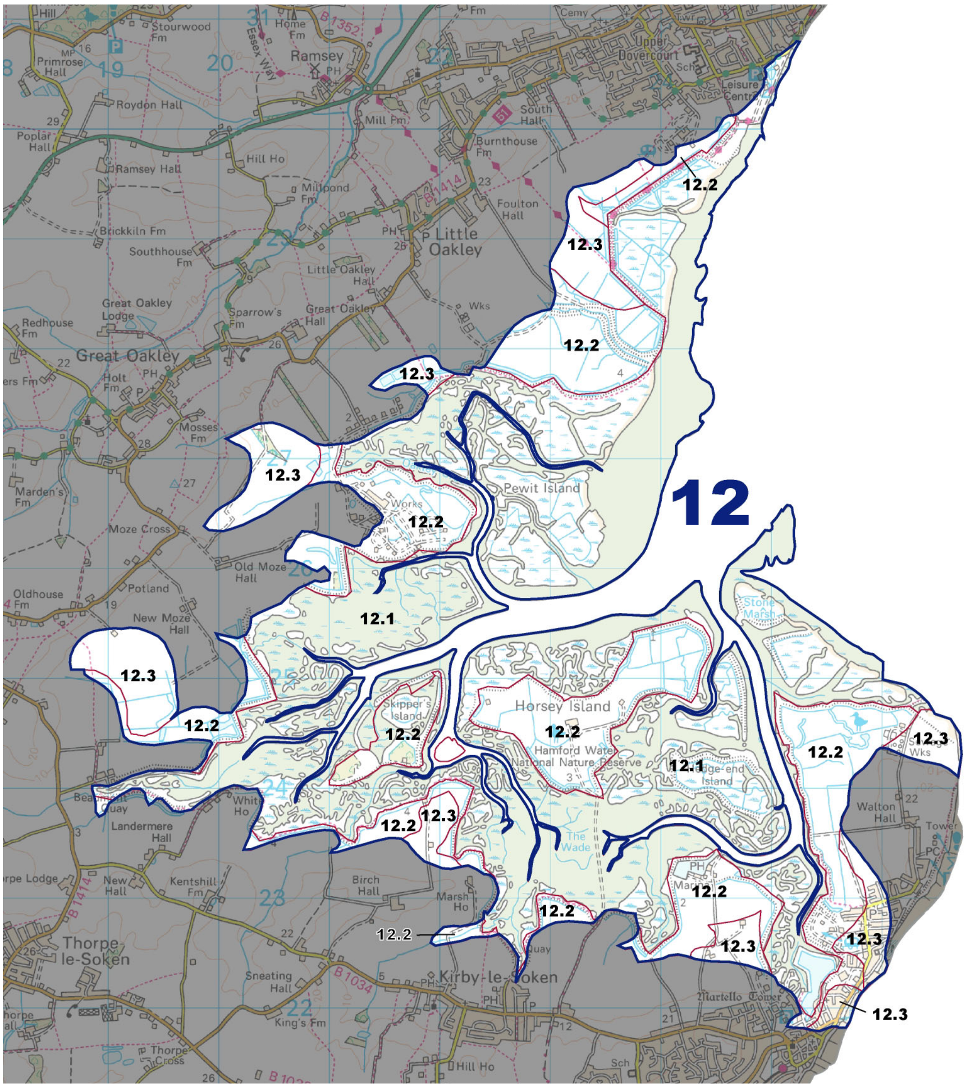


Fig 31 Geodiviersity Character Zones (GCA 12)

GCZ 12.1 Hamford Water saltmarsh

Summary

The zone within Hamford Water comprises tidal creeks, intertidal mud and sand flats, saltmarshes, islands and beaches.

Geology

The area is underlain by London Clay which outcrops within the basin as small islands. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. The London Clay is formed into a depression extending from Walton to Dovercourt.

Infilling the depression within the London Clay are fine-grained sediments deposited by the sea at high tide level within the confines of the embayment. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher energy such as storms. The deposits built up over time at the high tide limit allowing the colonisation of plants and formation of saltmarsh. As the saltmarsh develops the types of vegetation it can support increase and diversify.

Soil

Within areas of the saltmarsh the soils formed upon the marine alluvium are referred to as Saline. They are of variable texture depending upon the lithologies of the parent material. The soils can range from soft and unripened where they are subjected to regular flooding and fresh sediment input to firm and ripened on higher sites or on sandier parent materials. All variations are frequently calcareous. The soils can be utilised for some summer grazing.

Topography/Geomorphology

The geomorphology of the embayment is formed by a depression in the underlying London Clay and restricted landward by a ridge of rising ground. It is unusual as the embayment is fed only by a few small streams and not major rivers as elsewhere on the Essex coast. The large shallow basin (below c.2 mOD) comprises tidal creeks, intertidal mud and sand flats, saltmarshes, islands and beaches. The extensive saltmarsh covers a large proportion of the area and supports communities of coastal plants which are rare or extremely local in Britain. The mudflats also support a number of local plants. The shingle spits mark the seaward edge from Dovercourt to Crabknow Spit and from Walton to Stone Point. The shingle is topped by low, retreating sand dunes which are colonised by grasses.

Human Exploitation

Historically aggregate has been dredged from the Pye Sand area at Walton for construction purposes which has consequences for future erosion rates. Tidal courses have been altered to enable easier access for the transportation of material to and from Beaumont Quay. The quay was built in 1832 and a circular limekiln added later, probably in 1869-70. Limekilns were usually built close to the raw material used for making lime (chalk) but in coastal areas more permanent and substantial kilns were built in harbours and wharfs where chalk and fuel for the kiln could be brought in by sea. The limekiln is still extant, and Beaumont Quay survives.

Rarity	Distinct geomorphological area within the District	3
Cultural Association	Historical associations with utilisation of the area and possible palaeoenvironmental information	3
Amenity Value	Partly accessible landscape of research value for current and past morphological processes	3
Capacity for change	Highly susceptible to environmental change or human intervention	3

GCZ 12.2 Drained saltmarsh surrounding Hamford Water

Summary

The zone includes areas of drained saltmarsh located inland of the sea wall surrounding Hamford Water.

Geology

The zone is underlain by London Clay, which outcrops within the basin as small islands. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine-grained sediments deposited by the sea at high tide level within the sheltered estuarine embayment. The marine alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher energy such as storms. The deposits built up over time at the high tide limit allowing the colonisation of plants and formation of saltmarsh. As the saltmarsh develops the types of vegetation it can support increase and diversify.

Soil

The soils developed upon the alluvium are typical coastal marshland soils of the Wallasea Soil Series. These are characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have high ground water table. Soils of the Windsor Soil Series have developed upon outcrops of London Clay within the basin. The Windsor Soil Series are characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally valley slopes and the undulating lowlands. There is a wide range in quality of agricultural land from grade 2 to 4 which is likely to relate to drainage and levels of soil improvement.

Topography/Geomorphology

Much of the land is above 2 mOD with some 'islands' above 5 mOD. A sea wall or bank separates much of the drained marsh from the active saltmarsh. The drainage has utilised the former creeks as well as introducing more regular, linear drains. Upon the islands the original creeks are still recognizable within the drainage system. Areas of drained marsh and improved grass fields are located east of Little Oakley, east of Beaumont, north of Kirby-le-Soken and north of Frinton where the flat landscape of the marsh is devoid of trees or hedgerows. The landscape is one of unimproved grass marsh at Walton Hall, Old Moze Hall and on Bramble Island, with grass and scrub at The Naze. There are a few islands of exposed London Clay such as Skippers Island and Horsey Island which are protected through designation as nature reserves. Horsey Island is used as grazing marsh.

Human Exploitation

Much of the area is used for agricultural purposes and is largely undeveloped. The area would have been unsuitable for settlement in the past but has been subjected to a small amount of development since the drainage of the marshes. Around Walton urban development has encroached into the area with residential homes, holiday homes, sewage works and a marina.

The area has been utilised for industrial purposes since prehistoric times. Salterns, recognisable as red hills, dating from the Iron Age/Roman period have been identified surrounding Hamford Water and a high number have been found within the zone. This zone would have been utilised due to its location within the tidal influence of the basin and close proximity to higher and drier land. Later industrial activities include the Port Walton Brick and Tile Works (HER 15516) on the northern side of Walton. There were two rectangular kilns here. The ground on which the old brickworks stood has since become a camping site and there is a possibility of archaeological remains below ground level. The former dock west of the brickworks and foundry has been filled in but otherwise it apparently survives.

Rarity	Areas of drained saltmarsh are limited in distribution to the coastal zone inland of the sea wall	2
Cultural Association	Remains of evidence for prehistoric to post-medieval industrial and agricultural activities may survive.	3
Amenity Value	Remains of early industrial sites often visible within the landscape i.e. red hills and accessible for further investigation	3
Capacity for change	Vulnerable to increasing development and agricultural intensification	3

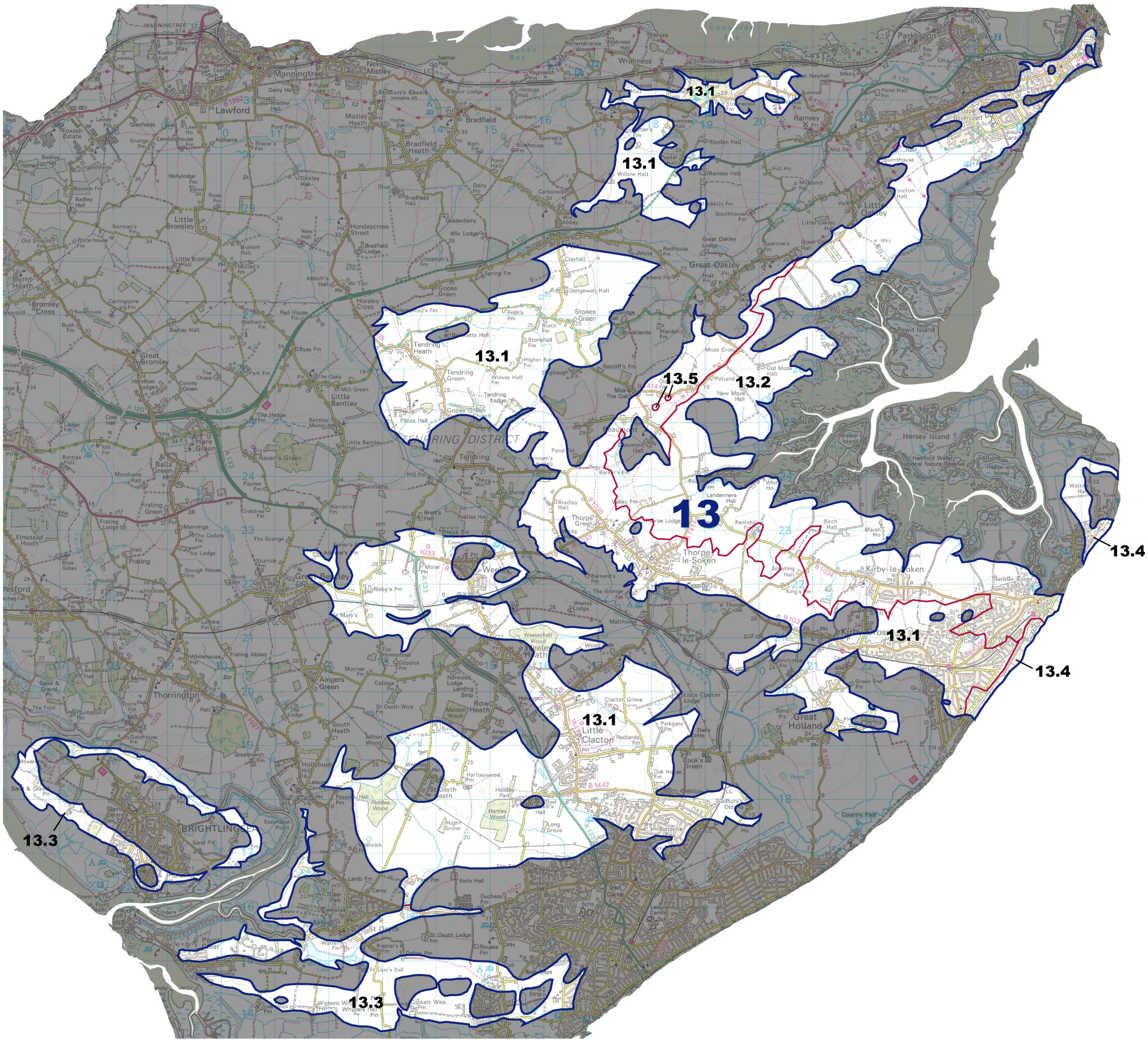


Fig 32 Geodiviersity Character Zones (GCA 13)

GCZ 13.1 London Clay plateau covering the northeast and southeast of the District

Summary

London Clay plateau covering the north-east and south-east of the District surrounding the Oakley Ridge in the north and Holland Brook in the south to the coast at Frinton.

Geology

The London Clay is exposed at the surface. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. Exposures of the London Clay at Harwich and Walton (GCZ 13.4) have revealed a huge diversity of fossils from the Eocene period and the form of preservation of these fossils within these areas is of significance for palaeobotanical and palaeozoological research. A borehole was sunk at Weeley which penetrated over 300 m into the London Clay which revealed the basement rocks to be Silurian (c.420,000 million years old). In its unweathered state it is a stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit. The clay can be up to 150 m thick in places. The London Clay plateau lies adjacent to brickearth and various Kesgrave Gravels which are not mapped within this zone. However, the nature of the vegetation found within this zone would indicate that there are surviving remnants of brickearth and gravels upon the London Clay. Possible patches of sands and gravels are reported within the cliffs from which palaeoliths may have been derived.

Soil

The dominant soil formed upon the plateau and slopes belongs to the Windsor Soil Series. The Windsor Soil Series is characterised by deep clayey soils mostly with brown subsoils. The distribution therefore is generally valley slopes and the undulating lowlands. The damper clay soils are often suited to woodland. In flatter areas particularly where the clay plain lies adjacent to the brickearth plateau the soils belong to the Tendring Soil Series. The Tendring Soil Series is characterised by usually deep and stoneless loams and drain reasonably well, although it can also contain sufficient water to avoid drought in most years. These are typical soils of the plateau landscape and are higher grade agricultural soils. The zone covers land of variable agricultural quality (Grade 1-3) reflecting the soil type and drainage in most instances, where the soil has been improved or lies adjacent to the brickearth the agricultural quality is higher.

Topography/Geomorphology

The London Clay plateau covers a large area of land that flanks the Hamford Water embayment inland and stretches towards the north-east and south-east coastlines.

The Clay is exposed on the high ground above 30 mOD near the Oakley Ridge and headwaters of the Holland Brook and along the higher valley slopes down to c.10 mOD. Streams cross the plateau, arising from springs which are often close to wooded areas and at the intersection of the sand and gravel with the underlying clay in adjacent areas. There are few areas of open water, mainly small reservoirs close to the springs. The field pattern is varied, fields are often large with irregular and sometimes stepped field boundaries. The zone contains both larger and small areas of woodland, some of it ancient. Between St Osyth and Weeley Heath are two larger areas of ancient woodlands with SSSI status, Weeleyhall Wood and Riddles Wood. Weeleyhall Wood is one of the largest ancient woods in the Tendring peninsula and contains one of the best examples in Essex of base-poor springline alder woodland. Along the southern shore of the Stour Estuary part of the Stour and Copperas Wood SSSI lies within the zone. The Stour and Copperas Woods together comprise the largest area of woodland in north-east Essex. They are ancient woods lying on the southern shore of the Stour Estuary. They contain the only example in the county where coastal and woodland habitats meet.

Human Exploitation

Along the beach and within the vicinity of Frinton a number of Palaeolithic flints have been recovered (HER 3556, 3557 and 2813), some are reported to have come from pockets of sands and gravels within the cliffs. The flints are unrelated to the London Clay deposits. Historically settlement of the inland area was of low density with scattered farmsteads and cottages, hamlets and small villages built up around greens or along roads. Towards the north and in the central areas this pattern has remained little affected by modern development. The zone contains a large number of smaller settlements, including Little Clacton, Weeley, Tendring Heath, Tendring Green, Stones Green, Thorpe-le-Soken, Great Holland and Beaumont, as well as larger settlements that have become built-up in modern times, such as parts of Clacton and Frinton. The heavy clay soils would not have been easily worked and have only become more productive due to agricultural intensification. Methods and practices of soil improvement and increased cultivation has led to larger areas of arable fields within the zone. At Montana's Nursery, Little Clacton (HER 17833) excavation has revealed that quarrying may have taken place in the Medieval period, possibly in association with pottery and tile making. There are a high number of identified brick and tilemaking works (HER 15624, 15504, 15505, 15506, 15489) associated with the zone. Clay would have been sourced locally, from the surrounding fields and there is evidence possibly from Medieval times. Smith's Brick and Tile Works (HER 15504), north-east of Weeley Railway Station dates from 1845. Many of the brickworks were in operation from the c.1890’s to the Second World War. Remains of brickworks have been uncovered during excavation near Stones Green at Kiln House (HER 1915) suggesting that below ground remains for further sites may be preserved within the zone.

Rarity	The exposed London Clay is widespread across the eastern half of the District	1
Cultural Association	Contains a high number of historical industrial sites	3
Amenity Value	The Weeley borehole site is recommended as a Local Geological Site (LoGS)	3
Capacity for change	High capacity for change due to extensive coverage	1

GCZ 13.2 London Clay slopes around Hamford Water and towards the coast

Summary

The zone covers the exposed London Clay on the slopes around the embayment at Hamford Water which stretches towards the coast at Dovercourt Bay and Walton.

Geology

The London Clay is exposed along the slopes. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. Exposures of the London Clay at Harwich and Walton (GCZ 13.4) have revealed a huge diversity of fossils from the Eocene period and the form of preservation of these fossils within these areas is of significance for palaeobotanical and palaeozoological research. In its unweathered state it is a stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit. The clay can be up to 150 m thick in places.

Soil

The Windsor Soil Series is characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. Soil improvement and intensive cultivation has created higher quality agricultural land in places and the land is of fair to good agricultural grade (Grade 2/3). The fields are divided by either small streams draining into Hamford Water, low hedges or in places belts of trees

Topography/Geomorphology

Around the embayment of Hamford Water the London Clay slopes represent a degraded cliff line and have moderately steep upper slopes. The slopes fall from below 20 to c.5 mOD with the lower slopes becoming less steep. The gently shelving slopes border the open marshes of Hamford Water and have patches of head at their base. Areas of standing water persist in less well drained areas.

Human Exploitation

The settlement of the zone is largely dispersed with scattered farmsteads and manorial halls. The soil has been improved and intensively cultivated and the boundaries of the regimented field system largely follow the curve of the Hamford Water basin. The modern expansion of Harwich and Frinton suburbs onto the coastal slopes has led to the encroachment of built-up residential development and associated amenity/recreation areas. As part of the development of Dovercourt as a seaside resort a spa house was constructed in 1854 to utilise the waters of a spring emanating from the cliffs. The water was described as ‘chalybeate’ (containing a high concentration of iron compounds) and was considered to be of high therapeutic value. The Spa House consisted of a pump-room, conservatory, saloon, and library. The Spa was very successful and continued to do business until at least 1910. It was probably demolished in 1920 and was the last of the Essex spas. Until recently the remains of the foundations and floor tiles could be seen in front of the beach huts.

The copperas industry was an important industry in eighteenth century Essex which involved gathering of pyrite nodules (known as ‘copperas stones’) from beaches, where they had been washed out of the London Clay, and by industrial process converting them to chemicals. The Walton copperas industry was in existence by the late 17th century. Over 230 tons a year were removed from the beach at Walton in the period 1715-1720. The Walton works had closed by the mid-1830s but Copperas stones to supply copperas works elsewhere continued to be collected from Walton and Harwich up until 1909. There were a small number of brickworks within the zone in the mid to late 19th century, located close to the docks (HER 15697, 15698). The majority of bricks made here were transported away by barges. The brickworks continued until the mid 1890s and thereafter Portland cement manufacture became the principal industry. The manufacture of Portland cement was first introduced into Essex by J. Pattrick & Son of Dovercourt, probably during the 1860s. The cement works were built on the edge of the drained marshes at Parkeston (GCZ 15.5) at the base of the London Clay slopes.

Rarity	The exposed London Clay is widespread across the eastern half of the District	2
Cultural Association	Contains varied historical industrial and recreational sites	3
Amenity Value	Limited research potential from inland sites	1
Capacity for change	High capacity for change	1

GCZ 13.3 London Clay coastal slopes around Brightlingsea and St Osyth

Summary

The zone covers the gentle coastal slopes around Brightlingsea and St Osyth down to the surrounding marshland and towards the coast at Clacton.

Geology

The London Clay is exposed along the slopes. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. Exposures of the London Clay at Harwich and Walton (GCZ 13.4) have revealed a huge diversity of fossils from the Eocene period and the form of preservation of these fossils within these areas is of significance for palaeobotanical and palaeozoological research. In its unweathered state it is a stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit. The clay can be up to 150 m thick in places.

Soil

The soils developed upon the London Clay slopes are mapped as belonging to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. Towards St Osyth the soils have been improved and cultivated resulting in large-scale regular arable fields

Topography/Geomorphology

The gentle coastal slopes fall from heights of around 15 to 5 mOD bordering the marshland. Small streams flow into the surrounding marshland and River Colne. The landscape forms a patchwork of pasture fields interspersed with copses and small woods around Brightlingsea.

Human Exploitation

The landscape would have been one of limited development and little settlement with scattered farms associated with the utilisation of the adjacent marshland. In places the soils have been improved and cultivated resulting in large-scale regular arable fields separated by intermittent hedgerows or belts of trees. The historic settlement of Brightlingsea was largely located upon the London Clay slopes, the modern built-up settlement has expanded within this zone. Jaywick and Clacton suburban development has led to the expansion of residential settlement onto the coastal slopes and an airfield. There was a small number of 19th century brickworks located within the zone (HER 15702, 15703, 15704) located close to the railways or creeks. These areas have not been developed and there is the potential for below ground deposits related to the industries to have survived.

Rarity	The exposed London Clay is widespread across the eastern half of the District	1
Cultural Association	Significant below ground deposits relating to historical industries may survive.	2
Amenity Value	Limited research potential from inland sites	1
Capacity for change	Moderate capacity to change due to the sensitive nature of the coastal slopes	2

GCZ 13.4 Harwich Formation and London Clay exposures within the cliffs and foreshore at Harwich and The Naze.

Summary

The zone includes exposures of the Harwich Formation and highly fossiliferous London Clay within the cliffs and foreshore at Harwich and The Naze at Walton. Both sites are designated geological SSSIs.

Geology

The oldest bedrock exposed in the zone is the sediments laid down in a sandy clay sub-tropical sea around 55 million years ago. The Eocene Harwich Formation is notable as it preserves bands of ash derived from explosive volcanic eruptions in Scotland during this period. These ash bands have become cemented as siltstone and contain veins of green banded calcite (calcium carbonate). The layers of volcanic ash are bluish grey, silty clays when fresh, but weather to a pale yellow-brown. The 'Harwich Stone Band' is one of the most distinctive of the ash bands in the Harwich Formation, found at the base of the London Clay and exposed in the cliffs at Harwich south of the lighthouse. The Harwich Formation was superseded by London Clay which represents the continuation of sedimentation within a marine environment. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. A diverse bird fauna has been preserved in small pockets within the London Clay, including a small parrot *(Psittaciformes*) and a tiny raptor *(Falconiformes*). The site is of considerable importance in the study of bird evolution. The diversity of fossils and form of preservation of these fossils in this area is of significance for palaeobotanical research. In its unweathered state the London Clay is a stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit. The clay can be up to 150 m thick in places.

At Beacon Cliff, Harwich, Red Crag (GCA 18) deposits were recorded on top of the London Clay. The fossiliferous sand has now been lost due to coastal erosion but may be preserved inland or elsewhere within the cliffs along this stretch of coast.

The Harwich Stone Band and London Clay are exposed in places along the foreshore. A sand and shingle beach covers these at the base of the cliffs. At The Naze the beach incorporates a large amount of fossilised material washed out of the London Clay.

Soil

There is no soil development upon the foreshore. Upon the cliff-tops are soils of the Windsor Soil Series. These are characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally valley slopes and the undulating lowlands. They are often woodland soils.

Topography/Geomorphology

At Walton and Harwich the sediments are visible in the cliffs and foreshore below mean high tide. At Walton the deposits are covered by a narrow sand and shingle beach, with abundant fossils derived from the London Clay mixed with the beach material. The stone band at Harwich has formed a naturally-occurring rocky shore. Between the Pier and The Guard the beach is sand and shingle, where the coastline turns southeastwards the beach is less stony. The beaches have protective barriers in the form of breakwaters and groynes to help trap sediment. At Walton the London Clay is capped by Cooks Green Gravels (GCZ 7.8) and forms an 'island' at The Naze. Inland the slopes fall gently away from below 20 m to below 5 mOD towards the former marshland. The north-facing slopes towards the coast are relatively steeper.

Human Exploitation

The Harwich Stone Band contains attractive veins of green banded calcite (calcium carbonate) which have been used as decorative stones in the past. In the 18th century the streets of Harwich were cobbled with dressed stones taken from the Harwich Stone Band. The beaches are utilised recreationally and are popular for fossil hunting. Groynes and breakwaters are situated along the coast to prevent erosion of the beaches. The soils upon the inland slopes have been improved and are used for farming. Part of the zone has been developed due to the expansion of the residential areas of nearby Walton.

Rarity	Significant exposures and excellent preservation of fossils	3
Cultural Association	No cultural association	1
Amenity Value	Exposures visible in the cliffs along public beach	3
Capacity for change	Cliffs are actively eroding and subject to landslips at Walton	3

GCZ 13.5 Patches of mixed sand and gravels within the London Clay plateau at Beaumont

Summary

The zone includes two small discrete patches of Kesgrave Gravels and brickearth upon the London Clay plateau at Beaumont

Geology

The gravels are underlain and lie within the London Clay plateau. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers

The sediments are composed of sand and gravel deposited by an earlier course of the pre-Anglian Thames when it flowed across the north of the District. Their grain size reveals they were deposited under high energy conditions within a cold climate environment. Their mapping suggests they have become mixed with sediments deposited during a later glacial stage. Alternatively, their proximity to the Oakley Gravels suggests that the Kesgrave sediments were deposited at the same time as the Oakley Gravels and are part of the second highest of the four Kesgrave Members within the District.

Soils

The patches of gravel lie within an area of Tendring soils. The Tendring Soil Series is characterised by usually deep and stoneless loams and drain reasonably well, although it can also contain sufficient water to avoid drought in most years. These are typical soils of the plateau landscape and are high grade agricultural soils.

Topography/Geomorphology

The two small patches lie above 25 mOD upon the plateau southeast of the Oakley Ridge. The deposits are contained within the modern boundaries of two fields south of Oldhouse Farm, Beaumont. A large pond covers much of the zone.

Human Exploitation

This small zone is within the London Clay plateau and situated within the settlement at Beaumont. Cartographic evidence may indicate quarrying of the gravels, there is a small pond visible on the 1st Edition OS Map which has increased in area. The land is grassed and used for equestrian purposes.

Rarity	Deposits of limited area across the District	2
Cultural Association	No known cultural associations	1
Amenity Value	Limited value due to size and mixed nature of the	1

	sediments	
Capacity for change	Within an existing settlement and at risk from development due to proximity	2

GCZ 13.6 Head deposits around Hamford Water

Summary

Discrete patches of head deposits at the base of the London Clay slopes around the fringe of the saltmarsh and alluvial deposits at Hamford Water.

Geology

The head deposits are underlain by London Clay, which are exposed along the gently shelving coastal slopes. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

At the base of the slopes are unsorted deposits composed of clays, silts, sand and gravel (head) that were derived from sediments upslope and incorporated into a clay matrix derived from the London Clay slopes. These sediments are transported downslope under the action of water falling as rain and slope runoff and were deposited at the base of the slope.

Soil

The small patches of head deposit are within the alluvium at the base of the London Clay slopes and the soils that are mapped for this zone reflects these dominant geologies. The soils developed within the alluvial areas are typical coastal marshland soils of the Wallasea Soil Series. These are characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high ground-water table. The soils developed upon the London Clay and areas of high clay content belong to the Windsor Soil Series. These are characterised by deep clayey soils mostly with brown subsoils. Their distribution therefore is generally on valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland.

Topography/Geomorphology

Due to the nature of the deposits they are only found at the base of slopes. The discrete patches lie at around c.5 mOD within the surrounding marshland and are not notably distinguished from the marshland topography.

Human Exploitation

The saltmarsh area would have been unsuitable for settlement in its natural state and the patches of head would not have been large enough to allow settlement upon them. Since the drainage of parts of the marsh the slope deposits around Walton have now been built upon with residential settlement and holiday homes. The patches of head are fringed with the remains of salterns, prehistoric and historic saltmaking sites. Their location may be associated with the head deposits as this may have provided areas of more solid and possibly drier land adjacent to the saltmarsh areas where those involved in the industry could have avoided the tidal waters needed for the process. At the base of the inland coastal slopes at Walton was the historic brickworks known as Flory's Brickworks (HER 15701), possibly situated to take advantage of the transport links to the sea offered by the proximity to Hamford Water.

Rarity	Relatively limited distribution throughout the District but product of common slope processes	2
Cultural Association	Association with the distribution of prehistoric and historic industrial processes.	2
Amenity Value	Of limited research value due to redeposited nature of the deposit	1
Capacity for change	High capacity for change	1

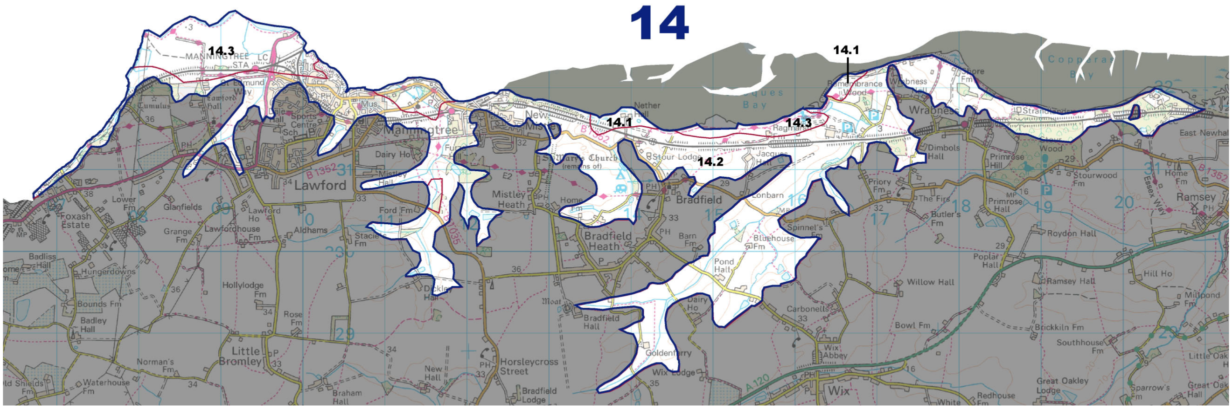


Fig 33 Geodiviersity Character Zones (GCA 14)

GCZ 14.1 Unsorted slope deposits at the base of the Stour Valley coastal slopes

Summary

The unsorted slope deposits (head) lie along the base of the Stour coastal slopes at Wrabness Point and Nether Hall.

Geology

The head deposits are underlain by London Clay, which are exposed along the gently shelving coastal slopes. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

At the base of the slopes are unsorted deposits composed of clays, silts, sand and gravel (head) that are derived from sediments upslope and incorporated into a clay matrix derived from the London Clay slopes. These sediments are transported downslope under the action of water falling as rain and slope runoff and are deposited at the base of the slope.

Soil

The head deposits are located within an area where soils of the Wix Soil Series have developed. The Wix Soil Series is characterised by deep sandy or sandy silt loams. Where they are formed on gravelly sediments they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. The surrounding area is of fair to good quality agricultural land (Grade 1/2).

Topography/Geomorphology

The small discrete patches of head lie between 10m OD to 5 mOD at the base of the coastal slopes. They form small promontories at the coast at Wrabness Point and around Nether Hall. The landscape is gently sloping towards the coast and is largely open fields.

Human Exploitation

The small areas covered by the deposits include the manorial site of Nether Hall, possibly due to its more prominent position along the coast. The land is largely rural open fields and undeveloped.

Rarity	Relatively limited distribution throughout the District but product of common slope processes	2
Cultural Association	No known cultural association	1
Amenity Value	Of limited research value due to redeposited nature of the deposit	1
Capacity for change	High capacity for change	1

GCZ 14.2 London Clay slopes of the Stour Valley system

Summary

Exposed London Clay occurs on the slopes of the tributary valleys of the Stour, including Shir Burn, and Wignall Brook.

Geology

The London Clay slopes have become exposed due to weathering and erosion since the Anglian glacial period. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. Significant areas of woodland within the zone indicate that patches of sand and gravel may survive upon the slopes in places.

Soil

The soils developed upon the London Clay slopes belong to the Wix Soil Series. These are characterised by deep sandy or sandy silt loams. Where they are formed on soils with gravel they can have a moderate to strong stony component, which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands.

Geomorphology

The Stour Valley system includes the Shir Burn, Wignall Brook and brooks east and west of Bradfield and between Manningtree and Mistley as well as the smaller tributaries feeding into these larger streams and the River Stour. The streams flow northwards to the Stour, and are relatively short in length (less than 5 km long). The valleys differ slightly in their profiles west to east with asymmetrical valleys in the east and largely symmetrical valleys in the west. The valleys fall from below 35 mOD to c.5 mOD. Some of the valleys are steep sided and wooded in places. Reservoirs have been formed along lengths of the streams at Mistley, Bradfield and Wrabness. The coastal valley slopes are less steep and fall from c.25 mOD to 5 mOD. The Stour and Copperas Woods SSSI are located within the zone upon the coastal slopes. Together the ancient woodland comprise the largest area of woodland in north-east Essex. The character of the woods suggests they are formed on gravels above the London Clay. They contain the only example in the county where coastal and woodland habitats meet. (See also 15.3)

Human Exploitation

The area is largely rural with scattered farms and settlement. The more gentle slopes have been drained in places and utilised for agriculture. Settlement has been concentrated towards the coastal areas, the historic port at Manningtree facilitated the growth of the Medieval market town and smaller settlements were located at Mistley and Lawford. Part of the area has been encroached upon by the extension of the modern built-up settlement at Manningtree. The railway line crosses the zone in places and has led to the development of small industrial areas. The London Clay has been extracted historically for the production of bricks. Two brickworks have been recorded within the zone. They operated in the mid to late 19th century and were located close to the railway (HER 15470) at Manningtree and at Wix (HER 15355). In undeveloped areas below ground remains may survive.

Rarity	One of a number of valley systems with London Clay slopes within the District	1
Cultural Association	Some historical industrial related activities	2
Amenity Value	Low potential for research and difficult access	1
Capacity for change	Moderate capacity to change due to the natural balance of valley systems	2

GCZ 14.3 Terrace deposits at the base of the coastal slopes of the Stour Valley system

Summary

Discontinuous terrace deposits lie at the base of the coastal slopes of the Stour Valley system between Wrabness and Manningtree where they form part of the floodplain.

Geology

The terrace deposits are underlain by London Clay, which are exposed along the gently shelving coastal slopes. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The sediments are composed of sand and gravel deposited within a high energy fluvial system.

Soil

The soils developed on the terrace gravels at the head of the Stour estuary are varied. Much of the area is covered by soils of the Ludford Soil Association with soils of both the Fladbury and Wallasea Soil Series at the western and eastern extremes reflecting an input from freshwater and marine fluvial systems respectively. The Ludford Soil Series is characterised by deep loams and can be fine, coarse and sandy soils. Where they are developed upon gravels they can have a stony component locally. They are often well drained with a slight risk of soil erosion. The Fladbury Soil Series are deep stoneless silty clay loams or clayey soils formed on freshwater alluvial sediments. They are often calcareous. The soils are difficult to work and prone to waterlogging in flat areas such as floodplain environments. Due to this they are often only suitable for grazing or grassland. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high ground-water table. Their use is often restricted to winter cereals and grassland/grazing and even then they are prone to compaction under arable cropping and poaching under grassland. The soils developed upon the gravels on the higher ground along the coast belong to the Wix Soil Series. The Wix Soil Series are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands.

Topography/Geomorphology

The larger area of terrace gravels within the zone lies at the base of the coastal slopes below 5 mOD between the tributaries of the Shir Burn and Wignall Brook. The floodplain area receives freshwater input from these valleys and would have been subject to flooding by tidal waters of the estuary. The land is protected from the River Stour by a sea wall along the northern boundary and the land has been subjected to drainage. The land is dissected by linear drains and the branching Hall Fleet; larger, former creeks are visible as cropmarks. Along the coast the separate patches of gravels lie below 10 mOD to 5 mOD, forming small promontories.

Human Exploitation

Settlement within the zone is largely rural, with scattered farmsteads and part of the small settlement of Mistley Green. At Mistley Place Park the grounds have been landscaped and include a lake. The area around Ragmarsh Farm is rough grassland. The regular fields are bounded by hedgerows and there are small plantations

The railway line, including Manningtree Station, cuts though part of the zone. There is evidence for historical quarrying in the area now covered by the sewage works and industrial development at Manningtree. A sea wall has been built along the River Stour and the channel of the Shir Burn has been altered to affect the flow of waters into the area.

Rarity	Terrace gravels of unknown source or distribution	1
Cultural Association	Small scale historical industrial activities	2
Amenity Value	Of value for association to Kesgrave Members	2
Capacity for change	Potential for encroachment and disturbance by development	2

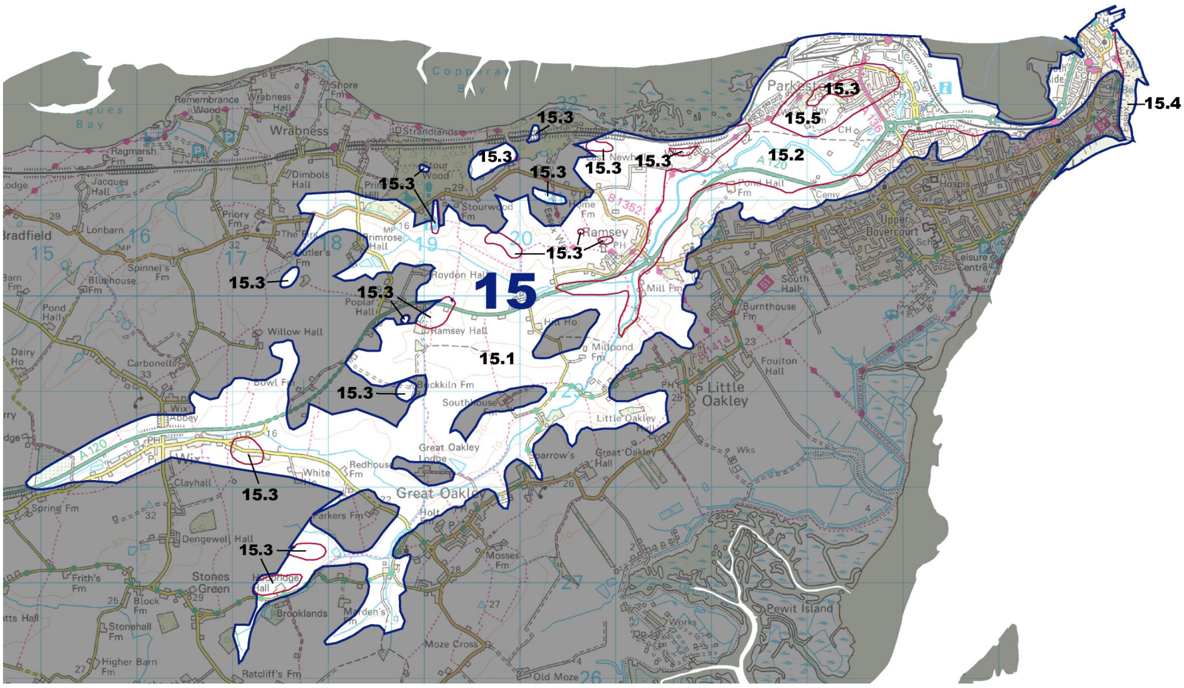


Fig 34 Geodiviersity Character Zones (GCA 15)

GCZ 15.1 London Clay slopes within the Ramsey Valley system

Summary

London Clay occurs on slopes of the Ramsey Valley and tributary valleys within the system.

Geology

London Clay is exposed upon the slopes of the valley. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

At Ramsey a large sarsen stone (sandstone) has been transported from the area of the Chilterns during a glacial period. These erratics are unusual and do not reflect the underlying geology.

Soil

The Windsor Soil Series is developed upon the exposed London Clay along the steeper valley slopes. These are characterised by deep clayey soils mostly with brown subsoils. Their distribution therefore is generally on valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. This makes them more suited to winter cereals and grassland and the land is often used for dairying. The land is of poorer agricultural quality but has been improved in places.

Topography/Geomorphology

The Ramsey Creek valley is asymmetrical along much of its length with steep sided northwest facing slopes falling from c.30 mOD-5 mOD. The Ramsey Creek and its tributaries have relatively shallow south-east facing slopes with large, broad open catchments covering a large area compared to the shorter and narrow catchments on the opposite side of the valley. There are a high number of reservoirs in the upper reaches along the tributary valleys. There is little woodland along the valley, small groves and plantations are concentrated in the upper reaches.

Human Exploitation

The zone has remained largely undeveloped, with occasional scattered farmsteads and small settlements at Wix and Ramsey. The landscape is pastoral upon the steeper slopes and largely arable upon the gentler slopes and in the lower reaches.

The expansion of Upper Dovercourt has led to modern built-up residential development in the extreme eastern zone. There was limited and small-scale extraction of the London Clay for the manufacture of bricks from the mid 18th century (HER 15563, 3520).

Rarity	One of a number of valley systems with London Clay slopes within the District	1
Cultural Association	Some historical industrial related activities	2
Amenity Value	Low potential for research and difficult access. The sarsen stone at Ramsey has been	2

	recommended as a Local Geological Site (LoGS)	
Capacity for change	Moderate capacity for change within a valley system	2

GCZ 15.2 Freshwater alluvial deposits along the Ramsey Creek Valley system

Summary

Freshwater alluvium deposits occurs within the floodplain of the lower reaches of the Ramsey Creek Valley

Geology

The alluvium is deposited upon London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The fine-grained clay and silt freshwater alluvial sediments are deposited within the floodplain under flood conditions and can include organic deposits.

Soil

The soils developed upon the alluvial deposits are mapped as the Wallasea Soil Series upon the 1:250,000 scale NATMAP digital soil data. These are typically formed on marine alluvium.It is more likely the soils formed upon the freshwater alluvium belong to the Conway Soil Series. The characteristics of these soils will be similar and due to the poor drainage the land is of poor agricultural quality. This has been improved in places through artificial drainage and the soil improvement.

Topography/Geomorphology

The floodplain lies below the 5 mOD contour line in the lower reaches of the tributary valley and main channel of the Ramsey Creek down to the wide, open floodplain at the coast. Drainage channels have been cut along the valleys to drain the land and springs feed into the Creek. Along much of its length the Creek is relatively straight, an abandoned loop has been cut off from the main channel at Pond Hall Farm.

Human Exploitation

There is no settlement within the zone. Small fields of pasture and paddocks lie adjacent to the Creek at Ramsey. The land either side of lower valley slopes has been subjected to drainage and improvement. There is a ford and river crossing at Ramsey. The zone is crossed by the A120 and a large roundabout at Ramsey.

Rarity	Limited distribution of freshwater alluvial deposits	3
Cultural Association	No known cultural associations	1
Amenity Value	Potential for palaeoenvironmental remains relating to the Holocene and evolution of the valley	3
Capacity for change	Limited capacity for change including to environmental change and human intervention	3

GCZ 15.3 Patches of gravels along the western slopes of the Ramsey valley system

Summary

Small, discrete patches of mixed origin sands and gravels are situated at the top of the western tributary valley slopes and within the floodplain at Parkeston.

Geology

The patches of sand and gravel lie upon London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The superficial sediments are composed of sand and gravel initially deposited by an earlier course of the pre-Anglian Thames when it flowed across the north of the District. Their grain size reveals they were deposited under high energy conditions within a cold climate environment. Their mapping suggests they have become mixed with sediments deposited during a later period. The gravels lie in an area between known Ardleigh and Oakley gravels which suggests that the Kesgrave sediments were deposited at the same time as the Ardleigh/Oakley Gravels and are part of the second highest of the four Kesgrave Formations within the District.

Soil

The patches of gravel lie within a larger area of exposed London Clay and are likely to affect the soil type only locally. The typical London Clay soils belong to the Windsor Soil Series. This is characterised by deep clayey soils mostly with brown subsoils. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. The gravels would influence the drainage of these soils and the quality of agricultural land is good.

Topography/Geomorphology

The discrete patches of gravel survive upon relatively flat land situated at the top of the valley slopes, between the 25 and 20 mOD contour lines. The landscape is largely open in the upper reaches of the valley. Towards the coast patches of gravels lie upon the lower coastal slopes (c.15 mOD) within and surrounding the Stour and Copperas Wood SSSI. Together the ancient woodland comprises the largest area of woodland in north-east Essex. They contain the only example in the county where coastal and woodland habitats meet. (See also GCZ 14.2) Upon the ‘island’ within Parkeston Marsh a remnant of woodland survives known as Raycliff Wood.

Human Exploitation

The discrete patches of gravels lie between the boundary of the London Clay plateau and the valley of the Ramsey Creek system. Settlement within this landscape was limited with scattered farms and cottages. The area is largely rural. There are indications for historic industry within the zone and at Wix there was a mid-19th century brickworks (HER 15696), which may have been sited purposely on the gravel and took clay from the surrounding area.

Rarity	Part of a larger band of Kesgrave Formation gravels	1
Cultural Association	Association with historical industrial related activities	2
Amenity Value	Association with Kesgrave Formations of interest. Of limited distribution and low potential for research.	1
Capacity for change	Moderate capacity for change due to limited distribution	2

GCZ 15.4 'Island' of exposed London Clay at Parkeston within the floodplain of the Ramsey Creek

Summary

The isolated outcrop of London Clay, known as 'Ramsey Ray Island' is capped by gravels and situated within the floodplain and former marshland at Parkeston.

Geology

The London Clay is exposed along the slopes of the 'island'. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The London Clay is capped by sands and gravels (GCZ 15.3)

Soil

The typical London Clay soils belong to the Windsor Soil Series. This is characterised by deep clayey soils mostly with brown subsoils. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. This makes them more suited to winter cereals and grassland and the land is often used for dairying. They are often woodland soils.

Topography/Geomorphology

The outcrop of London Clay forms a small hill rising up to 15 mOD within the surrounding low lying (c.5 mOD) and flat landscape of the former marshland. In extent it reaches up to c.1.3 km in length and over 0.5 km in width. The north-west facing slope is short and steep compared to the shallow slopes around much of its circumference.

Human Exploitation

The 'island' would have rested within an area formerly unsuitable for settlement. Historically it was used largely for agricultural purposes with a farmstead situated upon it. The small zone contained two brickworks (HER 15699, 15700) which would have extracted the London Clay. The industrial development of the zone expanded with the drainage of the surrounding marsh and laying of the railway. Much of the zone is now covered by modern industrial works with part used as a golf course.

Rarity	Exposures of London Clay widespread within District	1
Cultural Association	Historical industrial development within the zone	2
Amenity Value	Much of the zone is used for industrial purposes	1
Capacity for change	Moderate capacity for change due to limited distribution and isolated location	2

GCZ 15.5 Drained marsh at Parkeston to Harwich

Summary

The area of floodplain lies within the lower reaches of the Ramsey Valley system towards the coast at Parkeston and around the embayment to Harwich. The land is covered by alluvium and was formerly marshland.

Geology

The estuarine alluvium lies within the floodplain upon London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. A borehole sunk near Harwich Pier reached depths of over 300 m to hard slaty Silurian rocks that date to c. 420 million years.

Within the floodplain upon the London Clay are fine-grained sediments deposited by the floodwaters of the Ramsey Creek and by the sea when the tide would enter the creeks and channels within the floodplain at high tide. The brackish and estuarine alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser-grained deposits reflecting periods of higher energy. The deposits built up over time at the high tide limit and in sheltered areas allowing the colonisation of plants and formation of saltmarsh. As the saltmarsh develoed the types of vegetation it can support increase and diversify and soils develop.

Soil

The soil that is developed upon the alluvium belong to the Wallasea Soil Series. This is characterised by deep stoneless silty clay or clayey soils which are typical of coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high ground-water table. The agricultural quality of these soils is poor before drainage and improvement.

Topography/Geomorphology

The Creek changes from a gently meandering river as it flows across the floodplain to a highly altered channel, confined between artificial floodbanks near the Stour. The large open floodplain and former marshland has been drained and reclaimed by the confinement of the creek and building of a sea wall from Parkeston, around Bathside Bay to Harwich.

Human Exploitation

Settlement was concentrated within the Medieval town at Harwich. The zone has been severely affected by industrial development associated with the port at Harwich and the quay at Parkeston. The development involved the drainage and reclamation of the marshland and protection of the land by sea walls and confinement of the river by artificial floodbanks. A small area of rough grassland exists within the floodplain which has become a golf course. The land was transformed to allow better access and transport links to and from the coast. The railway runs across the former marsh to Harwich and to Parkeston Quay. The mODern A120 follows this route along much of its length. The Dovercourt cement works were located next to the railway and docks to aid the transport of the product (GCZ 13.2) The industrial landscape has expanded and covers much of the zone.

Rarity	Areas of drained saltmarsh are limited in distribution to the coastal zone inland of the sea wall	3
Cultural Association	Limited possibility for evidence relating to former landuse to survive	2
Amenity Value	Few open areas for further research and possible palaeoenvironmental evidence. The borehole site at Harwich is recommended as a Local Geological Site (LoGS)	2
Capacity for change	Heavily developed and altered, moderate capacity to absorb further change	2

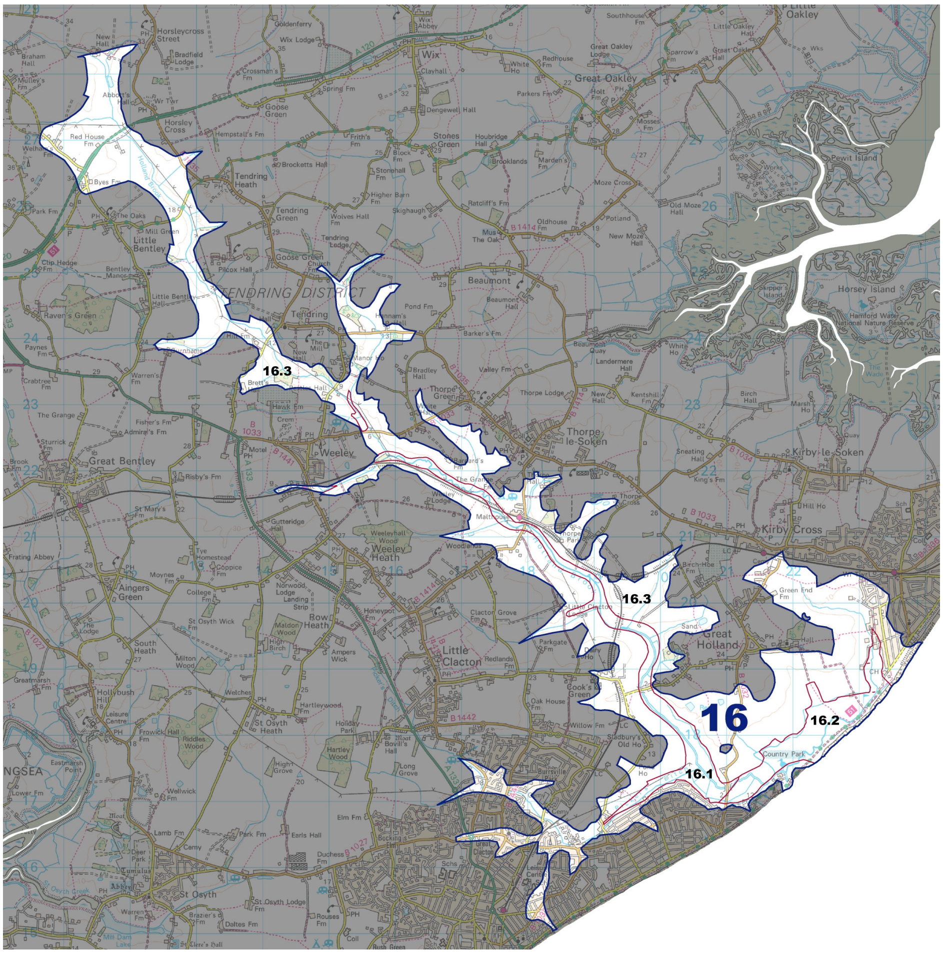


Fig 35 Geodiviersity Character Zones (GCA 16)

GCZ 16.1 Alluvial deposits within the floodplain valley of the Holland Brook

Summary

The freshwater alluvial deposits exist upon the narrow floodplain within the tributaries and along the length of the Holland Brook valley.

Geology

The alluvium is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The freshwater alluvium is deposited by floodwaters within the floodplain of the valley. In the upper reaches of the brook up to c.1.2 m of stoneless grey silty alluvium over thin sandy gravel has been recorded. Downstream the alluvium is at least 1.8 m thick. The alluvium has the potential for providing palaeoenvironmental evidence for environmental change during the Holocene period.

Soil

Within the floodplain soils of the Fladbury Soil Series or Conway Soil Series develop upon the alluvium. These soils are deep stoneless silty clay loams or clayey soils. The soils are difficult to work and prone to waterlogging in flat areas such as floodplain environments. Due to this they are often only suitable for grazing or grassland and are of low quality agricultural grade.

Topography/Geomorphology

The alluvial deposits lie below 5 mOD within the narrow floodplain of the Holland Brook. In the headwaters above Rice Bridge, near Thorpe-le-Soken the river meanders strongly within a relatively narrow floodplain at the valley bottom. Beyond Rice Bridge a weir controls the flow of the river and the channel straightens out. Above the weir issues feed into the brook and the landscape is open with few field boundaries. Downstream the land has been subjected to intensive drainage with small reservoirs and numerous linear drains feeding into the brook. Part of the zone lieis within the Holland Haven Marshes SSSI.

Human Exploitation

The floodplain would have been unsuitable for settlement and is largely undeveloped. The small fields demarcate the edge of the floodplain and form a pastoral landscape. The valley is crossed by the railway on embankments. Between 1896 and 1903 brickworks operated on land between Holland Brook, Harwich Road and the Great Eastern Railway (HER 15468). A siding from the Great Eastern Railway was constructed into the brickworks. The route of the railway siding can still be determined and some remains of the red brick rectangular updraught kiln are standing. Small industrial estates have been developed close to the railway stations and bridges at Weeley and Thorpe-le-Soken. A small caravan park is located upon the floodplain of the tributary valley at Weeley.

Rarity	Limited distribution of freshwater alluvial deposits	3
Cultural Association	No direct cultural associations	1
Amenity Value	Potential for palaeoenvironmental remains relating to the Holocene and evolution of the valley	3
Capacity for change	Limited capacity for change including environmental change and human intervention	3

GCZ 16.2 Estuarine alluvial deposits within the lower reaches of the Holland Brook and Holland Haven marsh

Summary

Estuarine alluvial deposits occur within the widening floodplain of the lower reaches of the Holland Brook. The floodplain opens out into Holland Haven marsh at the coast.

Geology

The alluvium is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The freshwater and estuarine waters mix within the floodplain to create brackish water conditions. The alluvium can range from clays, silty clays and sandy clays and the marine component can often contain shells, organic deposits and coarser grained deposits reflecting periods of higher energy. The floodplain deposits build up over time through successive flooding and tidal inundation. In sheltered areas the build up of sediment above daily flooding levels allows the colonisation of plants and formation of marsh. As the marsh develops the types of vegetation it can support increase and diversify and soils develop. The alluvium has the potential for providing palaeoenvironmental evidence for sea-level and environmental change during the Holocene period.

Soil

At the coast soils of the Wallasea Soil Series have developed upon the freshwater/estuarine alluvium. The Wallasea Soil Series is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high ground-water table. Their use is often restricted to winter cereals and grassland/grazing and even then they are prone to compaction under arable cropping and poaching under grassland. The quality of agricultural land is low.

Topography/Geomorphology

At the bottom of the valley towards the coast the floodplain opens out. The brook doglegs and changes from flowing in a south-eastern direction to north-eastern creating a wide band of floodplain lying parallel to the coast. The Holland Brook and tributaries cross the floodplain and are joined by an extensive radiating ditch system where freshwater meets estuarine to create brackish waters within a marshland habitat. The building of the seawall has enclosed the former open estuarine marsh. Bodies of open water lie within the marsh and parallel to the seawall. At the coast groynes and breakwaters have been built to protect the beach along the exposed coast.

Human Exploitation

The land would have been unsuitable for settlement or development. A seawall has been built and the land drained extensively. The adjoining grassland created through drainage of the marshes is used as coastal grazing and as a golf course.

Rarity	Distinct and uncommon landscape of marine and freshwater alluvial deposits	3
Cultural Association	Potential for palaeoenvironmental remains relating to the Holocene, sea-level change and evolution of the valley	3
Amenity Value	The land is undeveloped and potential	3

	waterlogged deposits may survive.	
Capacity for change	Limited capacity for change including environmental change and human intervention	3

GCZ 16.3 London Clay slopes of the Holland Brook valley

Summary

London Clay is exposed along the steep valley sides of the Holland Brook valley and tributary valleys.

Geology

London Clay is exposed along the valley slopes. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The slopes are flanked by the sediments of the Cooks Green Gravels and Wivenhoe Gravels. The Cooks Green and Wivenhoe Gravels accord with the third highest of the four Kesgrave Formations on the Tendring Plateau (GCA 7).

Soil

Upon the slopes the soils vary with soils of the Wix and Windsor Soil Series. The Wix Soil Series is characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. Around the Holland Brook, these soils display patterned ground features which are relict features formed during the Devensian glacial stage. The Windsor Soil Series is characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally on valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. The quality of agricultural land upon these soils is fairly poor where they have not been subjected to improvement. The London Clay soils have been improved and intensively cultivated upon the shallower slopes.

Topography/Geomorphology

The Holland Brook valley system includes the Holland Brook and tributaries including Tendring Brook, Weeley Brook and Pickers Ditch. The Holland Brook is the largest stream (c.16 km long) in the District and divides much of the area diagonally. The brook flows northwest-southeast into the sea at Holland Haven. Its valley is asymmetric with steeper south-western slopes falling from 25 mOD to 5 mOD. The valley of the Holland Brook is relatively constrained along its length and broadens slightly in the lower reaches. The landscape is pastoral along the steeper valley slopes with mixed woodland, some of it ancient deciduous woodland. Reservoirs are located along the streams and upon the slopes of the tributary valleys and Holland Brook valley. The coastal slopes descend gradually towards the flat marshland along the coastal edge.

Human Exploitation

Much of the area would have been unsuitable for settlement or development. The land is largely rural with large scale regular fields separated by small streams and drains with few hedgerows. A small hamlet near Thorpe-le-Soken, scattered farms and cottages are located upon shallower slopes at the head of the valley and tributary valleys along the system. The railway line follows the slope of the valley from Weeley and crosses the brook on embankments towards Clacton. Towards the coast the small village of Great Clacton has been amalgamated within the larger residential development of Clacton. The London Clay upon the valley slopes was extracted for brickmaking. The remains of a kiln from a late 19th century brickworks (HER 15468) survive above ground close to Thorpe-le-Soken railway station. Towards the coast prominent buildings have utilised the septarian nodules, or ‘septaria’ from the London Clay, such as the church of St. John the Baptist at Great Clacton.

Rarity	One of a number of valley systems with London	1

	Clay slopes within the District	
Cultural Association	Some historical industrial related activities	2
Amenity Value	Potential for coastal exposures of Eocene stratigraphy. Prominent buildings utilising the septaria are visible, including Great Clacton Church- recommended as a Local Geological Site (LoGS)	3
Capacity for change	High capacity for change	1

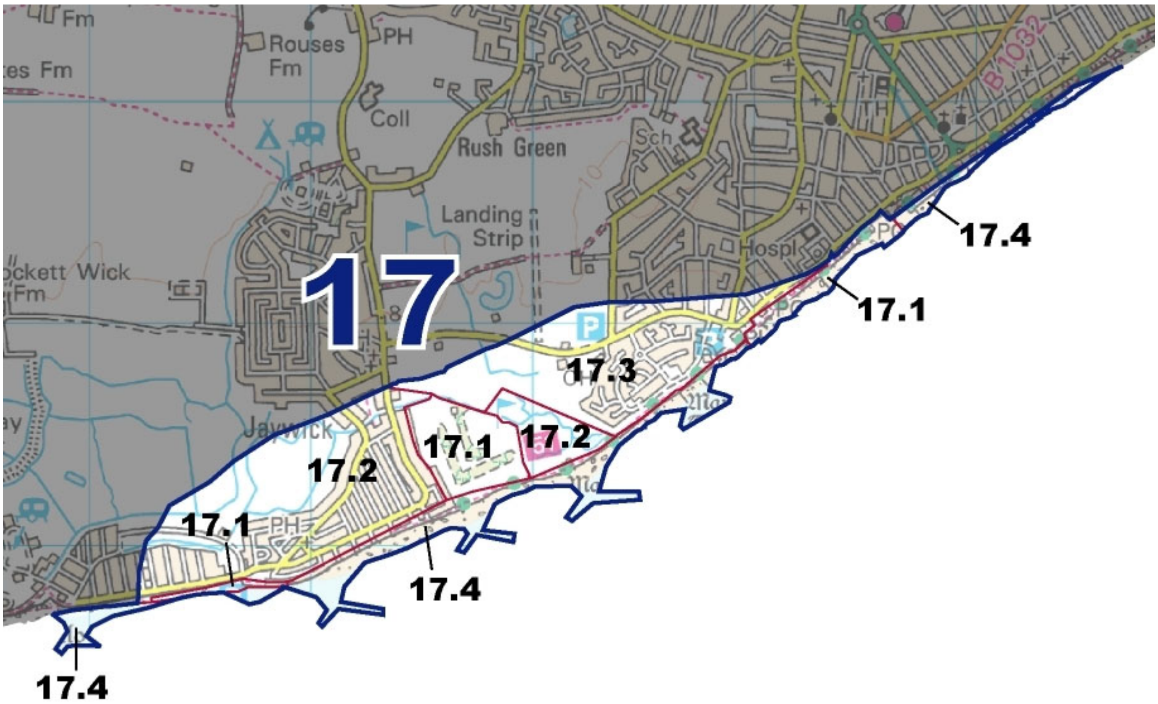


Fig 36 Geodiviersity Character Zones (GCA 17)

GCZ 17.1 Clacton Channel deposits at Clacton, Westcliff and the foreshore at Jaywick

Summary

The zone covers a complex of channel deposits associated with the Thames-Medway system found inland and in the West Cliff at Clacton, and the foreshore at Jaywick. The zone covers three separate areas which make up the Clacton Cliffs SSSI which are of international significance both archaeologically and geologically.

Geology

Exposures within the cliffs and investigations inland have revealed a stratigraphic sequence which shows fine-grained freshwater and estuarine sediments occupying a channel cut through the Lower Holland Gravels and into the underlying London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The sands and gravels into which the 'Clacton' Channel has been cut have been identified as belonging to the Lower Holland Gravels. The Holland gravels accord with the lowest of the four Kesgrave Members on the Tendring Plateau (GCA 5) and were laid down by the combined Thames-Medway Rivers under cold climate conditions. The Lower Holland Gravels form the final terrace aggradation by the confluent Thames-Medway before the diversion of the Thames due to blockage of the channel upstream by the Anglian icesheet and is contemporary with the St Osyth Lower Gravel (GCA 5).

The Clacton Channel deposits are a sequence of freshwater and estuarine sediments (Lower and Upper Freshwater Beds and Clacton Estuarine Beds) occupying a channel cut into an earlier gravel accumulation (Lower Holland Gravels) and the underlying London Clay. The full stratigraphic sequence infilling the channel is up to c.20 m thick in aggregate though this can vary along the channel. The final channel deposit, the Clacton Estuarine Beds can be found to lie around c.3-5 m below ground level. The stratigraphic sequence within the cliffs is varied and has been generalized (Bridgland, 1994). The basal channel deposits consist of up to 7 m of clayey gravel and sand known as the Lower Freshwater Beds. Above this the sediments become finer grained with up to 4m of loamy sands with clays (Upper Freshwater Beds). A change in the tidal influence is reflected with the deposition of the Clacton Estuarine Beds which are composed of up to 5 m of sand with shells and clays over laminated clay. The channel deposits were deposited under temperate conditions within a lower energy environment. The channel deposits have yielded abundant molluscan and mammalian fossil remains, fossil plants and pollen, all of which indicate a Hoxnian interglacial age (MIS 11) 425,000-380,000 years ago. However, elements of the Clacton Channel deposits may be of a later date, Ipswichian (MIS 5e) dating to c.120,000 years ago, pointing to the complexity of the deposits and adding to their archaeological and geological importance. A deterioration of climatic conditions and significant change to a higher energy fluvial system is reflected by the deposition of the Wigborough Gravels (GCA 8) which cover the channel deposits in places with up to 2 m of bedded sands and gravels. The Wigborough Gravel possibly was deposited by the diverted post-Anglian Thames-Medway River and are the last Thames gravels found in the Tendring District.

Alternatively the gravels may belong to an early River Colne. These gravels are found between 1-3 m below the surface.

The alluvial deposits along the beach consist of sand and shingle.

Soil

Where the area borders the drained marshes in the south the soils developed belong to the Wallasea Soil Series. This is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high ground-water table.

Geomorphology

The channel was the product of the Thames-Medway Rivers and represents an early phase of deposition by the river after it was diverted by Anglian ice blocking its channel upstream. The Clacton channel deposits are approximately 500 m's wide. The separate channels reveal an anastomising river system flowing from the south with an estuarine influence. In places the channels are separated by a ridge of London clay which is exposed at the surface.

The low coastal cliffs reveal a natural cross-section of the gently domed St Osyth coastal ridge from Point Clear to Clacton which reaches up to 15 m in height. Within the zone the cliffs reach up to c.5 m in height and are no longer visible due to sea defences. A narrow beach has formed along the exposed coast and is protected by groynes and breakwaters.

Human Exploitation

Within the cliffs an undisturbed Palaeolithic occupation surface has been identified. This has become the type-site of the internationally significant Clactonian Industry which is based on a crude working technique. The finds have revealed human occupation along the diverted Thames-Medway shortly after the Anglian glaciation during an interglacial known as the Hoxnian which began about c.425,000-years ago and ended c.380,000 years ago. Two full-scale archaeological excavations have taken place on the golf course. The Freshwater Beds have yielded the largest collections of Clactonian artefacts. A number of finds including a flintworking site (HER 2950) from which artefacts comprising 141 cores, 51 shatter pieces, 12 choppers and 1163 flakes were recovered. Animal bones were also found, including horse, deer, rhinoceros and bos-bison. The deposits also contained one of the few wooden implements, the Clacton spear, which could be securely dated to the Palaeolithic (HER 17686). Analysis of the finds indicate hunting, hide processing, wood and bone working from a simple suite of tools.

Since the drainage of the adjoining marsh the landscape has been altered significantly and the inland area is now covered by part of the settlement of Jaywick and the residential expansion of Clacton. Inland the landscape consists of rough grassland and small areas of mixed woodland with drainage channels as boundaries. The open areas are largely used for recreational purposes and include a golf course. The cliffs are now obscured by sea defences and the beach is protected by a series of groynes and breakwaters.

Rarity	Only known location of Clacton channel deposits	3
Cultural Association	Type site for Clactonian industry	3
Amenity Value	No visible exposures but further excavations possible	3
Capacity for change	Internationally significant interglacial deposits less than 3 m below ground surface, gravels less than 1m below ground surface.	3

GCZ 17.2 Former marshland within the 'Clacton Channel'

Summary

Alluvial sediments and London Clay exposures occur within the area of the Clacton channel deposits adjacent to the Colne estuary marshland

Geology

London Clay outcrops within an alluvial plain. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

Resting upon the London Clay are fine grained sediments deposited by the sea at high tide level within an estuarine environment. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser grained deposits reflecting periods of higher-energy such as storms. The deposits build up over time and in sheltered areas which allows the colonisation of plants and formation of saltmarsh. Subsequent flood events or rising sea level rises cover the vegetation with muds and the buried vegetation eventually breaks down to a peat deposit. These sediments were laid down during the Holocene and can provide a record of changing sea-levels. These alluvial deposits lie inland of the sea defences and have been artificially drained and improved for cultivation.

The zone lies within an area of mapped Clacton Channel deposits (GCZ 17.1) and has the potential to contain significant interglacial stratigraphic deposits and important Palaeolithic archaeology.

Soil

The soils developed within the zone belong to the Wallasea Soil Series. This is characterised by deep stoneless silty clay or clayey soils, formed on marine alluvium. It is typically formed upon coastal marshland. The soils often have organic surface horizons. They suffer from seasonal waterlogging and have a high ground-water table.

Topography/Geomorphology

The flat landscape lies below 5 mOD along the coastal edge within a drained marshland adjacent to the Colne Estuary marsh.

Human Exploitation

The remains of a saltern within the zone indicates the zone lay at the edge of the coastal marshes while the salt processing industry was in use in order to exploit the tidal waters. Substantial drainage of the marsh within the zone has led to the encroachment of residential development at Jaywick into the zone. The zone has become separated from the marshland by substantial drainage channels which have facilitated the conversion of part of the land to a golf course.

Rarity	Within the projected distribution of the Clacton Channel deposits and former marshland	3
Cultural Association	Known association with the Clactonian flint industry	3
Amenity Value	Open areas of high research potential	2
Capacity for change	Limited capacity for change including further development	3

GCZ 17.3 London Clay and alluvial deposits within the 'Clacton Channel'

Summary

Alluvial deposits lie at the base of the adjoining London Clay slopes within an area of mapped Clacton Channel deposits.

Geology

London Clay outcrops within an alluvial plain. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

A thin strip of blown sand is mapped as being exposed behind the sea wall. Blown sand is typically a fine-grained and well sorted deposit.

Resting upon the London Clay are fine-grained sediments deposited by the sea at high tide level within an estuarine environment. The alluvium can range from clays, silty clays and sandy clays and can often contain shells, organic deposits and coarser grained deposits reflecting periods of higher energy such as storms. The deposits build up over time and in sheltered areas allowing the colonisation of plants and formation of saltmarsh. Subsequent flood events or sea-level rises cover the vegetation with muds and the buried vegetation eventually breaks down to a peat deposit. These sediments have been laid down during the Holocene and can provide a record of changing sea-levels. These alluvial deposits lie inland of the sea defences and have been artificially drained and improved for cultivation.

The zone lies within an area of mapped Clacton Channel deposits (GCZ 17.1) and has the potential to contain significant interglacial deposits which contain important Palaeolithic archaeology.

Soil

The area lies adjacent to the London Clay coastal slopes where soils of the Wix Soil Series have developed. The continuation of these soils into the zone reflects the influence of the London Clay. These are characterised by deep sandy or sandy silt loams. Where they are formed on gravelly sediments the soils can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. Their main landuse includes cereals and other arable crops. They are often formed on gentle valley slopes and undulating lowlands.

Topography/Geomorphology

The zone lies at the base of the London Clay slopes along the coastal edge, around 5 mOD. The alluvial deposits upon the flat floodplain indicate the area was former marshland, with the creeks partially surviving as drainage channels.

Human Exploitation

The zone has been subjected to drainage and development with the expansion of the residential urban settlement and recreational areas of Clacton.

Rarity	Within the projected distribution of the Clacton Channel deposits and former marshland	3
Cultural Association	Known association with the Clactonian flint industry and association with prehistoric or historic industrial related industry	3

Amenity Value	Open areas of high research potential	2
Capacity for change	Limited capacity for change including further development	3

GCZ 17.4 Beach deposits along the coast between Clacton and Jaywick

Summary

The zone covers the narrow stretch of beach within proximity of the Clacton Channel deposits recorded within the cliffs between Clacton and Jaywick. The zone excludes the areas of coast covered within the Clacton Cliffs SSSI.

Geology

The alluvial beach deposits are underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

A thin strip of blown sand is mapped as being exposed within the intertidal zone. Blown sand is typically a fine-grained and well sorted deposit.

The alluvial deposits along the beach consist of sand and shingle.

Soil

There is no soil development upon the beach

Topography/Geomorphology

The narrow beach lies between the tidal high and low water mark. The coast is exposed and has been protected by the construction of numerous groynes and breakwaters including the distinctive fish-tail groynes along this stretch of coast.

Human Exploitation

The beach has been altered by the construction of coastal defences. It is used recreationally.

Rarity	Beach deposits found along much of the coastline	2
Cultural Association	No direct cultural association but association with the Clacton channel sediments which may lie beneath the beach sediments.	2
Amenity Value	Public access but limited research potential	1
Capacity for change	Limited capacity for change, specifically environmental changes	3

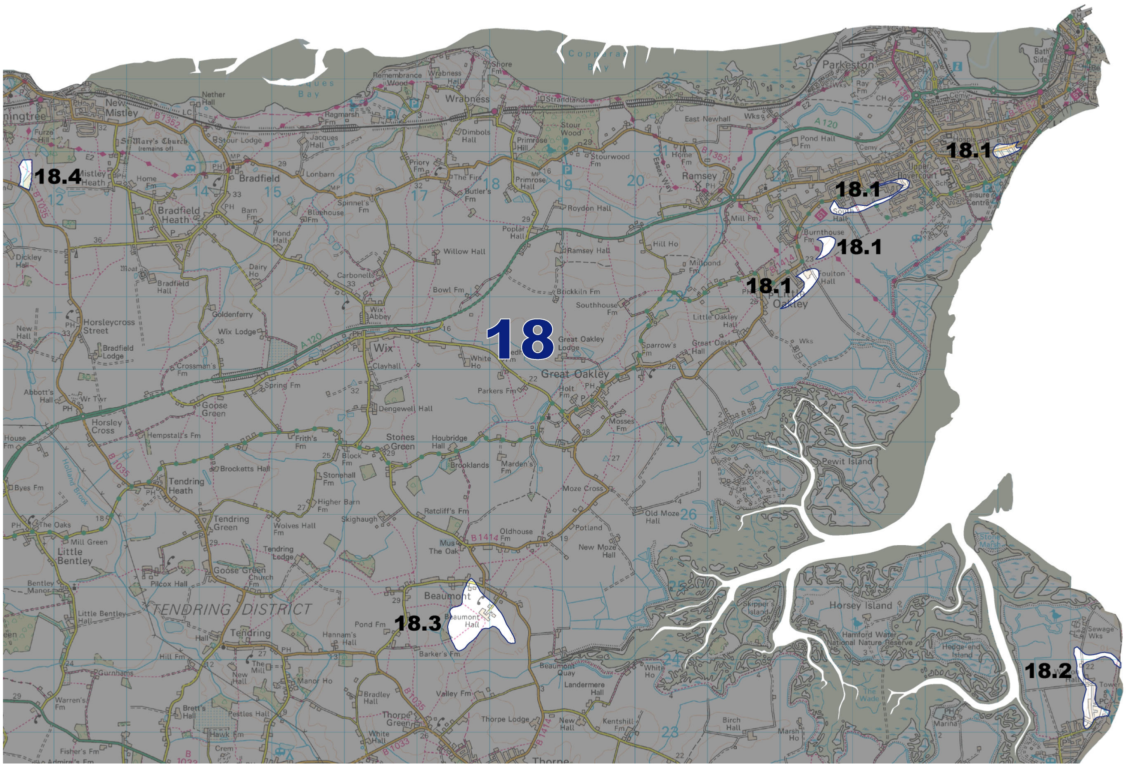


Fig 37 Geodiviersity Character Zones (GCA 18)

GCZ 18.1 Red Crag deposits along the Oakley Ridge

Summary

Discrete patches of Red Crag are exposed along the southern slopes of the Oakley Ridge towards the coast.

Geology

The Red Crag is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Red Crag is composed of sediments and shells deposited in the near-shore environments of the sea around 2.4 million years ago. The shells have been used to reveal a cooling of climate as the sequence progresses upwards. At the base of the Crag phosphatic nodules form a layer or bed, this deposit contains fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells. The deposit is divisible into two main units, a lower (shelly) Red Crag composed of sand with many shells and crossbedded structures representing sand dunes in a shallow sea and an upper (non-shelly) Red Crag of medium- to fine-grained iron-stained cross-bedded sands, posibly decalcified. The deposits can contain a small number of pebbles and major component of clay in certain areas. In a small pit at Little Oakley over 600 different species of mollusc were found in the Red Crag deposits revealing an extraordinarily rich molluscan fauna of the Red Crag sea

The Red Crag lies adjacent to and in places is capped by Oakley Gravels (GCA 2)

Soil

The soils in the area are mapped as belonging to the Wix Soil Series. This is characterised by deep sandy or sandy silt loams. Where they are formed on gravelly sediments they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. Towards the coast the soils belong to the Windsor Soil Series. This is characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally valley on slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. The Beaumont Soil Series (not on 1:250,000 soil mapping) forms over Red Crag where it is free of clay and iron-panning. The soils are calcareous brown earths suitable for arable agriculture and horticulture. They are easy working and freely draining soils though they need more frequent watering.

Topography/Geomorphology

The deposits are exposed along the upper London Clay slopes between heights of 20 and 5 mOD. They are capped by gravels in places.

Human Exploitation

The area would have had sparse settlement or development. Foulton Hall is situated upon the slopes south of Little Oakley. The expansion of the settlement at Dovercourt has resulted in built-up residential development onto the slopes. The London Clay slopes have been drained and improved to allow more intensive cultivation.

Rarity	Exposures are limited in extent and distribution within the District	3
Cultural Association	No known cultural association	1
Amenity Value	Exposures can be highly visible and prolific in fossil content	2
Capacity for change	Moderate capacity for change due to limited extent and distribution	2

GCZ 18.2 Cromerian age deposits at The Naze.

Summary

Exposures of Red Crag and interglacial Cromerian deposits occur within the cliffs at The Naze. The site lies within a geological SSSI.

Geology

The Red Crag is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers. A diverse bird fauna has been preserved in small pockets within the London Clay, including a small parrot *(Psittaciformes*) and a tiny raptor *(Falconiformes*). The site is of considerable importance in the study of bird evolution. The diversity of fossils and form of preservation of these fossils in this area is of significance for palaeobotanical research. In its unweathered state the London Clay is a stiff blue-grey clay containing mudstone concretions cemented with calcite (septaria) and fossils. The weathered clay is a brown, non-calcareous deposit.

The Red Crag is composed of sediments and shells deposited in the near-shore environments of the sea around 2.4 million years ago. It is found across much of north-east Essex and is exposed across the eastern coast of Tendring. At the base of the Crag phosphatic nodules form a layer or bed, this deposit contains fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells. The shells have been used to reveal a cooling of climate as the sequence progresses upwards. The deposit is divisible into two main units, a lower (shelly) Red Crag composed of sand with many shells and crossbedded structures representing sand dunes in a shallow sea and an upper (non-shelly) Red Crag of medium- to fine-grained iron-stained cross-bedded sands, possibly decalcified. The deposit can contain a small number of pebbles and a major component of clay in certain areas

Lying within a channel cut into the Red Crag are fine-grained silt deposits. Initially these are overlain by Cooks Green Gravels (GCZ 7.8). The sediments have been mapped as Chillesford Clay (part of the Norwich Crag) but pollen recovered from the silts indicate interglacial conditions and the stratigraphic position of the sediments suggest that they represent a later temperate period, within the Cromerian Complex. The Chillisford Clay has been dated to c. 1.9 million years.

Soil

The soils in the area are mapped as belonging to the Wix Soil Series. This is characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. The Beaumont Soil Series (not on 1:250,000 soil mapping) forms over Red Crag where it is free of clay and iron-panning. The soils are calcareous brown earths. They are easy working and freely draining soils though they need more frequent watering.

Topography/Geomorphology

The Red Crag is exposed in the coastal cliffs and upon the inland slopes of the coast upon an ‘island’ formed by an outcrop of London Clay capped by gravels. They lie between heights of around 20 mOD to 15 mOD on the gentle upper slopes of the outcrop. Part of the acid heath woodland that lies upon the flatter cliff top extend into the zone.

Human Exploitation

The elevated position of the deposits within the surrounding marshland and coastal location has attracted settlement and includes Walton Hall. The gentle slopes are covered by open agricultural land. In the south the expansion of the urban settlement of Walton has encroached upon the slopes.

Rarity	Only recorded exposure of deposits	3
Cultural Association	No known cultural association, however sediemtns represent a climatic period suitable for human occupation	2
Amenity Value	Possible exposures as a discontinuous deposit within the cliffs and of need for further research	3
Capacity for change	Limited capacity for change including environmental change and encroaching residential development	3

GCZ 18.3 Red Crag at Beaumont

Summary

A discrete patch of Red Crag exposed at Beaumont lies close to the inland extent of Hamford Water.

Geology

The Red Crag is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

The Red Crag is composed of sediments and shells deposited in the near-shore environments of the sea around 2.4 million years ago. It is found across much of north-east Essex and is exposed across the eastern coast of Tendring. At the base of the Crag phosphatic nodules form a layer or bed, this deposit contains fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells. The shells have been used to reveal a cooling of climate as the sequence progresses upwards. The deposit is divisible into two main units, a lower (shelly) Red Crag composed of sand with many shells and cross-bedded structures representing sand dunes in a shallow sea and an upper (non-shelly) Red Crag of medium- to fine-grained iron-stained crossbedded sands, possibly decalcified. The deposit can contain a small number of pebbles and major component of clay in certain areas

Soil

The Tendring Soil Series is characterised by usually deep and stoneless loams and drain reasonably well, although it can also contain sufficient water to avoid drought in most years. These are typical soils of the plateau landscape and are high grade agricultural soils. The Windsor Soil Series is characterised by deep clayey soils mostly with brown subsoils formed upon London Clay. Their distribution therefore is generally on valley slopes and the undulating lowlands. Their high clay content makes them difficult to work and prone to seasonal waterlogging and compaction under arable cropping and poaching under grassland. They are often woodland soils. The Windsor soils provide poorer quality agricultural land. The Beaumont Soil Series (not on 1:250,000 soil mapping) forms over Red Crag where it is free of clay and iron-panning. The soils are calcareous brown earths. They are easy working and freely draining soils though they need more frequent watering.

Topography/Geomorphology

The sediments survive on a further spur of land at about 25 mOD, capping the London Clay which is exposed down the slopes. The zone is largely rural and is peripheral to the village at Beaumont. Wooded areas surround the manorial church/hall site of Beaumont Hall and Beaumont House.

Human Exploitation

The zone has limited settlement or development. The elevated position possibly influenced the location of the Medieval church/hall complex of Beaumont Hall. Surrounding the houses and church are large open fields.

Rarity	Exposures are limited in extent and distribution within the District	3
Cultural Association	No known cultural association	1
Amenity Value	Exposures can be highly visible and prolific in fossil content	2
Capacity for change	Moderate capacity for change due to limited extent and distribution	2

GCZ 18.4 Possible exposure of Red Crag at Mistley

Summary

The zone covers a small area of historically recorded exposures of Red Crag at Mistley Park

Geology

The Red Crag is underlain by London Clay. The fine-grained sediments of the London Clay represent the accumulation of mud on a sub-tropical sea floor over 50 million years ago. The London Clay contains fossil bones of warm-loving marine mammals as well as birds, sharks and other animals and fossilised plants and wood representative of rainforest vegetation brought/washed in by rivers.

A number of exposures of Red Crag were recorded at Mistley Park at the beginning of the 20th century. The Red Crag is composed of sediments and shells deposited in the near-shore environments of the sea around 2.4 million years ago. It is found across much of north-east Essex and is exposed across the eastern coast of Tendring. At the base of the Crag phosphatic nodules form a layer or bed, this deposit contains fossil bones of marine animals. The Red Crag nodule bed is covered by layers of red, iron-stained sands with abundant fossil shells. The shells have been used to reveal a cooling of climate as the sequence progresses upwards. The deposit is divisible into two main units, a lower (shelly) Red Crag composed of sand with many shells and cross-bedded structures representing sand dunes in a shallow sea and an upper (non-shelly) Red Crag of medium- to fine-grained iron-stained cross-bedded sands, possibly decalcified. The deposit can contain a small number of pebbles and a major component of clay in certain areas.

Soil

The deposit is within an area where the Wix Soil Series is mapped. The Wix Soil Series is characterised by deep sandy or sandy silt loams. Where they are formed on gravelly lithologies they can have a moderate to strong stony component which makes them permeable. They are fairly resistant to erosion by water. They are often formed on gentle valley slopes and undulating lowlands. The Beaumont Soil Series (not on 1:250,000 soil mapping) forms over Red Crag where it is free of clay and iron-panning. The soils are calcareous brown earths suitable for arable agriculture and horticulture. They are easy working and freely draining soils though they need more frequent watering.

Topography/Geomorphology

The area lies along the London Clay slopes of the Stour Valley system, from below 20m to 10 mOD. The zone is partly wooded.

Human Exploitation

It is unclear whether the recordings of the Red Crag were from exposures or pits, which would indicate quarrying. The area is undeveloped.

Rarity	Exposures are limited in extent and distribution within the District	3
Cultural Association	No known cultural association	1
Amenity Value	One site, ‘near Oak Grove’, may have the potential to create an inland exposure of Red Crag.	2
Capacity for change	Moderate capacity for change due to limited extent and distribution, however possibly deeply buried	2

4 Geological Conservation

Statutory Designations

Sites of Special Scientific Interest (SSSIs)

A sample of the best of the UK's geological sites are legally protected through their designation as SSSIs. SSSIs are notified under the Wildlife and Countryside Act, 1981. The Countryside and Rights of Way Act (CRoW) 2000, greatly strengthened the legislation relating to the conservation of geology in England and Wales, placing emphasis on the positive management, rather than just conservation of SSSIs. The CRoW Act also makes it an offence to knowingly or recklessly damage a SSSI, including by irresponsible mineral or fossil collecting. The network of SSSIs in England is the responsibility of Natural England.

Tendring has nine Sites of Special Scientific Interest (SSSIs) that have been notified specifically for their geological value and a further one contiguous with its boundary (fig 39) and Appendix 2. This is a high number for such a small area, which testifies to the District's importance for geodiversity.

Geological Conservation Review (GCR) Sites

The Geological Conservation Review (GCR) was initiated by the Nature Conservancy Council in 1977 to identify, assess, document and eventually publish accounts of the most important parts of Great Britain's rich and varied geological heritage. GCR sites were selected in the basis of their scientific value rather than any educational or historical importance and in general only one site was selected as the best example of each aspect of geology under consideration. The sites selected - GCR sites - form the basis of statutory geological and geomorphological site conservation in Britain; all GCR sites in Tendring District are designated as SSSIs.

Non Statutory Designations

Regionally Important Geological/geomorphological Sites (RIGS)

RIGS were established in 1990 by the Nature Conservancy Council (NCC).They have support from Natural England and other national agencies, and are increasingly recognized by local planning authorities. RIGS are identified by locally-developed criteria and recommended to local authorities for designation as RIGS.

RIGS in Essex were selected by the Essex RIGS Group (now GeoEssex), a largely voluntary group composed of representatives from English Nature, Essex Wildlife Trust, Essex Field Club, Essex museums, Essex County Council's Planning Division and the county's two geological societies. The site selection process is based on clearly defined criteria including the value of the site for educational visits, for promoting public awareness of geology, for scientific study, its historical importance, or the site's aesthetic value in the landscape. There are currently no RIGS in Tendring District.

Local Geological Sites (LoGS)

Local Sites are sites of substantive nature conservation value. Although they do not have any statutory status, many are equal in quality to the representative sample of sites that make up the series of statutory Sites of Special Scientific Interest (SSSIs). Tendring District may designate certain areas as being of local conservation (including geological) interest.

Defra have recently published guidance on identification, selection and management of local sites (DEFRA, 2006). These sites can be designated in DPDs prepared under the Town and Country Planning system by Tendring District and, as such, would be a material consideration when planning applications are determined. Section 5 of this report identifies potential LoGS that may be designated in DPDs by Tendring District subject to the development of agreed criteria by the Essex Local Sites Partnership.

5 Gazetteer of geodiversity sites in Tendring District

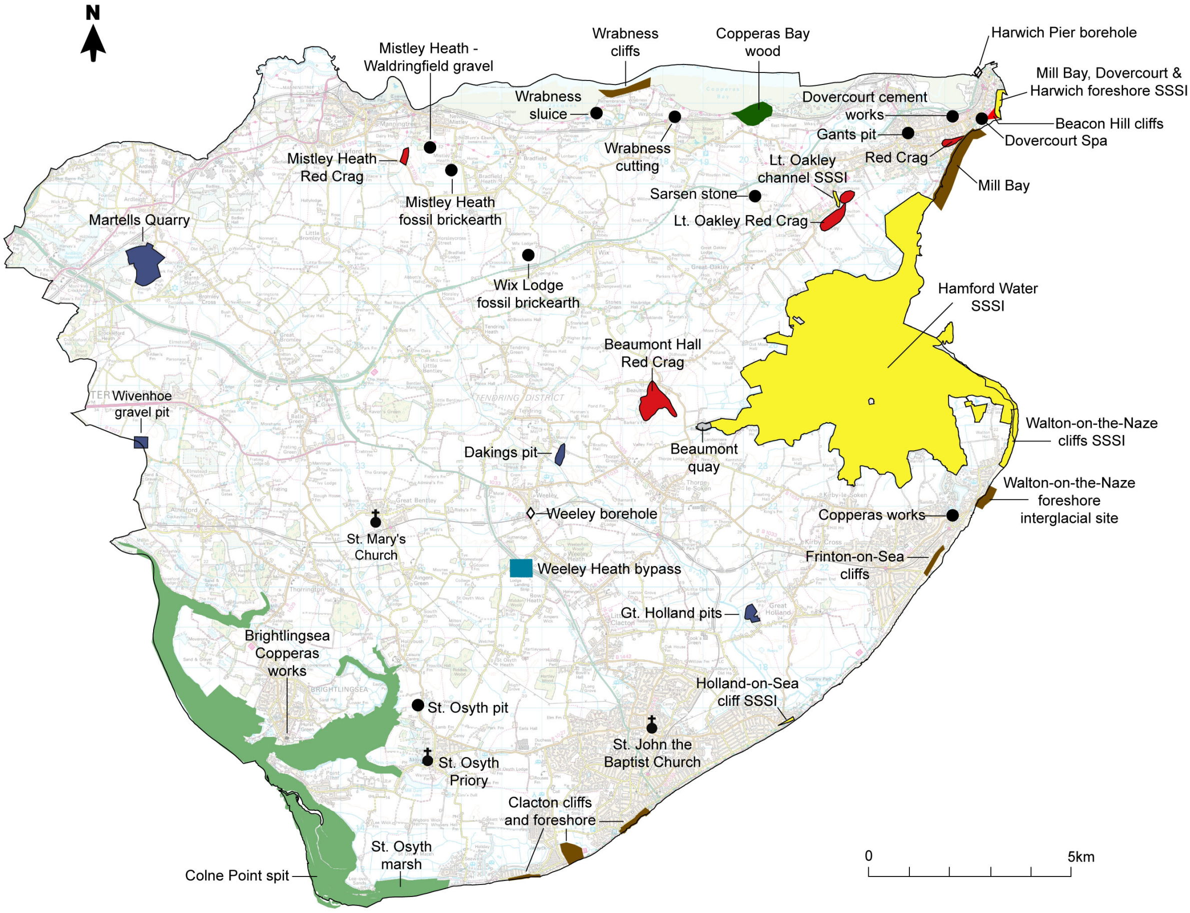


Fig. 38 Sites on the Tendring Geodiversity Gazeteer

Tendring has nine Sites of Special Scientific Interest (SSSIs) that have been notified specifically for their geological value and a further one contiguous with its boundary. This is a high number for such a small area, which testifies to the District's importance.

However there are a large number of other sites in Tendring that are of importance for their geology or geomorphology. These local sites are of importance for their scientific, historical and/or educational value unlike the strictly scientific criteria applied to SSSIs. These are not 'second tier' sites but sites of regional and local value in their own right. This gazetteer defines geological sites in the widest sense and includes buildings, walls, wells, spas, boreholes, plaques, landslips, and even a roadsign. The list is being refined as further research is carried out in the district.

Several sites have been recommended for designation by Tendring District Council as Local Geological Sites (LoGS) which are the equivalent of Local Wildlife Sites.

ARDLEIGH

Ardleigh Gravel Pit SSSI (Martells Quarry)

Grid reference: TM 053 280

Martells Quarry at Ardleigh is an important site for reconstructing the climate and landscape of Essex. The quarry reveals Ardleigh Gravel, part of the Kesgrave Sands and Gravels, which was laid down in cold conditions during the Ice Age by the Thames when it flowed across the Tendring peninsula. This is confirmed by beds of organic clay containing fossils of cold-climate plants. Also within this gravel are beds of organic clay with plant fossils and beetle remains, dating from a temperate interglacial stage. Deposits from two cold climate episodes are therefore represented here, separated by an interglacial period. The interglacial deposits are of considerable significance and may be unique in Britain. The deposits cannot be dated per se, but by comparison with other sites, and by reference to the geological sequence in the Netherlands, the interglacial deposits are thought to belong to the 'Cromerian Complex' and therefore assumed to be about 550,000 years old.

On top of the Ardleigh Gravel is the Martells Gravel which has a slightly different stone content (more *Rhaxella* chert, probably reworked from the Red Crag of the area) and structures indicating a flow from the north-east. Thus the Martells Gravel appears to have been deposited by a local river flowing from the north-east. At the very top of the Martells Gravel is a deformed, iron-rich deposit that is thought to represent a complex ancient soil horizon. This soil horizon has been found elsewhere and is known as the Valley Farm Soil, the redness indicating soil formation under a warm, dry Mediterranean climate. The deformation was caused by later periglacial activity, overprinting it with a cold climate soil known as the Barham Soil.

Existing or recommended site designation
Part of the site is an existing geological SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement
The organic clay beds are not presently exposed and the temperate organic clay is too deep

for it to be uncovered as a permanent exposure. However, the possibility of conserving a vertical cliff of gravel in a disused part of the site should be investigated. This would be an extremely useful teaching aid for students and, if suitably accessible, for public interest and education.

BEAUMONT

Beaumont Quay limekiln

Grid reference: TM 190 240

The circular brick limekiln at Beaumont Quay is the only complete limekiln surviving in Essex. The quay was built in 1832 but the limekiln is thought to have been added later, probably in 1869-70. Limekilns were usually built in chalk quarries to be close to the raw material used for making lime but in coastal areas more permanent and substantial kilns were built in harbours and wharfs where chalk and fuel for the kiln could be brought in by sea. The limekiln, and Beaumont Quay, is owned by Essex County Council.

Existing or recommended site designation

Listed building.

Recommendations for promotion, site management or enhancement

According to Essex County Council the quay and the limekiln have been recommended for scheduling as an ancient monument.

BEAUMONT

Patch of Red Crag at Beaumont Hall

Grid reference: approx TM 180 246

An isolated patch, or outlier, of Red Crag, about a quarter of a square mile in size, caps the top of the hill occupied by Beaumont Hall. It is one of the few fragments of a once continuous deposit of Red Crag across north Essex that has been almost entirely destroyed by erosion. The Red Crag in this part of Essex consists of loose sand with abundant fossil shells and the fossils of other marine animals that lived in the Red Crag Sea that existed about 2 million years ago.

The Red Crag at Beaumont was first brought to the attention of the scientific world by the well-known Essex geologist John Brown of Stanway, who obtained over 90 species of fossil shells from a pit near the south-eastern extremity of the outlier and privately published a list of them in 1846. At the end of the nineteenth century the amateur geologist Frederick Harmer (1835-1923) carried out a detailed study of the fossils of the Red Crag (see entry for Little Oakley) and re-opened Brown's pit where he succeeded in finding more than 260 species. Most of these were characteristic of the Walton Red Crag but a few were Arctic species which were rare or absent at Walton, indicating that this outlier may be slightly younger than the Walton Crag. With the permission of the landowner Harmer also dug a hole near the south-western limit of the Beaumont outlier which revealed 5 or 6 feet of Red Crag resting on London Clay. With the help of a labourer 7 or 8 tons of Crag sand were sifted and from this several species were encountered that were not found at the previous pit. Harmer published a detailed account of his work at Beaumont and elsewhere in the Quarterly Journal of the Geological Society in 1900.

Shelly Red Crag was formerly exposed in the sides of the pond near the church and in other temporary excavations made as part of the running of Beaumont Hall Farm. Farm workers would often come across the typical Red Crag gastropod *Neptunia contraria* that is known as the 'left-handed whelk' because it spirals in the opposite direction to almost all other known gastropods. At Walton, the normal right-handed specimens also occur but at Beaumont these were apparently unknown to the farm labourers and Harmer reports that they had formulated a theory for this: 'Before the flood, everything was left-handed'!

In 1900 the mineral content of the Red Crag at Beaumont was analysed by treating a 25 gram sample with concentrated hydrochloric acid. What remained was 50% quartz but the other 50% contained a rich assemblage of other minerals, some of which are familiar gemstones. Along with the more common rock-formng minerals such as feldspar and mica were rarer minerals such as zircon, rutile, kyanite, and ilmenite together with yellow crystals of corundum and green and blue grains of tourmaline. There were also tiny red garnets that were so plentiful that the heavy concentrate had a strong pinkish colour. Grains of topaz have also been found in the Red Crag although none were recorded from the Beaumont sample. The presence of such minerals in the Red Crag is evidence that these sands were derived from metamorphic rocks, probably from the erosion of the Scottish mountains, and may have been recycled several times over hundreds of millions of years before being deposited on the floor of the Red Crag Sea. As the Red Crag continues to be eroded, here and at Walton-on-the-Naze, these minerals will end up on to the floor of the North Sea – the next stage in a continuous 'rock cycle'.

The former Red Crag exposures at Beaumont are no longer accessible but fossil shells can be seen in places scattered on arable fields, such as by the public footpath east of Beaumonthall Wood. Red Crag sand and shells can also often be seen thrown out of animal burrows in the ditch bank alongside the footpath west of Beaumont Hall.

Existing or recommended site designation

Not yet applicable

Recommendations for promotion, site management or enhancement

Permission should be sought from the landowner to reopen a small section in the Red Crag. Such a section would be of scientific and historical interest as it is over 100 years since the Red Crag at Beaumont was last studied.

BRIGHTLINGSEA

Copperas works

Grid reference: TM 087 161 (approx)

The copperas industry was an important industry in eighteenth century Essex which involved gathering of pyrite nodules (known as 'copperas stones') from beaches, where they had been washed out of the London Clay, and by a lengthy and hazardous industrial process converting them to ferrous sulphate (green vitriol) which was an essential chemical for making dyes, ink, and several industrial chemicals such as sulphuric acid (see section on industries in the Tendring district).

In Brightlingsea, copperas was manufactured as early as 1542. In 1674 the famous Essex naturalist John Ray published an account of refining metals and minerals in England and in this book he describes the technical aspects of copperas manufacture at Brightlingsea. Philip Morant, in 1768, refers to a copperas works here and a 'copperas house' is marked on the 1777 Chapman and Andre map. The copperas works at Brightlingsea is commemorated by the road name Copperas Road. The Brightlingsea town guide refers to this local industry, including an account of a local legend that an owner of the works lost his life when he fell into a boiling cistern!

Existing or recommended site designation

None

Recommendations for promotion, site management or enhancement

None

CLACTON

Clacton Cliffs and Foreshore SSSI

Grid references: TM 173 143 (Clacton), TM 156 134 (golf course), TM 146 128 (Jaywick).

Clacton is one of the principal prehistoric sites in Europe and a site of considerable international importance. The story starts in the 1830s when Essex amateur geologist John Brown discovered channel deposits exposed in the West Cliff at Clacton, close to the pier and below the Martello tower on Marine Parade West. The channel deposits were seen to cut down through the Lower Holland Gravel (laid down by the Thames-Medway River) and into the London Clay. Brown had discovered what is now considered to be a key site in British Quaternary (Ice Age) studies because it allows the Quaternary geological sequence of the Lower Thames in south Essex to be linked to that of East Anglia. The site in those days was an eroding cliff (before it was obscured by sea defences) and it yielded some spectacular fossils including the bones of lion, rhinoceros and elephant. It has been designated as a Site of Special Scientific Interest (SSSI).

The Clacton Cliffs and Foreshore SSSI, as it is known, is a complex series of sediment-filled channels which intersect, but bear no relation to, the present coastline and consist of three separate sites (see map and section). The two main sites are where the channels were formerly exposed - the cliffs and foreshore at Clacton and the foreshore at Lion Point, Jaywick. The third site is between the two at Clacton Golf Course. A further site (not part of the SSSI) is the former Butlins holiday camp. Detailed descriptions can be found in *The Quaternary of the Thames* by David Bridgland (1994).

The channel is actually the bed of the Thames-Medway River when it flowed through here about 400,000 years ago. The sediments in the channel have provided a diverse fossil record with molluscs from freshwater and estuarine environments and a vertebrate record ranging from bones or teeth of vole, water rat and beaver to boar, deer, horse, lion, rhinoceros and straight-tusked elephant. There is also a sub-species of fallow deer unique to Clacton called *Dama dama clactoniana*. The sediments consist of freshwater clays, sands and gravels overlain by estuarine clays and peats which allow geologists to reconstruct the conditions when the deposits were laid down, with freshwater beds being overcome by a rise in sea-level. Pollen recovered from the freshwater sediments, tells us that the surrounding countryside at this time consisted of oak, elm and alder forest - indicating a warm-temperate climate - which declined in warmth in the estuarine beds as conifers and firs became dominant. Some of the molluscs are species (the 'Rhenish fauna') that indicate a link between the River Thames and the River Rhine. The combination of flora and fauna at Clacton give the deposits a particular character which enables the temperate, or interglacial, stage they belong to, to be distinguished from older and younger interglacial stages. In particular a link can be made to interglacial deposits at Hoxne in Suffolk, which gives its name to the interglacial stage, the Hoxnian, which occurred about 400,000 years ago. One of the pollen types present cannot be related to any species known today and it is referred to as 'Type X', which was thought to be indicative of the Hoxnian, though this now is challenged (see entry for Walton-on-the-Naze cliffs).

The Clacton channel is also uniquely important for evidence of early humans. Clacton is the 'type site' of the Clactonian Palaeolithic industry; a simple flint-working industry, with flakes struck off larger flints, leaving cores. No hand-axes have been found. The flint tools are from the Freshwater Beds in the channel and they represent the earliest undisputed evidence of human presence in Essex (but see entry for Wivenhoe Gravel Pit; also there is now evidence of older human occupation in Britain in other parts of East Anglia and along the South Coast). The tip of a wooden spear, made of yew, was also found in the cliffs, which, until recently, was the oldest man-made wooden object in the world. It remains the oldest in Britain. 'Clacton man' was not a modern human (*Homo sapiens*) and was not Neanderthal (***Homo neanderthalensis*)**, but an ancestor of the Neanderthals and probably related to an earlier British human species known as 'Heidelberg man' (*Homo heidelbergensis*).

Controlled archaeological excavations were carried out at the golf course in 1934, which yielded 190 flint artefacts. In 1969 and 1970 a further series of excavations where made on the golf course along a line north-west to south-east across the southern bank of the channel. These yielded over 1200 artefacts, many of which were in mint condition, in other words they had not been blunted or otherwise damaged by incorporation into later deposits. In fact, in some cases the flints could actually be fitted back together (refitted), indicating not just that humans were in this area, but that they were actually living where the golf course is now, about 400,000 years ago, using the simplest technology. Because of their fresh condition, some of these tools have been analysed for microscopic signs of wear on the surfaces to try to establish how they were used and what they were used for. The results of this 'micro-wear analysis' confirmed that this site was a hunting/butchery location. Experiments have found that the wear on the surfaces of stone tools formed by working different materials have distinctive appearances and can be distinguished from one another. The slicing of meat associated with the butchering of animals produces a distinctive polish known as 'meat polish' and this was found on some of the Clacton tools together with probable evidence of the working of wood and bone, and the scraping of animal hides.

Although the Clacton channel deposits were discovered and extensively described in the nineteenth century they were only then known from the site of their original discovery. It was Essex amateur geologist Samuel Hazzledine Warren who recognised that part of the Clacton sequence occurs on the foreshore at Lion Point, Jaywick and was part of the same channel. Much of our present knowledge of the channel deposits can be credited to Warren who devoted a considerable proportion of his life's work to these deposits and to the Clactonian flint industry. It was Warren who found the tip of the wooden spear in 1911. Warren also collected a large number of fossils including a very small jaw of a straight-tusked elephant which he identified as belonging to an unborn individual. At the time of Warren's discoveries there were others who were also collecting fossils from the cliffs, such as local amateur geologist Harold Picton of Clacton College, who assembled a fine collection of mammal bones and teeth that he exhibited when he led a field trip to Clacton for the Essex Field Club in 1911.

Work on the Clacton Channel sequence is far from over. This account is, of necessity, brief and omits much detail and argument, leaving a number of incomplete explanations. There are several channels in the complex and the evidence from these does not always agree; also the composition of the younger Wigborough Gravel (also laid down by the Thames-Medway River) which overlies the channel deposits is not the same as the Wigborough Gravel elsewhere on the Tendring peninsula, allowing debate as to its relation to the main body. Most interesting of all is the enigmatic 'Clactonian' flint industry, with its curious and puzzling lack of hand-axes which are so common at older and younger Palaeolithic sites.

Unfortunately the West Cliff is now landscaped and the Jaywick foreshore is obscured by the build up of shingle brought about by the 'fish-tail' coastal protection structures.

Existing or recommended site designation

Three separate sites are part of the Clacton Cliffs and Foreshore SSSI (Site of Special Scientific Interest).

Recommendations for promotion, site management or enhancement

This SSSI is one of the most important Ice Age sites in Britain. There is an opportunity here to increase public understanding of the geology of the area by providing interpretive panels on the coast. At Clacton, an ideal site for an interpretive panel is on the circular public observation terrace at the top of the cliff opposite Clacton Hospital (near the Martello tower).

DOVERCOURT

Dovercourt Spa

Grid reference: TM 259 315

As part of the development of Dovercourt as a seaside resort a spa house was constructed in 1854 to utilise the waters of a spring emanating from the cliffs. The water was described as 'chalybeate' (containing a high concentration of iron compounds) and was considered to be of high therapeutic value. The Spa House was described as a neat brick building overlooking the sea and consisted of a pump-room, conservatory, saloon, and library. The library contained not only books but also cases of local fossils. The Spa was very successful and continued to do business until at least 1910. It was probably demolished just after the First World War and was the last of the Essex spas. Until recently the remains of the foundations and floor tiles could be seen in front of the beach huts. A large plaque commemorating the existence of the spa has been erected on the site by the Harwich Society.

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

None

DOVERCOURT

Gants Pit

Grid reference: TM 240 313

Although it has now been infilled, Gants Pit in Dovercourt is famous as the richest site for Palaeolithic hand-axes in Essex. It was situated on the west side of the junction of the main Harwich Road and Parkeston Road and is named after the former tenant of Pound Farm, Mr. W. Gant, who leased the land. It is sometimes referred to as Pound Farm Pit.

The first discoveries were made in 1908 by a Lieut.-Colonel W. Underwood who, while walking in the area, noticed gravel being worked at this spot which was a farm field overlooking the Stour valley. He suspected that it was a likely spot for flint implements and interviewed the workmen. They informed him that they new nothing of such objects but had collected a large number of bones, which they had sold to a passing rag and bone merchant! Underwood searched the piles of gravel on the floor of the pit and did indeed find evidence of worked flints. He returned to the pit on a later occasion with representative examples of Palaeolithic implements for the men to see, and asked them to look out for such things. This proved to be great success and over 150 hand-axes were found in just three years.

The site was independently discovered by the Essex amateur geologist and prehistorian Samuel Hazzledine Warren who took a particular interest in the hand-axes and managed to persuade the workmen to write in pencil on the implements the depth at which they found them. The results of this exercise demonstrated that the implements were found throughout the 9 foot (3 metre) depth of the pit but they had a greater surface patina the higher up they were in the gravel. This showed the ‘weathering’ effect of the percolation of ground water over thousands of years. A few of the hand-axes were very slightly rolled but most were in fresh condition with no abrasion which meant that the river hadn’t transported them very far. Warren therefore concluded that this was the debris of an important Palaeolithic living site that had been washed by the river into a bank of gravel and sand.

The pit ceased working in the 1920s. The site is now levelled and occupied by Spring Meadow Primary School and playing field. There has, however, recently been renewed interest in the site and investigations were carried out in 2001 by a team of archaeologists and geologists led by David Bridgland. This was following up on an observation that gravel with Palaeolithic flakes was exposed in the foundations for a southern extension of the school in the 1980s. Several Palaeolithic flakes were recovered in 2001, leading to further excavations in 2006 when three trenches were dug using a JCB excavator in different parts of the site. One trench revealed fragments of fossil mammal bone and a number of Palaeolithic artefacts, which appears to confirm that the mammal fauna and the artefacts came from the same gravel. These investigations established the approximate extent of the gravel remaining beneath the site, which may hold further information about the climate and wildlife of the area when these early humans were living here. It is also hoped to establish an accurate age for the site. The results also found that the original gravel pit was quite small, probably no larger than the footprint of the main school buildings, which makes the large number of hand-axes found all the more remarkable. The investigations were hampered by waterlogged conditions at the base of the trenches that reached the impervious London Clay bedrock. A surprising discovery, however, was made at the base of the trench at the eastern corner of the site. Here was found a thin remnant of Red Crag, consisting of sand with numerous fossil shells, lying on top of London Clay.

A total of 208 hand axes have come from Gants Pit. Some of them were large and beautiful, and many were magnificently worked, their colour ranging from yellowish brown to lightish blue. The mammal bones found represented species such as beaver, rhinoceros, straight-tusked elephant, fallow deer, red deer and ox (aurochs). The gravel that contained the implements and bones appears to be a local terrace gravel from the Stour valley, banked up against the much older Oakley Gravel, which is of Thames-Medway origin.

Material from Gants Pit is distributed around several museums including Ipswich, Colchester, Norwich, Cambridge, Oxford and the Natural History Museum in London. The majority of the hand-axes are in the British Museum.

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

There is an opportunity here to increase public understanding of the geology and Palaeolithic archaeology of the area by means of publicity for this unique site.

DOVERCOURT

Exposures of Red Crag

Grid reference: various

The patch, or outlier, of Red Crag at Little Oakley extends north-east along a ridge of high ground towards Upper Dovercourt where the characteristic red sand and fossil shells can be seen in the cultivated fields in the vicinity of South Hall Farm. In the nineteenth century it was also visible in several roadside sections. This outlier is one of the few fragments of a once continuous deposit of Red Crag across north Essex that has been almost entirely destroyed by erosion. The Red Crag in this part of Essex consists of loose sand with abundant fossil shells and the fossils of other marine animals that lived in the Red Crag Sea that existed about 2 million years ago.

A further patch of Red Crag, about one kilometre long, caps the hill overlooking Mill Bay and extends beneath Fronks Road as far as the coast. It was first exposed in the floor of a gravel pit, which is almost certainly the pit marked on the 1876 Ordnance Survey map in a field south of the main road at TM 248 309. This whole area has now been redeveloped. In the nineteenth century Red Crag shells and bones could also be found on the top of the cliff 'near the hotel' but this was destroyed by cliff falls and what is left is now obscured.

Existing or recommended site designation

None

Recommendations for promotion, site management or enhancement

None

DOVERCOURT

Mammoth tooth from Mill Bay

Grid reference: Not known

In 1933, the well-known Essex amateur geologist and archaeologist Samuel Hazzledine Warren reported in the *Essex Naturalist* that he had found the tooth of a mammoth in Mill Bay, Dovercourt but unfortunately he does not give the exact location. The specimen is now in the Natural History Museum, London.

Warren identified the tooth as from the 'steppe mammoth' *Mammuthus trogontherii* rather its descendant, the familiar and more specialised woolly mammoth, *Mammuthus primigenius*. Teeth from the steppe mammoth have been found elsewhere in Essex, such as the Ilford brick pits that have produced complete skeletons of this species.

Existing or recommended site designation

None

Recommendations for promotion, site management or enhancement

Not applicable

FRINTON

Frinton Cliffs

Grid reference: TM 248 205 (approx)

The Francis Frith photographic company continued in business until 1968 and a photograph in the Frith Collection, taken in about 1955, shows the coast at Frinton before the modern sea defences were built. The picture shows 25 metre (75 ft) high cliffs of London Clay overlain by Ice Age sands and gravels that formerly existed here when this was still a wild and untamed coastline. A wide platform of London Clay was visible at low tide that yielded fossils of Eocene fossil shark teeth and fish remains. Several fossil fruits and seeds could also be collected in those days and one particular 9 millimetre long fossil fruit was found that was completely new to science. In recognition of the locality it was given the scientific genus name *Frintonia*. It is from a family of herbaceous or woody climbers that exist today in mainly tropical climates which is further confirmation of the warm climate when the London Clay rainforest was in existence Also found in the London Clay cliffs were transparent crystals of gypsum (calcium sulphate), known as selenite, which were given the local name ‘Frinton glass’.

Existing or recommended site designation

None

Recommendations for promotion, site management or enhancement

There are few places in Essex that have had a fossil named after them. There is the possibility of using this to promote the geology of the area.

GREAT BENTLEY

St. Mary’s Church

Grid reference: TM 108 217

The parish church of Great Bentley is unusual as it is largely constructed of ferricrete, an iron-cemented gravel that was quarried locally. This stone, which makes a remarkably durable building material, was formed within local Ice Age gravels as an 'iron pan', which can be up to a metre in thickness, at the level of the groundwater table. In the church walls the blocks of ferricrete are laid in an attractive pattern. The nave is thought to date from about 1130 and the tower late fourteenth century. Ferricrete is one of the few building stones native to Essex. The church walls also contain some fine cobbles of attractive metamorphic and igneous rocks which may have originated locally from the Thames gravels (Wivenhoe Gravel).

Existing or recommended site designation
Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement
Provide the church council with information on the stone of the building for use in their publications.

GREAT CLACTON
Sarsen stone
Grid reference: Not known

The geologist A.E. Salter, in his landmark paper *Sarsen, basalt and other boulders in Essex,* published in the *Essex Naturalist* in 1914, referred to a large erratic boulder at Great Clacton but its precise location is not known. He described it as a sarsen stone 4'x3'x1' in size and so it should be possible to establish its whereabouts. Apart from the sarsen stone at Ramsey, this is the only other natural erratic boulder known from the Tendring district.

Sarsens are boulders of extremely hard sandstone that were formed in the Reading Beds, 60 million year old sandy deposits from the Palaeocene period that occur on top of the Chalk. The sarsens in north Essex were carried from the Chilterns by ice and by the Thames during the Ice Age but is difficult to imagine that a boulder this size could have been carried this far east by the Thames. It is equally difficult to believe that it could have been transported north from the North Downs of Kent by the River Medway. This boulder is therefore of scientific interest in the context of reconstructing the history of the evolution of the landscape of north-east Essex.

Existing or recommended site designation

Not yet applicable

Recommendations for promotion, site management or enhancement

Locate the sarsen stone by encouraging local people to search for it. This would make an interesting project for a local school or society.

GREAT CLACTON

Great Clacton parish church

Grid reference: TM 176 165

The church of St.John the Baptist at Great Clacton is a local landmark with a short, pyramidal spire. The building has Norman origins and is notable because it is constructed almost entirely from septarian nodules, or 'septaria' from the London Clay. These nodules were no doubt collected locally from the foreshore and are one of the few building stones native to Essex. Several churches in the Tendring district are constructed wholly or partly of septaria but this is a fine example in an urban area.

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

Provide the church council with information on the stone of the building for use in their publications.

GREAT HOLLAND

Great Holland Pits Nature Reserve

Grid reference: TM 204 190

A former gravel pit in the Cooks Green Gravel (laid down by the early River Thames) that is now an Essex Wildlife Trust nature reserve. No current visible exposure of gravel but there are level areas of gravel present beneath scrub that could easily be cleared to reveal a wide variety of rock types. These are mostly cobbles and boulders left behind by the quarry operations. There is an excellent opportunity here to promote geology by exposing these areas of gravel and allowing visitors to identify rock types and speculate on how they got here.

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

Expose areas of gravel. Explain the geology to visitors by means of interpretive panel and leaflets.

HARWICH

Beacon Hill

Grid reference: TM 262 317

In 1704 the naturalist Samuel Dale described a cliff of sand containing fossils at Beacon Cliff, Harwich which appears to be the first record of the East Anglian Crag deposits in the scientific literature. The fossiliferous sand is now known as the Red Crag but unfortunately this exposure, which lay on top of the London Clay, has now been lost due to coastal erosion.

A fine illustration of this cliff was published in 1730 in Samuel Dale's '*The History and Antiquities of Harwich and Dovercourt*' which was the first book to describe and illustrate fossils from Essex. In 1829 a description of the cliff was published in the Transactions of the Geological Society which tells of a much smaller exposure and only 12 years later, in 1841, it had almost completely disappeared. In that year Essex amateur geologist John Brown wrote that it "is so reduced….by the action of the waves that only by close attention can it be traced". By 1877 the Geological Survey memoir stated that "a few fragments of shells at one spot on the top were all that remained".

Currently on display in the geology gallery of Ipswich Museum is a small fossil dog-whelk from this lost outcrop of Red Crag. Attached to the specimen is a typical nineteenth century hand-written label with the words 'Beacon Hill, Harwich 1815'.

The recovery of ‘cement stones’ for cement manufacture from the London Clay cliffs and foreshore hereabouts led to many important fossil discoveries. The stone was dug by hand, which meant that fossils could be easily seen, recovered and sold to passing collectors. Numerous spectacular fossils of early mammals were found in the nodules together with giant turtles and other marine creatures. Many of these fossils went to the Natural History Museum in London but several are in the collections of Colchester, Ipswich and Norwich Museums. Of particular interest was the first discovery in the world of the skeleton of the earliest ancestor of the horse (see separate entry for Harwich Foreshore SSSI).

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

An interpretive plaque on the geological history of Harwich would be appropriate on Beacon Hill.

HARWICH

Site of Roman cement works

Grid reference: TM 251 315 (site of John Pattrick’s cement works)

The manufacture of ‘Roman cement’ from the local ‘cement stone’ nodules (septaria) from the Harwich cliffs was a very important local industry in the first half of the nineteenth century, employing up to 500 men. In the 1830s there was as many as five factories at work but the most successful cement manufacturer was John Pattrick whose Dovercourt works continued to operate until 1890 and was finally sold in 1906.

The recovery of cement stones from the foreshore, and by dredging from the sea bed, led to many important fossil discoveries. In later years Pattrick’s works had a chimney, 320 feet high, which was a feature on the Harwich skyline until about 1939. The site, between the Main Road and the railway, is described and illustrated in Leonard Weaver’s 1990 book *Harwich: Gateway to the Continent*. Pattrick’s wharf is said to be now occupied by Harwich Sailing Club.

Existing or recommended site designation

Not applicable at the present time.

Recommendations for promotion, site management or enhancement

Locate any remaining evidence of the Roman cement industry in the town and establish a means of conserving it. This would make a valuable contribution to the history of the town and an ideal Local Heritage Initiative project for a local society.

HARWICH

Site of Harwich borehole

Grid reference: TM 259 328

Commenced in 1854 in search of a clean water supply for the town, the Harwich borehole was the first to penetrate the deep 'Palaeozoic basement' of Essex. The borehole took nearly three years to complete and reached the hard, slaty rocks of Silurian age (approx. 420 million years old) at a depth of over 300 metres. The site was by the harbour, near the pier, just west of the former Great Eastern Hotel.

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

A bronze plaque on the sea wall closest to the site to commemorate what was the first attempt to investigate the deep geology of Essex.

HARWICH

Harwich Foreshore SSSI

Grid reference: TM 263 316 to TM 263 323

This locality is particularly important as the best exposure of the ‘Harwich Stone Band’, the most distinctive of the ash bands in the Harwich Formation at the base of the London Clay which contains volcanic ash from explosive volcanic eruptions in Scotland during Eocene times some 50 million years ago. The stone band makes this part of the coast the only naturally-occurring rocky shore along the entire distance between Norfolk and Kent and may even be the reason for the existence of the Harwich peninsula. The Harwich Stone Band contains attractive veins of green banded calcite (calcium carbonate) which can be cut and polished and is one of the few decorative stones native to Essex. Samuel Dale, the Essex naturalist and author of '*The History and Antiquities of Harwich and Dovercourt*' (1730), records that in his time the streets of Harwich were cobbled with dressed stones taken from this bed.

The foreshore is also of prime importance for London Clay fossils, particularly for fossil fruits and seeds from the Eocene rainforest. Also found are fossil sharks' teeth amongst the beach shingle. Harwich is also famous for numerous fossils found by the workmen employed in the Harwich cement industry. These include some of the world's first fossils of early mammals that were beginning to spread across the globe following the extinction of the dinosaurs. This includes *Hyracotherium*, the earliest ancestor of the horse. Many giant fossil turtles were also found, several of which are on display in Ipswich and Norwich museums.

The fossils from Harwich have been collected and studied for more than 300 years making this an important site in the history of geology (see separate entry for Beacon Hill).

Existing or recommended site designation

Existing geological SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement

Locate any remaining dressed blocks of the 'Harwich stone band' used as paving in the town. Such paving may still be present in alleyways or beneath tarmac. An interpretive plaque on the geological history of Harwich would be appropriate on Beacon Hill (see separate entry for Beacon Hill).

HOLLAND-ON-SEA

Holland-on-Sea Cliff SSSI

Grid reference: TM 211 166

About 450,000 years ago a catastrophic change affected the Thames causing it to alter its course and adopt the route we know today. The gravel in the cliff at Holland-on-Sea dates from just before and just after the Thames was diverted (Lower Holland Gravel and Upper Holland Gravel). The stone content of the Lower Gravel is typically of a mixture of stone types from the early Thames and the Medway, indicating that this area was the confluence of the two rivers. The Upper Gravel includes *Rhaxella* chert brought in by meltwater streams from the Anglian ice sheet. The deposits reveal just how rapid the diversion was as the Thames suddenly ceased to flow through central Essex as a result of being blocked upstream between Hertfordshire and Colchester by the Anglian ice sheet. Gravel of the same age is present in St. Osyth Gravel Pit. St. Osyth lies upstream from the confluence with the Thames and Medway rivers whereas Holland-on-Sea lies within the area of the confluence.

Existing or recommended site designation

Existing Geological SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement

An interpretive plaque on the geological history of the cliff at Holland-on-Sea may be appropriate on public open space.

JAYWICK

Interglacial 'channels'

TM 146 128 and TM 155 130

Although the Clacton channel deposits were discovered and extensively described in the nineteenth century they were only known from the site of their original discovery – the cliffs at Clacton. It was Essex amateur geologist Samuel Hazzledine Warren who recognised that part of the Clacton sequence also occurs on the foreshore at Lion Point, Jaywick (TM 146 128) and was part of the same channel. The deposits filling this channel have yielded fossils of animals such as lion, rhinoceros and straight-tusked elephant and are thought to have been deposited by the early Thames during the Hoxnian interglacial stage, about 400,000 years ago. The route of this channel between Jaywick and Clacton is designated as a Site of Special Scientific Interest (SSSI) (see entry for Clacton Cliffs and Foreshore SSSI).

Coincidently, a further, but younger, channel was discovered on the Jaywick foreshore in the late 1990s. This channel was cut into the London Clay and contained a white marl deposit which yielded a tooth of a straight-tusked elephant, the base of an antler of a giant deer, various bones, teeth and horns of aurochs (giant ox), and a finger bone of a brown bear.

Various lines of evidence point to this channel being deposited by a local river during the Ipswichian interglacial stage, about 120,000 years ago.

Both channels have unfortunately now been obscured by the build up of shingle as a result of the construction of the 'fish-tail' coastal protection structures.

Existing or recommended site designation

Jaywick is part of the Clacton Cliffs and Foreshore SSSI (Site of Special Scientific Interest).

Recommendations for promotion, site management or enhancement

This SSSI is one of the most important Ice Age sites in Britain. There is an opportunity here to increase public understanding of the geology of the area by providing interpretive panels on the coast.

KIRBY LE SOKEN

Hamford Water National Nature Reserve

Grid reference: TM 267 238 (approx)

Hamford Water is a large, shallow inlet between Walton-on-the-Naze and Dovercourt with an interesting complex of saltmarsh, sandbanks and tidal creeks. It is unusual as it is similar to an estuary but is only fed by a few small streams and not a major river as elsewhere on the Essex coast. Extensive saltmarsh covers one third of the area. There are several islands of London Clay that protrude above the level of the marsh such as Skippers Island which is an Essex Wildlife Trust nature reserve.

The Hamford Water embayment - a depression in the London Clay bedrock – is filled with marine sediment, and demonstrates the influence of the surrounding geological features on the 'estuarine' processes. Normal estuaries on flat lands develop a funnel shape that is controlled by the energy of waves and tides. Hamford Water cannot do that because of the rising ground and the lack of river valleys; it is consequently short and fat. The mouth is constricted by The Naze, Horsey Island, Foulton Hall Corner and Pye Sand. Lose any one of these and the tidal energy would destroy the soft sediments at the site. Unfortunately this is exactly what is beginning to happen and the reason could be that Pye Sand is only about a third of its original size – the result of marine dredging possibly as much as a century ago.

Hamford Water is internationally important for wildlife, particularly breeding birds, and most of the area is a National Nature Reserve. Much of it is privately owned and public access is restricted but it can be viewed from the sea wall footpaths.

Existing or recommended site designation

Existing Biological SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement

There is a major loss of saltmarsh in Hamford Water. Seek further information from Natural England.

KIRBY-LE-SOKEN

Soken Wood

Grid reference: TM 220 223

Soken Wood is a relatively new native broadleaved woodland created in November 2000. Because of the wood's close proximity to The Naze, which is rich in fossil plants from the London Clay, part of the site has been planted up with exotic species of prehistoric origin. The trees planted are stands of monkey-puzzle and ginkgo, with individual specimens of witch hazel, magnolia, oriental plane, tulip tree and dawn redwood.

Soken Wood is owned by The Woodland Trust and is open at all times. There is an information board and parking.

A giant, mature monkey-puzzle tree is nearby in the private grounds of Kings Farm on Sneating Hall Lane (TM 204 219). It can be seen clearly from the road.

Existing or recommended site designation

None

Recommendations for promotion, site management or enhancement

None

LITTLE OAKLEY

Harmer's Red Crag excavations

Grid reference: Exact site not known

The existence of shelly Red Crag capping the high ground at Little Oakley has been known since at least the 1860s but it was not until the remarkable work of amateur geologist Frederick Harmer (1835-1923) in the early years of the twentieth century that the site received any attention. Harmer was a Norwich wool merchant and textile manufacturer who was also a specialist in fossil molluscs and his thorough study of British Tertiary and Quaternary deposits provided the basis for today's accepted views. The invention of the motor car gave Harmer the opportunity to do more geological field work especially at Little Oakley, where, with the permission of the landowner, he re-opened a shallow pit to the west of the village and sieved the sand for fossil shells over a period of several years.

The result of these efforts was his two volume work '*The Pliocene Mollusca of Great Britain*' published in 1919 in which he states that over 600 different species of mollusc were found in this pit (nearly 400 of the species illustrated are from Little Oakley). Harmer's work has shown the extraordinarily rich molluscan fauna of the Red Crag Sea which existed over Essex and East Anglia about two million years ago. Harmer records that all of the fossils came from 'an area of twenty yards square' and says that they were obtained 'during many years labour, and by the sifting and examination of something like 200 tons of material'.

Harmer's pit has long ago been filled in but the site is of great historical interest as one of Britain's most prolific fossil localities.

Existing or recommended site designation

None (exact location not known)

Recommendations for promotion, site management or enhancement

None

LITTLE OAKLEY

Little Oakley Channel SSSI

Grid reference: TM 223 294

During the Summer of 1939, only a few months before the outbreak of the Second World

War, a sewer trench was being dug along the road through Little Oakley and the excavation was noticed by amateur geologist Samuel Hazzledine Warren as he was driving through the village. The sand thrown out of the excavation was found to be rich in shells, deer antlers and mammal bones and Warren described the discovery in the pages of the 'Essex Naturalist' in 1940. Because of the war no further investigation was carried out at the time but it is surprising that, despite the apparent importance of the discovery, the site did not receive any more attention until the 1980s. Using Warren's notes, geologists then relocated the site using mechanical excavators. Warren had correctly identified the deposit as the infilling of a river channel of the same age as the famous Cromer Forest-bed in Norfolk which dates from an early part of the Ice Age before the arrival of the Anglian ice sheet.

The channel is cut into the Oakley Gravel, part of the Kesgrave Sands and Gravels, which was laid down by a former course of the River Thames, at the point where it may have been joined by the early River Medway. The Oakley Gravel is the downstream equivalent of the Ardleigh Gravel. The channel contains fossils that include the bones rhinoceros, giant deer, hyaena, horse, boar, vole and fish, a rich assemblage of freshwater shells and a fine pollen record which has enabled geologists to reconstruct the flora and fauna of this distant period of the Ice Age. The channel can be dated by comparing the assemblage of mollusc shells with those from sites in north Norfolk, and the pollen assemblage with sites in the Netherlands. These indicate a broadly 'Cromerian' age, though it is not clear whether it is the same age as the interglacial deposits at Ardleigh Gravel Pit (see separate site entry) or later. This is confirmed by analysis of amino acids from mollusc shells. Although the channel's exact age is still not known it is thought to be about 575,000 years old. A remnant of the much older Red Crag, for which Little Oakley is also well known (see separate site record), lies adjacent to and just below the channel deposit.

The 1980s excavation was backfilled and there is now no indication on the surface that this strip on the edge of a farm field is one of the most important geological sites in Essex.

Existing or recommended site designation

Existing geological SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement

None

LITTLE OAKLEY

Phosphate pits

Grid reference: Exact location not known

In north Essex and Suffolk the basal pebble bed of the Red Crag, or 'coprolite bed' as it was called, was used as a raw material for the manufacture of phosphate fertiliser before the advent of artificial fertilisers. The geologist Frederick Harmer (see above) reported that phosphate was dug at two locations in Little Oakley: one to the north of the village near the old rectory in Rectory Lane and one to the south near Newhouse Farm. In 1877 geologist William Whitaker, in his geological Survey Memoir of the area, reported that the Rectory glebe produced about 300 tons of phosphatic nodules and pits to the south of the village produced about 1,000 tons.

Existing or recommended site designation

None (exact location not known)

Recommendations for promotion, site management or enhancement

Not applicable

MISTLEY HEATH

Potential exposure of Waldringfield Gravel

Grid reference: TM 1225 3095

Waldringfield Gravel is the oldest deposit from a former course of the River Thames in the Tendring district but no exposures of this gravel are known. It is important to locate or create such an exposure for scientific study and public education. The Ordnance Survey map of 1897 shows a gravel pit on the edge of woodland in Mistley Park, south-east of Furze Hill, which may have worked the Waldringfield Gravel. It is hoped that this former gravel pit can be located and a small section re-excavated with permission of the landowner. This pit is ideally located in an area close to other sites of potential geological interest (see other entries under Mistley Heath). The pit is also adjacent to the Essex Way, a long distance public footpath.

Existing or recommended site designation

None

Recommendations for promotion, site management or enhancement
It is hoped that this gravel pit can be located and a small section re-excavated with permission of the landowner.

MISTLEY HEATH
Potential exposure of Red Crag
Grid reference: approx TM 1167 3075

W.H. Dalton, in an Essex Field Club Museum Handbook in 1900, describes a number of exposures of Red Crag at Mistley Park. Most of these are now inaccessible but one site, 'near Oak Grove' may have the potential to create an inland exposure of Red Crag.

Victorian geological maps show Red Crag exposed on either side of the valley of a minor stream which flows north and passes under the Clacton Road. The geological maps show Oak Grove be about 200 metres north of the road on the eastern side of the valley. Dalton did not say whether this was a natural exposure or a gravel pit, and merely stated that it exposed 'laminated ironstone and phosphatic nodules'.

Existing or recommended site designation
None (exact location not known)

Recommendations for promotion, site management or enhancement
It is hoped that this site can be located and a small section excavated with permission of the landowner. The site appears to be near to a public footpath.

MISTLEY HEATH
Discovery of elephant and rhinoceros remains
Grid reference: Exact location not known

In 1966 the geologist H.E.P. Spencer reported in the *Essex Naturalist* (volume 31, page 351) that work on the anti-aircraft battery at Mistley Heath during the Second World War resulted in the discovery of elephant and rhinoceros remains in brickearth. He also said that this brickearth was subsequently also seen at Wix Lodge.

The site has not yet been relocated. Spencer may have been referring to the underground cold war operations room at Mistley (the 'secret bunker') at TM 122 313 but this was not built until 1951. It is possible that the bunker was built on the site of the anti-aircraft battery he refers to. Most fossiliferous brickearth is situated on the coast, at sea level or thereabouts. If rediscovered, this site would be the first at a higher altitude, and could potentially be very important. It may date from 'marine isotope stage 7' – an interglacial stage that occurred about 200,000 years ago.

Existing or recommended site designation
None (exact location not known)

Recommendations for promotion, site management or enhancement
Further research is required to establish the exact site of these finds.

RAMSEY
Copperas Wood and Copperas Bay
Grid reference: TM 204 318

The copperas industry was an important industry in eighteenth century Essex which involved gathering of pyrite nodules (known as 'copperas stones') from beaches, where they had been washed out of the London Clay, and by a lengthy and hazardous industrial process converting them to ferrous sulphate (green vitriol) which was an essential chemical for making dyes, ink and several industrial chemicals such as sulphuric acid (see section on industries in the Tendring district).

A copperas works is marked on the 1882 geological map as 'Copperas House' and the exact site may have been where Copperas Wood Farm now is. The copperas industry is commemorated in the name of the wood and the bay but information on this industry is lacking in the publicity for Copperas Wood, which is an Essex Wildlife Trust reserve.

Existing or recommended site designation
Part of the Stour Estuary SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement
Encourage Essex Wildlife Trust, the owner of Copperas Wood, to promote the geology of

the area by providing information on the copperas industry.

RAMSEY

Sarsen Stone

Grid reference: TM 201 296

Against the boundary wall of Hill house is a sarsen stone about one metre square and some 30 centimetres thick. This example was probably found on nearby farmland. A local resident claimed that it was placed here so that the wheel of a cart could be wedged against it to stop the cart from rolling down the hill.

Sarsens are boulders of extremely hard sandstone that were formed in the Reading Beds, 60 million year old deposits from the Palaeocene period that occur on top of the Chalk. They occur in North Essex and Suffolk and were carried from the Chilterns by ice and by the Thames during the Ice Age but is unusual to find one this far east.

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

Publicise the importance of the stone to local people.

ST. OSYTH

Colne Point Shingle Spit

Grid reference: TM 108 125

Colne Point, near St. Osyth, is the best example in Essex of a shingle spit. The spit is 4 kilometres long and is all that remains of a much larger area that existed in the 19th century but has now mostly been developed by the seaside holiday industry. It is of great interest for studying the movement of shingle and the development of shingle structures. It is an Essex Wildlife Trust reserve.

Existing or recommended site designation

Part of the Colne Estuary SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement

None

ST. OSYTH

St. Osyth Marsh

Grid reference: TM 090 144 to TM 130 126

St. Osyth Marsh is an important site for documenting the changes in salt marsh growth, and is one of a few marsh areas in Britain to have been dated. The age of the marsh is about 4,300 years, the date provided by the analysis of a peat seam preserved in grey-black clay at the site. The characteristic assemblage of features - creeks, saltpans and salt marsh cliff - are all present here, and reflect the maturity of the marsh system. The saltpans have been intensively researched by geomorphologists, and provide much information relating to the formation and development of this unique coastal landform.

St. Osyth Marsh is also one of the few places in Britain where the development of wave-built protective beach ridges called cheniers has been described fully. Here the cheniers consist mostly of sand and gravel, unlike those further south on the Dengie peninsula which are made up almost entirely of shells. A rigorous study of the beach ridges at St. Osyth Marsh was carried out recently to determine their true form and origin using ground-penetrating radar and the results published in the journal *Sedimentary Geology* in 2003.

Existing or recommended site designation

Part of the Colne Estuary SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement

None

ST. OSYTH

St. Osyth Gravel Pit SSSI

Grid reference: TM 120 174

About 450,000 years ago a catastrophic change affected the Thames causing it to alter its course and adopt the route we know today. The gravel at St. Osyth pit is of two types: the Lower St. Osyth Gravel, which dates from just before the Thames was diverted, and above this is the Upper St. Osyth Gravel which was laid down after the Thames had disappeared from the area. This is clearly indicated by the stone content of the Lower Gravel which is typical of that deposited by the early Thames (the Kesgrave Sands and Gravels). The Upper Gravel, on the other hand, has fewer of the 'exotic' stone types of the early Thames, such as quartz and quartzite, and more *Rhaxella* chert, brought in by meltwater streams from the nearby Anglian ice sheet.

The deposits reveal just how rapid the diversion was as the Thames suddenly ceased to flow through central Essex as a result of being blocked upstream in Hertfordshire and west Essex by the Anglian ice sheet. Gravel of the same age is present in the cliff at Holland-on-Sea. St. Osyth lies upstream from the confluence with the Thames and Medway rivers whereas Holland lies within the area of the confluence.

The St.Osyth Gravel Pit SSSI is a triangular overgrown hollow which has been saved from landfilling but unfortunately no sand and gravel is now visible. This is an important site for providing evidence of the diversion of the Thames and it would be of great value if a section of sand and gravel could be created in the vicinity, possibly on the other side of the road where there is a disused gravel pit that has been landscaped but not infilled.

Existing or recommended site designation
Existing Geological SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement
No sand and gravel is now visible in the hollow which is the SSSI. It is recommended therefore that a section be created nearby for public interest and education, possibly on the other side of the road in the disused gravel pit that has not been infilled. This opportunity should be seized if any part of these former pits is to become a public open space.

ST. OSYTH
St.Osyth Priory
Grid reference: TM 121 157

Erected in 1481, the battlemented gatehouse of St. Osyth Priory is one of the finest examples in Britain of the use of flint ‘flushwork’. Flushwork is the name given to the technique of setting ‘knapped’ flints (flints skilfully worked to produce a flat face) into a wall, often in intricate patterns alongside another stone such as limestone. The architectural historian Alec Clifton-Taylor, when describing St. Osyth Priory gatehouse, said that “the sight of those split flints, flickering and sparkling in the sunlight, is a delight in so rich a setting, above all when the sun suddenly catches them after a shower of rain”. The fact that the flint is still in pristine condition, after over 500 years of weathering, shows how hard and durable this rock is. The majority of flint buildings are found where chalk occurs at the surface and local flint is readily available. Elsewhere, such as in the Tendring district, flint was usually only used for the most important buildings such as churches and abbeys. The fine quality flint needed for workmanship such as this, however, probably did not come from Essex, but from Brandon in Suffolk, an area where a thick layer of excellent quality black flint has been mined since the Stone Age.

St. Osyth’s Priory is privately owned and no longer open to the public but the gatehouse can be viewed from the green open space between the gatehouse and the road where there is also car parking. Other natural stones can also be seen, particularly in the boundary wall of the priory which is constructed of local septarian nodules, or ‘septaria’, from the London Clay. From here a glimpse is possible of the lofty tower at the priory which is perhaps the most striking example of the use of septaria. It was built in 1853 after the priory became a private residence and is entirely faced with a chequer board pattern of imported limestone and septaria, the stone most probably obtained from the demolition of monastic buildings. A chequerboard pattern of septaria and flint can be seen at St.Osyth Church, opposite.

Existing or recommended site designation

None

Recommendations for promotion, site management or enhancement

None

THORPE LE SOKEN

Dakings Pit

Grid reference: TM 155 233

A rich assemblage of Palaeolithic artefacts has been recovered from this overgrown pit in the garden of Hillhouse Farm. The deposits are mapped as Cooks Green Gravel (part of the Kesgrave Sands and Gravels) but a recent investigation suggests that the gravel may be a post-Anglian deposit of the nearby Holland Brook. In 1970 a 3 metre wide face was cleaned at the north-east end. The pit is historically important; archaeologists such as Leakey, Oakley, Warren and Wymer carried out research here from 1933 to 1970.

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

Encourage owner to maintain the pit face in good condition.

WALTON-ON-THE-NAZE

The Naze Cliffs SSSI

Grid reference: TM 266 235

The most spectacular exposure of Red Crag in East Anglia is at the Naze where the red, shelly sand can be seen resting on blue-grey London Clay. The Naze is one of the finest geological sites in Britain; both the Red Crag and London Clay here are of international importance and the cliffs are designated a Site of Special Scientific Interest (SSSI). The Red Crag and the overlying sediments represent a remarkably complete sequence of late Pliocene/early Pleistocene deposits which has yielded information on climatic deterioration at the beginning of the Ice Age. Digging in the cliffs is not permitted but fossil shells are numerous in the slipped masses. The cliffs can be dangerous in wet weather.

The underlying London Clay was laid down in a subtropical sea during the Eocene period, some 50 million years ago. The coastline at the time was some distance away and consisted of rainforest dominated by mangroves, similar to that found in present day Malaysia. Fruits and seeds, twigs, and logs of wood from these rainforest plants were washed into sea and can be found preserved in pyrite (iron sulphide) in great numbers on the beach beneath the cliffs. This fossil wood made up the bulk of the ‘copperas stones’, which was the raw material for the local copperas industry. The London Clay at Walton is famous for the best-preserved bird fossils of Eocene age in the world. The fossilised bones of early mammals that lived in the rainforest have also been found on the beach (see entry for Harwich). Also found amongst the beach shingle are fossil sharks’ teeth and fish bones.

The London Clay also contains layers of volcanic ash from eruptions in Scotland during the time the London Clay sea was in existence.

The rust-red colour of the Red Crag sand and its contained fossils is the most distinctive feature of the cliffs and is due to the former presence of pyrite that was washed from the London Clay into the Red Crag and there oxidised. The final product of this chemical reaction is a red iron oxide, which has stained the sand and fossil shells producing attractive colours. Red iron oxide (ferric iron) needs contact with the air to form. Thus the thickness of the iron staining may indicate that the Red Crag was exposed to the air in what is now Essex and East Anglia for a long period before it was submerged again and the next geological stratum (the Norwich Crag) deposited. This is evidence of significant changes of sea level or uplift and subsidence of the land.

The Red Crag is 4-5 metres thick, comprising shelly sands with sedimentary structures indicating that it was deposited in underwater dunes at a water depth of 20-30 metres. The Red Crag Sea was home to an astonishing number of species of shellfish - nearly 300 species have been recorded from the Naze – which shows the extraordinarily rich fauna of the Red Crag Sea which existed over what is now Essex and East Anglia about two million years ago. Some of these species have a preference for warmer waters and these seem to be less common in the younger outcrops of Red Crag in Suffolk with arctic species beginning to appear. This is taken by some to be an indication of the onset of the Ice Age, which is why the Red Crag was classed as early Pleistocene in age. This argument is not universally accepted and the Red Crag is now placed in the Pliocene.

The Pleistocene deposits overlying the Red Crag, once over 4 metres thick, have been reduced as the cliffs have receded. From the base they consist of sand, a sequence of sands, silts and clays (from which fossil pollen has been obtained), Cooks Green Gravel, further silty deposits and brickearth. The pollen assemblage is dominated by alder and silver fir but there is also a type of pollen that cannot be related to any species known today and is referred to as “type X”. This species was thought to be representative of the Hoxnian interglacial stage (see entry for Clacton cliffs) but this cannot be correct, as the overlying Cooks Green Gravel is older than this. The Cooks Green Gravel was actually laid down by the River Thames when it flowed across this area before the arrival of the Anglian ice sheet. The Pleistocene sediments at the top of the cliff are noticeably contorted and deformed which was caused by the freezing and thawing of permafrost during the most recent glacial stage when the climate of the Walton area was similar to the present day arctic.

The Naze cliffs also provide a magnificent example of rotational landslips, a sight that is becoming increasingly rare as much of the coastline is subjected to coast protection works. Another example in Essex is at Hadleigh Castle near Southend. The slippage is mostly caused by water passing through the Pleistocene deposits and Red Crag and resting on the impervious London Clay, creating a spring line. This saturates and weakens the base of the Red Crag, causing the slips.

Above all, the Naze cliffs are a stunning and increasingly rare example of a natural, wild coastline which benefits wildlife and visitors alike. This is in sharp contrast to virtually every other section of high ground on the Essex coast that has been subjected to extensive coast protection work.

Existing or recommended site designation
Existing Geological SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement
Promotion of the geology of the Naze to the public by means of leaflets and an interpretive panel. Substantial coastal defences are proposed at the Naze called the 'Crag Walk'. This will eventually lead to complete loss of the Red Crag exposures unless a robust maintenance and management regime is in place. If this scheme goes ahead it is essential that GeoEssex is involved in the production of a management plan.

WALTON ON THE NAZE
Copperas works
Grid reference: Exact location not known

The copperas industry was an important industry in eighteenth century Essex which involved gathering of pyrite nodules (known as 'copperas stones') from beaches, where they had been washed out of the London Clay, and by a lengthy and hazardous industrial process converting them to ferrous sulphate (green vitriol) which was an essential chemical for making dyes, ink, and several industrial chemicals such as sulphuric acid (see section on Industries in the Tendring District).

The Walton copperas industry was in existence by the late seventeenth century. Old records show that over 230 tons a year were removed from the beach at Walton in the period 1715-1720 which is well over half a ton a day – a remarkable amount. Reference to the abundance of copperas on the Walton beaches was made by Daniel Defoe in 1724 and the copperas works is shown on the 1777 Chapman & Andre map of Essex as 'Copperas House'. An indication of the size and scale of the industry can be judged by an indenture dated 1702 which is held by the Essex Record Office which gives an inventory of goods and utensils at the Walton works. The Walton works had closed by the mid-1830s but copperas stones to supply copperas works elsewhere continued to be collected from Walton and Harwich until 1909. The Victoria County History (1907) states that the works were "just to the west of the High Street, and within a few feet of the vicarage, where there is still an open space, bare of vegetation and saturated with sulphurous matter".

Existing or recommended site designation

None (site not yet located)

Recommendations for promotion, site management or enhancement

It should be possible to locate the exact site of Walton copperas works. This would make a valuable contribution to the history of the town and make an ideal Local Heritage Initiative project for a local society.

WALTON-ON-THE-NAZE

Walton foreshore interglacial site

Grid reference: approx. TM 260 223

The occurrence of fossil bones of large mammals at Walton has been recognised for a very long time and there are records that such bones were often attributed to giants. Elephant bones and teeth from Walton were the subject of the earliest recorded reference to fossils in Essex; Camden's *Britannia*, first published in 1610, refers to the bones of 'giants' being found in the thirteenth and sixteenth centuries. In fact, the town of Walton may claim the earliest historical record for the discovery of Ice Age fossil mammals in Britain.

The majority of the bones, however, were collected in the first half of the nineteenth century. In 1803 an account was published of the discovery, following a cliff fall, of an enormous animal which measured 30 feet, with bones 6 or 7 feet in length. About this time Walton was visited by James Parkinson (1755-1824), a London doctor who first described the disorder of the nervous system now known as Parkinson's disease. Parkinson acquired a very large collection of fossils and played an important role in the development of palaeontology with his three-volume work *Organic Remains of a Former World* published between 1804 and 1811. He was also a founder member of the Geological Society of London, which was formed in 1807. Parkinson listed and described the fossils he obtained from Walton, which included the bones of rhinoceros, elephant and hippopotamus, found by digging in the clay on the beach. Parkinson was a friend of Henry Menish, a Chelmsford doctor, who also obtained several fossils from Walton. The auction catalogue of Menish's collection, published in 1810, included "a most singularly astonishing tusk and bones of an elephant found in the separation of a rock at Walton on the Naze" and a "matchless specimen of the tusk of a stupendous elephant, in fine preservation".

The eminent Essex geologist John Brown of Stanway collected bones from Walton in the 1830s. His specimens were examined by the famous Victorian palaeontologist and zoologist Richard Owen, who described and illustrated several of the bones and teeth including part of the lower jaw of a hyaena, which was the first record of this creature from Essex. Almost 150 years later, in 1979, the fossils from these deposits were reviewed and modern techniques used to identify the species present. The animals represented included straight-tusked elephant, mammoth, narrow-nosed rhinoceros, hippopotamus, hyaena, ox or bison, giant deer, red deer, and horse. The presence of hippo is characteristic of the Ipswichian interglacial stage, which means that these fossils are 120,000 years old.

The precise location of these discoveries is unclear. The assemblage of mammals looks mixed, and may come from more than one stratum or more than one locality. However from the written accounts there is no doubt that they came from the erosion of a low cliff of clay and from a bed of clay exposed on the foreshore, and that this was about one mile south of the Naze cliffs. The supply of fossils appears to have dried up in the 1850s, perhaps because of the construction of sea defences, and in the 1970s and 1980s this site was known as Walton's 'lost interglacial site'. However, all that changed in 1995 with the construction of the new East Terrace Breakwater (TM 260 223). During this work more than twenty large bones were found, including two elephant teeth. It would appear that the deposit containing the bones is still present, but covered by a thick deposit of beach sand. The fossils found in 1995 are on display in the Walton Heritage Centre housed in the Old Life Boat House - close to the site of the discovery.

Bones from this deposit are in several other museums around the country including

Colchester, Saffron Walden and Manchester. Unfortunately, some of Parkinson's collection from Walton was donated to the museum of the Royal College of Surgeons in London, which was destroyed during the Blitz.

Existing or recommended site designation

Not applicable

Recommendations for promotion, site management or enhancement

Include information about this little known aspect of Walton's geology in educational material proposed for the Naze. Assist Walton Heritage Centre with improved displays and interpretation of the fossils they hold.

WEELEY

Weeley borehole

Grid reference: TM 14737 21833

In the latter part of the nineteenth century, the discovery of a deep coalfield near Dover stimulated the search for coal in East Anglia. The Eastern Counties Coal Boring and Development Syndicate was formed for this purpose and they sunk a borehole at Weeley in 1896. The borehole penetrated the deep Palaeozoic basement rocks at a depth of over 330 metres (1,100 feet) and continued to 372 metres (1,221 feet) before the project was finally abandoned. As at Harwich, the basement was found to be Silurian rocks (approx. 420 million years old) and not the younger Carboniferous Coal Measures that had been hoped for. The syndicate was finally wound up a year or so later. A section of the core from the bottom of the borehole is on display in Colchester's Natural History Museum. The site of the borehole is about 100 metres north-east of Weeley railway station.

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

Provide a plaque on the station building commemorating the borehole for public interest and education.

WEELEY HEATH

Weeley Heath bypass

Grid reference: TM 145 204

Deposits that appear to have been laid down by the River Medway were exposed in 1994 in a cutting excavated for the A133 Weeley Heath bypass. Although marked on the geological map as Wivenhoe/Cooks Green Gravel, the sediments proved to be mainly fine-grained deposits indicating slow moving water. These included organic deposits containing plant fossils and pollen which are currently being studied. Beneath the organic sediments, at the base of the cutting, was a gravel containing soft, local rocks such as claystone nodules and even pieces of London Clay. Such non-durable rocks are extremely rare in cold-climate gravels that make up the major part of all river terraces in Britain and it is therefore clear that these sediments are very different from what would normally be expected.

Studies of samples taken from the gravel above and below the organic deposits revealed that some layers were poor in Medway-derived pebbles and others were strongly dominated by Medway material. The implication of this is that at the time the gravel was laid down the confluence between the River Medway and the River Thames was very close by, so that the poorly mixed deposits of both rivers occur at this site and the variations are due to changes in the flow of each river.

The result of research at this site suggest that the basal gravel at Weeley Heath, and perhaps the fine-grained sediments that overlie it, were laid down in a channel of the River Medway upstream from its confluence with the Thames. The nature of the gravel, and the fact that it contains plant fossils, suggests that it is of interglacial origin.

Existing or recommended site designation

None

Recommendations for promotion, site management or enhancement

Not applicable

WIVENHOE

1. Wivenhoe Gravel Pit SSSI

Grid reference: TM 050 235

Wivenhoe Gravel Pit is the type locality for the Wivenhoe Gravel, part of the Kesgrave Sands and Gravels which was laid down by the Thames when it flowed across this area before being diverted to its present course by ice during the Anglian glaciation. The Wivenhoe Gravel was laid down during two cold stages of the Ice Age and interbedded within the gravel is an organic silty clay containing fossils from a warm or temperate climate. These include plants, pollen from temperate-climate trees, and beetle remains. This clay represents an intervening interglacial stage but unfortunately the fossils it contains are not yet sufficiently distinctive to identify which interglacial stage. However, judging from the position of the Wivenhoe Gravel in the old Thames terrace sequence it is likely to be the temperate interval that immediately preceded the Anglian glaciation (this glaciation brought about the diversion of the Thames about 450,000 years ago). Much work is therefore required before this interval, recognised in recent years elsewhere in Britain but undefined, can be fully evaluated. Its status as a full interglacial has also yet to be established and it may be just an interstadial (a short-lived temperate-climate event in a predominately cold period). It is possible that the sediments date from the latter part of the 'Cromerian' interglacial, as defined by the Cromer Forest-bed in Norfolk.

The position of these temperate sediments in the Thames gravels is therefore highly significant, making Wivenhoe Gravel Pit an important source of evidence for reconstructing the evolution of the Thames.

Of additional interest at Wivenhoe Gravel Pit was the discovery of two flint flakes in the interglacial sediments that may have been worked by humans. If they represent a period of human occupation at Wivenhoe it will be the earliest evidence of humans anywhere in Essex and may be as much as 650,000 years old. They would be older than the human tools and remains discovered at Boxgrove in Sussex, which are thought to represent occupation by *Homo heidelbergensis*, a species of human that is probably a direct ancestor of the Neanderthals.

Existing or recommended site designation

Existing Geological SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement

The conserved area of the SSSI is just inside Colchester district but is not suitable for *maintaining a visible section. Investigate the possibility of creating a vertical cliff of Wivenhoe Gravel in another (disused) part of the site (inside Tendring district) as a teaching aid for students and, if suitably accessible, for public interest and education. This requires liaison with the pit owners.*

WRABNESS

Wrabness sluice interglacial site

Grid reference: TM 163 319

Brickearth dating from an interglacial stage of the Ice Age is exposed in the cliff and foreshore near Wrabness sluice. It yielded bones of elephant and mammoth at the beginning of the eighteenth century. They were described as “diverse bones of an extraordinary bigness” and the writer concluded that they were probably bones of elephants brought over by Emperor Claudius for use in his wars with the Britons. Bones of mammoth and straight-tusked elephant were also found here following a cliff fall in 1906.

The brickearth was originally thought to have dated from the Ipswichian interglacial stage (120,000 years ago), but is now thought to belong to the preceding interglacial stage (200,000 years ago).

Existing or recommended site designation

Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement

None at present

WRABNESS

Wrabness railway cutting

Grid reference: TM 183 315

When the Manningtree to Harwich railway was constructed in the 1850s the cutting east of Wrabness station revealed Red Crag beneath gravel. This patch, or outlier, of Red Crag caps the high ground here and probably extends, beneath the gravel, almost as far as the cliff on the River Stour at TM 172 323. The existence of Red Crag here would account for the occasional occurrence of Red Crag fossils on the beach such as whale bones and sharks' teeth. The cutting again revealed Red Crag in 1875 when the line was widened and at that time it was reported to consist of 'four feet of laminated ironstone' with a pebble bed of phosphatic nodules at the base, which was resting on London Clay bedrock. In north Essex and Suffolk the basal pebble bed of the Red Crag, or 'coprolite bed' as it was called, was used as a raw material for the manufacture of phosphate fertiliser before the advent of artificial fertilisers. It has been recorded that 'about 1,000 tons' of phosphatic nodules were obtained from 'Wrabness cutting and glebe' for this important industry.

The Red Crag Sea existed about 2 million years ago and the outlier at Wrabness is one of the few surviving fragments of a once continuous deposit of Red Crag across north Essex that has been almost entirely destroyed by erosion. The most famous exposure is at Walton but other outliers are to be found at Beaumont and Little Oakley.

The gravel overlying the Red Crag at Wrabness is known as Ardleigh Gravel and was laid down during the Ice Age by the Thames when it flowed across East Anglia, probably about 700,000 years ago.

Existing or recommended site designation
Recommended as a Local Geological Site (LoGS)

Recommendations for promotion, site management or enhancement
None

WRABNESS
Wrabness cliffs
Grid reference: TM 172 323

The cliffs at Wrabness consist of the upper part of the Eocene Harwich Formation and the lower few metres of the Walton Member of the London Clay. They provide the best onshore exposure of the Harwich Formation. Of particular interest is a complete sequence of bands of volcanic ash which probably originated from volcanoes in Scotland. These ash bands are present from the Harwich Stone Band to the top of the formation. Over 30 separate ash layers occur throughout some 10 metres of clay and silty clay which was deposited in a subtropical sea about 50 million years ago. The succession has been dated partly by analysing the iron-rich minerals in the ash which have preserved the direction of the Earth's magnetic field when the ash was laid down. This indicates that the succession is the same age as the Oldhaven Beds of Kent. The exposure of the Harwich Formation at Wrabness is of national importance as it provides the most complete succession of volcanic ashes attesting to the influence of early Eocene volcanism in southern England.

The same Eocene sediments contain an important fossil flora. Although the fossil fruit and seed flora from Wrabness is limited by comparison with some other sites, the importance of the Wrabness flora is in its mode of preservation. Here, some of the fruit and seeds are preserved in concretions as opposed to the carbonaceous preservation or preservation in iron pyrite that occurs elsewhere in the London Clay. This form of preservation is particularly important, as much detail has been retained which would otherwise have been obscured by the growth of pyrite. The preservation of these plant fossils in concretions has also protected them from the distortion that would have occurred as a result of shrinkage or through compression on burial. Wrabness has a great potential to provide new and significantly different insights into the structure and anatomy of the fossil floras of the London Clay.

The Wrabness cliffs in some places show faults in the London Clay which are records of prehistoric earthquakes. A fault was visible in the 19th century and illustrated in the 1885 geological survey memoir. It was obscured by a cliff fall but is said to be still visible at TM 170 322.

Existing or recommended site designation
Part of the Stour Estuary SSSI (Site of Special Scientific Interest)

Recommendations for promotion, site management or enhancement
Promotion of the geology of the area to the public by means of leaflets and an interpretive panel. Several Essex Wildlife Trust nature reserves are in the vicinity which bring many visitors to the area.

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Appendix 1 Geodiversity Characterisation Methodology

Methodology

The GIS component of the project was based on the current (2008) BGS 1:50k Superficial and bedrock geology shapefiles which are polygons. **Geological mapping boundaries of soft sediments is inherently inaccurate, thus the boudaries shown herein must be regarded as strongly indicative rather than definitive.**

The Kesgrave Sands and Gravels and Lowestoft Formations of the BGS 1:50k superficial geology was edited, to match the re-classification according to Bridgland 1994, into their respective Gravel Formations.

The reclassified superficial geological polygons were overlain upon the BGS bedrock shapefile. Where the bedrock was shown to be exposed at the surface these areas were 'cut out' of the bedrock shapefile and added to the superficial geology to create a new shapefile of only exposed geologies. These were grouped by type and merged to form a single geological polygon per type (ie. All brickearth deposits within the District)

To create the Geodiversity Character Areas the geological shapefile was overlain by various other GIS data source shapefiles with geodiversity elements ie. contours, rivers, soils etc. and using the 1:10k OS mapping data as background. Where the geological type formed the main characteristic the polygons were not altered (ie. Oakley gravels upon the ridge). Where the geology was not the dominant geodiversity characteristic, the polygon was subdivided according to the dominant element (ie. London Clay plateau separated from the London Clay valley slopes). The digital soil data (NATMAP) was mapped at a scale of 1:250,000 and so was not mapped at the same scale as the geological data, therefore the soil data is more generalised and does not necessarily tie in with the geological information at boundary extents.

The Geodiversity Character Areas were then further refined into Geodiversity Character Zones using the following data sources:

- Height
- Watercourse/bodies
- Soil
- Agricultural Land Classification (ECC)
- SSSI

- Geodiversity sites (gazetteer)
- Mineral sites
- Mineral application sites
- Historical mineral extraction sites
- Ancient woodland
- National Monument Mapping Project-Cropmarks
- Aerial photographs
- Historic Environment Record data (including Palaeolithic, Pleistocene and Industrial data)
- Portable Antiquity Scheme findspots
- Scheduled monuments
- Medway Valley Palaeolithic Project
- 1st edition OS mapping

Where there were clear variations in the natural landscape and topography, areas would be subdivided into zones i.e. to distinguish between valleys, plains, coastal slopes. Similarly clear divisions of soil types would be used to subdivide areas. In addition if there were similarities within areas these would be used to create zones, i.e. a highly industrialised zone or an intensively quarried area.

Some polygons have been amended from their original BGS mapping polygon due to the information from some of the above sources, specifically data from mineral sites, borehole data and excavated archaeological sites.

Once the areas had been divided into zones the relevant information from the GIS shapefiles was obtained by running a search by location on all the shapefiles listed above with the relevant zone selected. This enabled fast and accurate withdrawal of information from multiple sources. This information was then added to the zone description.

The scoring of the zones was based on the following criteria :

Rarity – how common or extensive the geology is over the District. This can reflect temporal and spatial extent e.g. Clacton channel (3) – the sediments laid within the channel were deposited over a relatively small area and over a relatively short time and are only identified within a small area. Whereas London Clay (1) was deposited over much of the District over a long period of time.

Cultural Association – the association between the geology and humans including early human occupation e.g. Clacton Channel (3) early human occupation or later industrial links such as the sites of the former copperas industry.

Amenity Value – combines value for appreciation of the natural, historical and scientific significance of a zone for education and recreation including elements such as access and visibility.

Capacity for change – The ability of the geology to absorb change. Change could be caused by below ground work associated with either development or extraction. Natural changes in environmental processes are also considered i.e. sea level change, coastal erosion, slope processes. The capacity for change will depend upon various factors such as depth of burial, extent, location and durability.

The polygons were hyperlinked to their descriptions and scores entered into the attribute table.

Appendix 2 SSSI Notifications

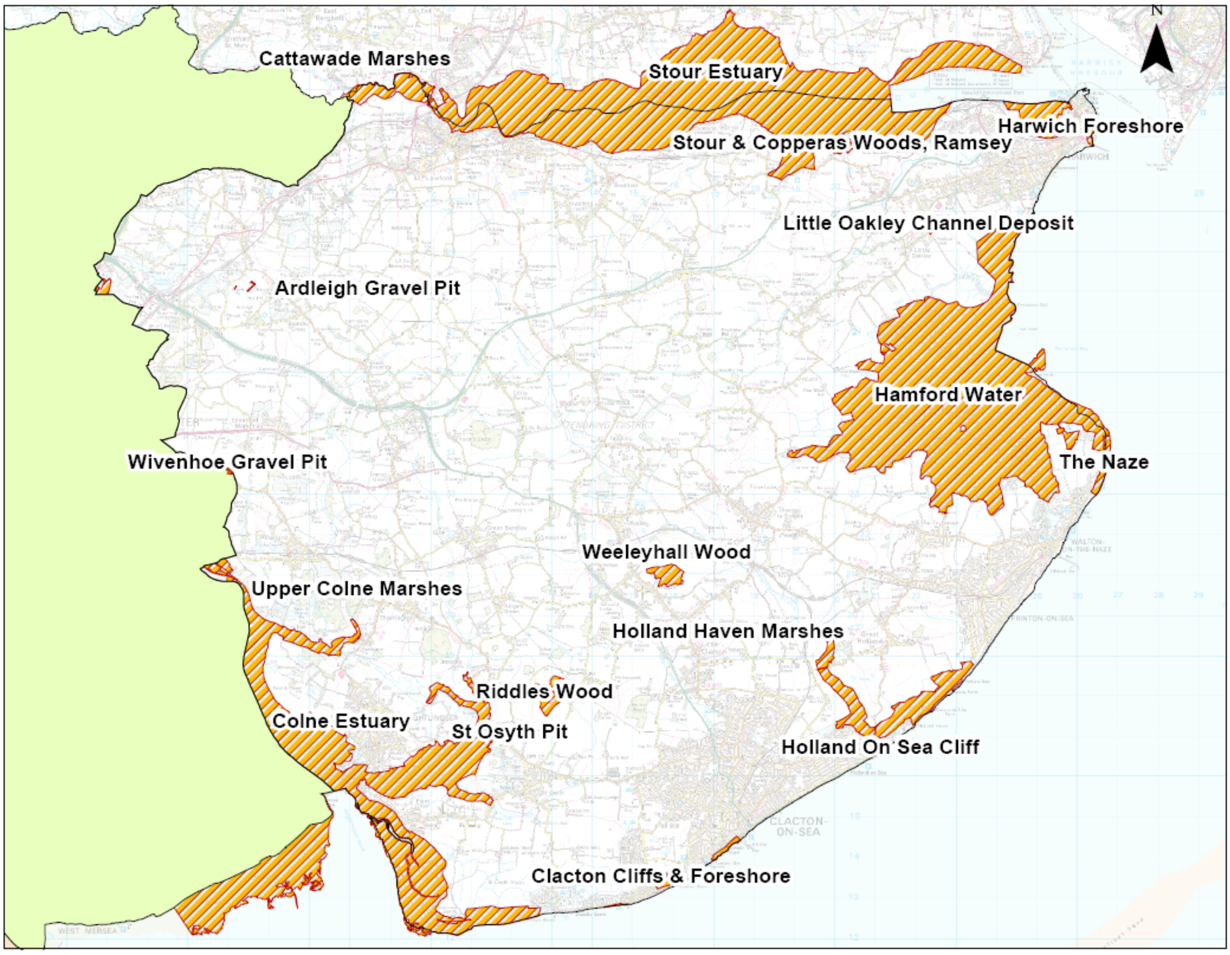

Fig 39 Location of SSSIs within Tendring

Site Name: Ardleigh Gravel Pit

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

National Grid Reference: TM 052281 **Area:** 1.2 (ha) 3.0 (ac)

TM 055281

Ordnance Survey Sheet 1: 50 000: 168 **1: 10 000:** TM 02 NE

Date Notified (Under 1949 Act): - **Date of Last Revision:** -

Date Notified (Under 1981 Act): 16.1.92. **Date of Last Revision:** -

Other Information:

A new site.

Description and Reasons for Notification:

Ardleigh Gravel Pit has exposed deposits belonging to the Kesgrave Formation (early Thames gravels) for many years. In the 1960's interglacial remains were recorded here and a Hoxnian age suggested. More recent exposures have revealed organic sediments from much older periods, interbedded with the Kesgrave deposits. The oldest of these is of interglacial origin and contains wood and other plant remains as well as pollen. The latter indicates an Early Middle Pleistocene age, perhaps within the Cromer Complex of interglacials recognised in the Netherlands, but probably earlier than the Cromerian *sensu stricto* of the British type site. The only other British locality where interglacial deposits similar to those at Ardleigh have been recorded is Broomfield, near Chelmsford, unfortunately no longer available for study. Higher in the sequence at Ardleigh a further horizon rich in pollen and plant remains occurs, but this time of cold climate (arctic) affinities. This horizon contains important plant macrofossils rare or unique in Britain. A fossil rubified soil has also been identified at the top of the fluvial sequence at Ardleigh, believed to represent the Valley Farm Soil of Suffolk. Currently work is progressing with the aim of correlating the Kesgrave gravels of southern East Anglia with deposits in the modern Middle Thames valley. The site at Ardleigh is clearly of major importance for British Pleistocene stratigraphy and palaeogeographical reconstruction. It is likely to become the type site for a new British Early Middle Pleistocene interglacial, the deposits from which are of international significance.

Site name: Cattawade Marshes
Status: Site of Special Scientific Interest (SSSI) notified under Section 28
of the Wildlife and Countryside Act 1981
National Grid Reference: TM 090329 **Area:** 88.2 (ha) 217.9 (ac)
Ordnance Survey Sheet 1: 50 000: 168 **1: 10 000:** TM 03 SE, TM 13 SW
Date Notified (Under 1949 Act): 1974 **Date of Last Revision:** 1974
Date Notified (Under 1981 Act): 1988 **Date of Last Revision:** -

Other Information:
An area of estuary east of the tidal barrage, formerly within Cattawade Marshes SSSI, has been transferred to Stour Estuary SSSI.

Description and Reasons for Notification:
Cattawade Marshes lie at the head of the Stour Estuary, between freshwater and tidal channels of the River Stour. These grazing marshes with associated open water and fen habitats are of major importance for the diversity of their breeding bird community, which includes species that have become uncommon throughout lowland Britain as a result of

habitat loss. The site has benefited from a sympathetic management regime aimed at enhancing the ornithological interest. The marshes are also of value as a complement to the adjacent Stour Estuary SSSI where breeding habitats for birds are relatively scarce. The undisturbed nesting habitats are particularly favourable to waders and wildfowl. Redshank, Lapwing and Oystercatcher breed within the cattle-grazed pasture, while Ringed Plover and Shelduck nest on the relict seawalls. Marshy pools and a system of dykes within the grassland, together with dense riverside vegetation, provide further nesting habitats, most notably for Shoveler, Teal, Tufted Duck and Water Rail. The neutral grassland is dominated by Couch *Elymus spp.*, Perennial Rye-grass *Lolium perenne* and Yorkshire Fog *Holcus lanatus*. Characteristic herbs of old grazing marsh, such as Grass Vetchling *Lathyrus nissolia* and Hairy buttercup *Ranunculus sardous* are present and, together with ant-hills, are indicative of the undisturbed nature of the site. Scattered marshy areas support a more diverse plant community including Marsh Foxtail *Alopecurus geniculatus*, Celery-leaved Buttercup *Ranunculus sceleratus*, Sea Club-rush *Scirpus maritimus* and Spear-leaved Orache *Atriplex prostrata*. Sea Club-rush also dominates the majority of ditches although those joining the river channels show a gradation, from saltmarsh with Common Saltmarshgrass *Puccinellia maritima*, Sea Aster *Aster tripolium* and Annual Sea-blite *Suaeda maritima* to marsh dominated by Common Reed *Phragmites australis* where salinity is lowest. Other species present along the fresh-water channel of the River Stour include Reed Sweet-grass *Gliceria maxima*, Great Willowherb *Epilobium hirsutum*, Purple Loosestrife *Lythrum salicaria* and Flowering-rush *Butomus umbellatus*.

Site Name: Clacton Cliffs & Foreshore

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

National Grid Reference: TM 146128

Area: 26.1 (ha) 64.49 (ac)

156134

173143

Ordnance Survey Sheet 1: 50 000: 168 **1: 10 000:** TM 11 SW, TM 11 SE

169

Date Notified (Under 1949 Act): - **Date of Last Revision:** -

Date Notified (Under 1981 Act): 1986 **Date of Last Revision:** -

Other Information:

A new site.

Description and Reasons for Notification:

Foreshore and cliff exposures and excavations in the Clacton district have provided opportunities for the study of one of the most important Pleistocene interglacial deposits in Britain. The celebrated Clacton channel deposits are a sequence of freshwater and estuarine sediments occupying a channel cut into an earlier gravel accumulation and the underlying Tertiary London Clay. They have yielded abundant molluscan and mammalian fossil remains, fossil plants and pollen, all of which indicate a Hoxnian interglacial age. The deposits also contain the type site of the internationally significant Clactonian Industry which, based on a crude working technique, is believed to be stratigraphically earlier than the Acheulian culture. The relationship between the Clacton Channel deposits and the other Pleistocene sediments of the area is poorly understood. There is need for further study of this critical site, which provides important comparisons, in a British context, with Hoxne and Swanscombe.

Site Name: Colne Estuary

Status: Site of Special Scientific Interest (SSSI) notified under Section 28
of the Wildlife and Countryside Act 1981

National Grid Reference: TM 075155 **Area:** 2915.2 (ha) 7203.4 (ac)

Ordnance Survey Sheet 1: 50 000: 168 **1: 10 000:** TM 01 NW, TM 01 NE,
TM 01 SE, TM 01 SW,
TM 02 SE, TM 02 SW,
TM 11 NW, TM 11 SW

Date Notified (Under 1949 Act): 1955 (part) **Date of Last Revision:** 1975
1971 (part)
1973 (part)

Date Notified (Under 1981 Act): 1989 **Date of Last Revision:** -

Other information:

The SSSI is within an area proposed as a Wetland of International Importance under the Ramsar Convention and a Special Protection Area under the EEC Council Directive on the Conservation of Wild Birds. Three areas: Brightlingsea Marshes, East Mersea and Colne Point form part of the Colne Estuary National Nature Reserve. Colne Point, Fingringhoe Wick and Howlands Marsh are owned and managed as nature reserves by the Essex Naturalists'

Trust. The Colne Estuary is listed as a site of national importance in the Nature Conservation Review (Ratcliffe, 1977).

Description and Reasons for Notification:

The Colne Estuary is comparatively short and branching, with five tidal arms which flow into the main river channel. The estuary is of international importance for wintering Brent Geese and Black-tailed Godwit and of national importance for breeding Little Terns and five other species of wintering waders and wildfowl. The variety of habitats which include mudflat, saltmarsh, grazing marsh, sand and shingle spits, disused gravel pits and reed beds, support outstanding assemblages of invertebrates and plants. Two areas of foreshore at East Mersea are of geological importance. Colne Point and St. Osyth Marsh are of geomorphological interest. The Colne Estuary has a narrow intertidal zone predominantly composed of flats of fine silt with mud flat communities typical of south eastern estuaries. The fauna is dominated by *Hydrobia ulvae* with *Macoma balthica*, *Scrobicularia plana*, *Hediste diversicolor* and *Nephtys hombergii*. Towards the mouth of the estuary the substratum becomes more sandy; *Zostera noltii* and *Zostera marina* have been recorded at Sandy Point. Due to a history of mariculture a range of introduced species occur, including *Crepidula fornicata*, *Urosalpinx cinerea*, *Crassostrea gigas* and *Mercenaria mercenaria*. Saltmarsh has colonised a large proportion of the estuary at Geedon Saltings, Colne Point and the Strood. The majority of this is high level marsh dominated by Saltmarsh-grass *Puccinellia maritima*, Sea Purslane *Halimione portulacoides* and Annual Sea-blite *Suaeda maritima* while the creek edges and disused oyster pits have been colonised by Glasswort *Salicornia spp*. Sea Aster *Aster tripolium*, and Cord grass *Spartina spp.* There are extensive saltpans on Geedon Saltings and Colne Point where there is a shorter sward of Saltmarsh-grass, Thrift *Armeria maritima* and Common Sea-Lavender *Limonium vulgare*. Nationally uncommon species such as Golden samphire *Inula crithmoide* and Shrubby Seablite *Suaeda vera* occur frequently in the upper marsh and at the foot of the sea-walls. Shrubby Seablite is particularly extensive at Colne Point where there is transitional from saltmarsh to sand-dune and shingle. This transition habitat is also important for the nationally uncommon Rock Sea-lavender *Limonium binervosum* and is one of the few East Anglian sites for Sea Heath *Frankenia laevis*. The saltmarsh and intertidal mud, with Mersea Flats forming the largest continuous area, provide extensive feeding areas for internationally important numbers of Brent Geest and Black-tailed Godwit. Nationally important numbers of Redshank, Dunlin, Sanderling, Ringed and Grey Plovers are also present together with significant numbers of Shelduck and Goldeneye. The grazing marsh at East Mersea and the Geedon Saltings are important feeding areas for Brent Geese, and the latter also contains the main high tide roost for waders. Shell, sand and shingle spits occur throughout the estuary, providing nesting habitats for Little Terns and Ringed Plover; at Colne Point the breeding colony of Little Terns contains nationally important numbers. The shingle ridges at Colne Point have been colonised by abundant Sea Campion *Silene maritima*, Yellow Horned-poppy *Glaucium flavum* and many mosses and lichens. Sand-dunes which top the shingle ridge form one of the few dune systems in Essex, with characteristic species such as Marram grass *Ammophila arenaria*, Sand Couch *Elymus farctus*, Sea Holly *Eryngium maritimum* and Sea Sandwort *Honkenya peploides*. The seawalls, foldings and areas of grazing marsh are unimproved neutral grassland, much of which is herb-rich, with the occasional scattered scrub. The grasses Sea Couch *Elymus pycnanthus*, Couch *Elymus repens*, Creeping Bent *Agrostis stolonifera*, Meadow Barley *Hordeum secalinum*, Red Fescue *Festuca rubra* and the nationally uncommon Sea Barley *H. marinum* are all frequent. Other plant species present include Grass Vetchling *Lathyrus nissolia*, Strawberry Clover *Trifolium fragiferum* and Spiny Restharrow *Ononis spinosa*, together with the nationally uncommon Sea Clover *Trifolium squamosum* and Slender Hare's-ear *Bupleurum tenuissimum*. Many anthills, produced by the meadow ant *Lasius flavus*, occur throughout the grazing marsh and provideadditional habitat for plants such as Lady's Bedstraw *Galium verum*. The former saltmarsh creeks and ditches within the grazing marsh add to the structural and species diversity, and are dominated by Water Dock *Rumex hydrolapathum*, Grey Club-rush *Schoenoplectus tabernaemontani*, Lesser Pond-sedge *Carex acutiformis* and Divided Sedge *C. divisa*, as well as Common Reed *Phragmites australis* and Sea Club-rush *Scirpus maritimus* which also dominate the majority of borrow dykes. The combination of these habitats provides excellent cover, feeding and breeding conditions for many birds including Whinchats in the more scrubby areas, Bearded Tits in the reed-beds and Pochard in pools dominated by Sea Clubrush. Predatory birds including Barn Owls, Short-eared Owls and Hen Harriers frequently hunt along the seawalls in winter. Much of the invertebrate interest is in the ungrazed marsh on Fingringhoe Ranges, indeed Langenhoe Marsh is the best Essex site for aquatic invertebrates outside the Thames Estuary. The Sea Club-rush filled ditches support nationally scarce and rare insects including the mosquito *Aedes flavescens*, the meniscus midge *Dixella attica*, numerous species of water beetle, rarest of which is *Graptodytes bilineatus*, and the nationally rare Scarce Emerald Damselfly *Lestes dryas*. This last species also occurs nearby in the disused gravel pits at Fingringhoe Wick Nature Reserve. Both sites support outstanding assemblages of dragonflies. Langenhoe is the only Essex site for the uncommon Hairy Dragonfly *Brachytron pratense*. Other species found on the couch-dominated grassland or in the ditches include the horsefly *Hybomitra ciureai*, the cranefly *Erioptera bivittata* whose larvae are found in brackish mud, and the aquatic weevil *Phytobius quadrinodosus*. The sand-dunes and shingle ridges at Colne Point are important for invertebrates, particularly spiders: one of these *Heliophanus auratus*, is known to occur in only the Essex estuaries. Other uncommon species present in the estuary include Roesel's Bush-cricket *Metrioptera roeselii* and several coastal moths including Ground Lackey *Malacosoma castrensis*, Mathew's Wainscot *Leucania pallens*, Silky Wainscot *Chilodes maritimus* and Dotted Fan Foot *Zanclognatha cribrumalis*. St. Osyth marsh is an important site for saltmarsh morphology, and is one of a few marsh areas in Britain to have been dated, the maximum age being 4280+ 45 years BP, the date provided by the analysis of a peat seam preserved in grey-black clay at the site. The assemblage of features - creeks, pans and saltmarsh cliff are all present at St. Osyth, and reflect the maturity of the marsh system. The saltpans have been intensively researched by geomorphologists, and provide much information relating to the formation and development of this unique coastal landform. One of the main interests in the Colne Point structure is the process of breaching and secondary spit genesis brought about by landwards over-roll across the marsh surface. This process is well displayed at present in the upper levels of the system. Geological exposures at East Mersea show important organic deposits beneath gravels which are attributed to the Thames-Medway system. These Pleistocene deposits of warm climate origin, but uncertain age, consist of silts, detrital muds and peats yielding freshwater and estuarine molluscs, ostracods, mammal and plant remains. They occupy one or more post-Anglian interglacial periods. Investigation of this locality is still in the early stages but it is clearly of considerable importance in Pleistocene studies.

Site name: Hamford Water

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of The Wildlife and Countryside Act 1981.

Part of the site is a National Nature Reserve (under Section 19 of The National Parks and Access to the Countryside Act 1949).

National Grid Reference: TM 235255 **Area**: 2185.76 (ha.)

Ordnance Survey Sheet 1:50,000: 169 1:10,000: TM 12 SE, TM 22 NW, TM 22 SE, TM 22 SW

Date Notified (under 1949 Act): 1956 **Date of last revision**: 1974

Date Notified (under 1981 Act): 1986 **Date of last revision**:

Other Information:

Hamford Water is a key site in "A Nature Conservation Review", edited by D.A. Ratcliffe, Cambridge University Press 1977. Most of the foreshore is leased by the NCC from The Crown Estate Commission and was declared a National Nature Reserve in 1983. It is proposed as a wetland of international importance under the Ramsar Convention and a

Special Protection Area under the EEC Directive on the Conservation of Wild Birds. Skipper's Island, one of the four main islands in Hamford Water, and the John Weston Reserve on the eastern boundary, are Essex Naturalists' Trust Reserves. The boundary of the site has been modified at re-notification by partial deletions and an extension.

Reasons for Notification:

Hamford Water is a tidal inlet whose mouth is about three miles south of Harwich. It is a large and shallow estuarine basin comprising tidal creeks, intertidal mud and sand flats, saltmarshes, islands, beaches and marsh grasslands. The site is of international importance for breeding Little Terns and wintering nark-bellied Brent Geese, wildfowl and waders, and of national importance for many other bird species. It also supports communities of coastal plants which are rare or extremely local in Britain, including Hog's Fennel *Peucedanum officinale* which is found elsewhere only in Kent. The site includes a number of islands and parts of islands, and extensive saltmarsh covers one third of the area. Thrift *Armeria maritima*, and Common Sea-lavender *Limonium vulgare*, together with the rarer Rock Sea lavender *L. binervosum* and Lax-flowered Sea-lavender *L. humile*. Sea Purslane *Halimione portulacoides* and Saltmarsh-grass *Puccinellia sp*. occur on the higher area; Sea Aster *Aster tripolium,* Glasswort *Salicornia sp* and Annual Sea-blite *Suaeda maritima*, on the lower areas and creek edges. On the upper marsh and at the foot of the seawall Shrubby Sea-blite *S. vera*, Golden-samphire *Inula crithmoides*, Sea Wormwood *Artemisia maritima* thrive alongside the Hog's Fennel. The uncommon Slender Hare's-ear*Bupleurum tenuissimum* is also found on the seawall. The intertidal areas support abundant invertebrates, mainly worms and thin shelled molluscs. The commonest species are the ragworm *Nereis diversicolor*, the bivalve molluscs *Macoma balthica*, *Scrobicularia plana* and the gastropod mollusc *Hydrobia ulvae*. There are Mussel *Mytilus edulis* beds and, in Kirby Creek, Oyster *Ostrea edulis* lays. The mudflats also support a number of local plants such as Small Cord-grass *Spartina maritima*, Narrow-leaved Eelgrass Z*ostera angustifolia* and Dwarf Eelgrass *z. noltii*. These form the main diet, on their autumn arrival, of approximately six thousand Brent Geese which over-winter in Hamford Water. Five other species winter in internationally important numbers - Shelduck, Teal, Grey Plover, Black-tailed Godwit and Sanderling. In addition, six species - Wigeon, Pintail, Ringed Plover, Curlew, Redshank and Dunlin - reach levels of national significance, together with important numbers of Bewick's Swan, Knot andTurnstone. The open areas of water attract many species of dabbling and diving duck including Mallard, Goldeneye and Eider. In very severe winter weather Hamford Water can shelter tens of thousands of duck, especially Wigeon. There are also important autumn and spring passage populations of Lapwing, Ringed Plover, Golden Plover and Grey Plover, Curlew, Bar-tailed Godwit, Black-tailed Godwit and Sanderling. There are major roosts of Grey and Ringed

Plover at Pewit Island, Stone Marsh, Middle Beach, and of Curlew, Redshank and godwits at Kirby Creek and on Horsey Island. Birds of prey, including Shorteared Owls, Hen Harriers and Marsh Harriers, are attracted to the area and Merlin have frequently been recorded. There is a Black-headed Gull colony on the breached and eroded seawall of Garnham's Island. The shingle spits mark the seaward edge from Dovercourt to Crabknow Spit and from Walton to Stone Point, and provide nest sites for internationally important numbers of Little Terns and nationally important numbers of Ringed Plover. The shingle is topped by low, retreating sand dunes which are colonised by grasses such as Sand Couch *Elymus farctus*, Lyme-grass *Leymus arenarius* and Marram *Ammophila arenaria*, and several uncommon plants including Sea-kale *Crambe maritima*, Sea-holly *Eryngium maritimum* and Sea Sandwort *Honkenya peploides*. Included within the site are the improved grass fields of Horsey Island which are feeding and roosting sites for the Hamford Water flock of Brent Geese, and for thousands of waders including Curlew and godwits. Also included are small remaining areas of unimproved grass marsh at Walton Hall, Old Moze Hall and on Bramble Island, and an area of grass and scrub at The Naze. This is the most easterly point in Essex and as such is major landfall for migrant birds.

Site Name: Harwich Foreshore
Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981 as amended
National Grid Reference: TM 263320 Area: 10.63 (ha.) 26.27 (ac.)
Ordnance Survey Sheet 1:500,000: 169 1:10,000: TM 23 SE
Date Notified (Under 1949 Act): – Date of Last Revision: –
Date Notified (Under 1981 Act): 1986 Date of Last Revision: –

Reasons for Notification:
This locality yields the only fossil flora securely with certainty attributable to the lowest division of the Eocene London Clay [A1]. Its composition is typical of the formation and specimens are abundant. Association of the plants with ash bands within the Clay may aid correlations elsewhere in the basin since they form useful marker horizons. A recently discovered site with great research potential.

Site name: Holland Haven Marshes
District: Tendring

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981.
Local Planning Authority: Tendering District Council

National grid reference: TM 211 170 Area: 208.83 ha 516.02ac
Ordnance survey sheet: 1:50,000: 169 1:10,000: TM11 NE, TM 21 NW
Date notified (Under 1949 Act): Date of last revision:
Date notified (under 1981 Act): 1 October 1992 Date of last revision:
Other information: This is a new site. Part of the site is a Country Park, owned and managed by Tendring District Council.

Description and reasons for notification:
Holland Haven Marshes in an area of reclaimed estuarine saltmarsh and freshwater marsh situated between Holland-on-Sea and Frinton-on-Sea. The site is bisected by Holland Brook and its tributaries, from which an extensive ditch system radiates. The ditch network represents an outstanding example of a freshwater to brackish water transition intimated by the aquatic plant communities, which include a number of nationally and locally scarce species. The adjoining grasslands are of botanical importance in their own right as well as acting as a buffer zone to the ditch system. Further interest is provided by the aquatic and terrestrial invertebrates and the birds which frequent the area, especially in winter. The salt-water influence is much in evidence downstream of Holland Bridge within the dykes of the coastal grazing marsh. The dominant emergent plants are Sea Club-rush Scirpus maritimus and Common Reed Phragmites australis while Parsley Water-dropwort Oenanthe lachenalii and Grey Club-rush Schoenoplectus lacustris ssp. tabernaemontani, both scarce in Essex, are locally frequent. Two nationally scarce plants are found in these meshohaline (moderately brackish) ditches: Brackish Water-crowfoot Ranunculus baudotii and Divided Sedge Carex divisa.

To the west of Holland Bridge the saline influence is less marked and the system is essentially freshwater or oligohaline (slightly brackish). Reed Canary-grass Phalaris arundinacea, Branched Bur-reed Sparganium erectum and Greater Reedmace Typha latifolia are the dominant emergent species, with Common Spike-rush Eleocharis palustris, Celery-leaved Buttercup Ranunculus sceleratus, Marsh Bedstraw Galium palustre and Water Pepper Polygonum hydropiper in the shallow water margins. Tubular Water-dropwort Oenanth fistulosa and Slender Spike-rush Eleocharis uniglumis, both rare in Essex, are also present. Rigid Hornwort Ceratophyllum demursum is widespread in these ditches, while the presence of the nationally uncommon Soft Hornwort Ceratophyllum submersum, at one location, is indicative of a brackish influence. Other fully aquatic plants include the invasive alien Water Fern Azolla filiculoides, Various-leaved Water Starwort Callitriche platycarpa, and Fat Duckweed Lemna gibba and Greater Duckweed Lemna polyrhiza, both of which are scarce in Essex. The grassland through which the ditch system runs comprises coastal and freshwater grazing marsh and an area of amenity grassland on Frinton golf course. It is generally dominated by grasses such as Creeping Bent Agrostis stolonifera, Crested Dog's-tail Cynosurus cristatus, Red Fescue Festuca rubra, Perennial Rye-grass Lolium perenne and Meadow Barley Hordeum secalinum, with Marsh Foxtail Alopecurus geniculatus in seasonally flooded depressions on the grazing land. Typically maritime species are distributed throughout the coastal marshland including Sea Couch Elymus pycnanthus, Strawberry Clover Trifolium fragiferum and Spiny Rest-harrow Ononis spinosa. Immediately behind the sea wall, where the land is subject to salt spray, a saltmarsh vegetation has developed with Sea milkwort Glaux maritima, Sea Hard-grass Parapholis strigosa, Greater Sea-spurrey Spergularia media, Saltmarsh Rush Juncus gerardii, and two nationally uncommon species, Sea Barley Hordeum marinum and Borrer's Saltmarsh Grass Puccinellia fasciculata. Growing in tracks where seepage of sea water occurs and Reflexed Saltmarsh Grass Puccinellia distans and the nationally scarce Curved Hard-grass Parapholis incurva. Through under-recorded, there are indications that the aquatic invertebrate fauna reflect the diversity of water conditions. A specialist brackish water species, a Red Data Book soldier fly Stratiomys singularior, has been recorded, and molluscs are abundant. The nationally notable Ruddy Darter dragonfly Sympetrum sanguineum and Stenopelmus rufinasus, a bettle associated with Water Fern, have also been found. Terrestrial invertebrates include a dense population of Roesel's Bush-cricket Metrioptera roeselii, which is also nationally notable, and a bumble bee Bombus muscorum which is rare in Essex. The Brown Argus butterfly Aricia agestis has been recorded in recent years from adjacent areas, and it is possible that this county rarity persists in small numbers on the site. Additional interest is provided by the birds which use the area. Hen Harrier and Short-eared Owl hunt over the marshes in winter, whilst the flooded low ways attract waders and wildfowl. These may include Wigeon (typically 1000, max 6500), Teal (several hundred), Pintail (max 35), Shoveler (max 20), Pochard (max 10), Ruff (max 90) and Snipe. A count of 900 Snipe in March 1988 represents a record number of this species in Essex. Several hundred Brent Geese graze the marshes in winter, and there are regular wintering flocks of Twite (max 160) and Lapland Bunting (max 70). The concrete wall immediately adjacent to the sea wall is the major area in Essex for wintering Purple Sandpipers, with 10 to 15 birds in most years. In summer, the marsh supports a typical range of breeding birds, including Skylark, Meadow Pipit and Yellow Wagtail, with Reed Warblers in the dykes and Ringed Plover behind the sea wall. During the spring and autumn migration, Spotted Redshank, Black-tailed Godwit, Whimbrel, Green and Common Sandpipers are see regularly on passage.

Site Name: Holland-on-Sea Cliff
Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981
National Grid Reference: TM 211167 **Area:** 0.7 (ha) 0.18 (ac)
Ordnance Survey Sheet 1: 50 000: 169 **1: 10 000:** TM 21 NW
Date Notified (Under 1949 Act): - **Date of Last Revision:** -
Date Notified (Under 1981 Act): 16.1.92. **Date of Last Revision:** -

Description and Reasons for Notification:
Cliff exposures at Holland-on-Sea comprise an important stratigraphic site closely related to the diversion of the Thames. The latter event, of great significance to the geomorphological evolution of the London Basin, was the result of blocking of the early Thames Valley across central Essex by the Anglian glaciation. At Holland two gravels are exposed, the site representing the type locality of both. The 'Lower Holland Gravel' is recognised as the final terrace aggradation by the Thames before its diversion, here including a small but significant contribution from the contemporary River Medway, which has been traced across eastern Essex to its confluence with the Thames in this area. The overlying 'Upper Holland Gravel' has a very different composition indicating that it is largely a Medway deposit, although with a proportion of glacial outwash material. A gravel of this type could only have been deposited while the Thames was blocked by ice and not reaching this lower part of its valley, since the eventual diversion of the Thames re-routed it via London and the old Medway valley to the Clacton area, truncating the Medway in the area of the modern Thames estuary. The events represented in the Holland section are of great significance in the reconstruction of the Pleistocene history of the Thames. As they can be precisely attributed to the Anglian glaciation, they provide a fixed dating point within the terrace sequence of the eastern London Basin and a means of correlation with sequences where the Anglian is represented elsewhere in southern Britain and on the continent. The Holland cliff section therefore represents a stratigraphic site of considerable importance.

Site Name: Little Oakley Channel
Deposit
District: Tendring

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981
Local Planning Authority: Tendring District Council
National Grid Reference: TM 223296 **Area:** 30.0 (ha) 74.0 (ac)
Ordnance Survey Sheet 1: 50 000: 169 **1: 10 000:** TM 22 NW
Date Notified (Under 1949 Act): - **Date of Last Revision:** -
Date Notified (Under 1981 Act): 25 June 1990 **Date of Last Revision:** -

Other Information:
This is a new site.

Description and Reasons for Notification:
Little Oakley Channel Deposit provides a reserve of Pleistocene interglacial channel-fill sediments,unique in Britain, and currently attributed to part of the Cromerian complex of interglacials recognized in the Netherlands. Excavations and borings at Little Oakley have yielded abundant faunal and floral remains, including numerous mammalian bones (many of extinct species), molluscs, ostracods, as well as a fine pollen record. The site is of great importance for Quaternary studies, not only because it seems to represent an early Middle Pleistocene interglacial unknown elsewhere in Britain, but also because it is associated with the early Thames drainage system, and therefore assists in the establishment of a link between the Pleistocene successions in the Thames Valley and East Anglia.

Site Name: The Naze
Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981
Local Planning Authority: Tendring District Council
National Grid Reference: TM 266237 **Area:** 22.0 (ha) 54.4 (ac)
Ordnance Survey Sheet 1: 50 000: 169 **1: 10 000:** TM 22 SE
Date Notified (Under 1949 Act): 1959 **Date of Last Revision:** 1975
Date Notified (Under 1981 Act): 1986 **Date of Last Revision:** -

Description and Reasons for Notification:
The main interest of this site is in the excellent cliff exposures of the earliest (Waltonian) sub-division of the Pleistocene Red Crag, which is here rich in marine Mollusca and other invertebrate fossils. This overlies older Tertiary sediment. This is the type of site for the earliest recognised stage of the British Pleistocene sequence, the Waltonian. The site

provides unrivalled sections in the Waltonian Crag essential to studies of Pleistocene stratigraphy, particularly with relevance to the lower limit of that period. The site yields abundant plant material from the Tertiary London Clay. Sections here in the A1 and A2 divisions of the formation offer a unique opportunity to study the flora in situ. This is the only locality to yield angiosperms preserved as carbonaceous compressions, invaluable for the study of small seed fossils. A key Tertiary palaeobotanical locality. An exceptional site where a diverse bird fauna has been preserved in small pockets within the London Clay along with other Lower Eocene plant and animal debris. An avifauna thought to be of a similar age has been recorded from the Mo Clay of Denmark. A small parrot *(Psittaciformes*) and a tiny raptor *(Falconiformes*) have been identified, but material indicates the presence of several other species including members of the orders Procellariiformes*,* Gruiformes, Charadriiformes and Cuculiformes*.* Eocene Procellariiformes and Charadriiformes have not been recorded outside Great Britain. The site is of considerable importance in the study of bird evolution.

Site Name: Riddles Wood
District: Tendring
Status: Site of Special Scientific Interest (SSSI) notified under Section 28
of the Wildlife and Countryside Act 1981
Local Planning Authority: Tendring District Council
National Grid Reference: TM 129180 **Area:** 37.3 (ha) 92.2 (ac)
Ordnance Survey Sheet 1: 50 000: 168 **1: 10 000:** TM 11 NW
Date Notified (Under 1949 Act): 1974 **Date of Last Revision:** -
Date Notified (Under 1981 Act): 1985 **Date of Last Revision:** -

Other Information:
The site is part of the former SSSI known as Tendring Woods.

Reasons for Notification:
Riddles Wood contains some of the best examples in Essex of chestnut coppice, derived from ancient pedunculate oak-hazel and pedunculate oak-hornbeam woodland. The soils are varied, being derived from glacial sands and gravels in the west and London Clay in the east. This results in a diversity of woodland types and a rich and varied ground flora, including several uncommon Essex species. The canopy consists mainly of Pedunculate Oak *Quercus robur*, over a coppice layer of Sweet Chestnut *Castanea sativa* with a scattering of Hazel *Corylus avellana* and a small area of Hornbeam *Carpinus betulus* along the eastern edge.

There is a small amount of Ash *Fraxinus excelsior*, mainly confined to the damper London Clay soils, while Birch *Betula spp.* and Aspen *Populus tremula* occur as invasive species of the young coppice. Holly *Ilex aquifolium* and Wild Service *Sorbus torminalis* occur locally, mainly along the boundary of the wood. The ground flora is dominated by Bramble *Rubus sp*., Bracken *Pteridium aquilinum*, or in places by Greater Stitchwort *Stellaria holostea*. In an area of poor, gravelly soil in the north-west, Wood Sage *Teucrium scorodonia* is co-dominant with Bracken, Creeping Soft-grass *Holcus mollis* and Honeysuckle *Lonicera periclymenum*. Other herb species include Moschatel *Adoxa moschatellina*, Yellow Archangel *Lamiastrum galeobdolon* and Common Cow-wheat *Melampyrum pratense*. Species of special note are Wood Small-reed *Calamagrostis epigejos*, Butcher's-broom *Ruscus aculeatus* and Broad-leaved Helleborine *Epipactis helleborine*, Soft Shield-fern *Polystichum setiferum* and the rare Orpine *Sedum telephium*. The plant communities have benefited from recent coppice management. Additional habitats are provided by a system of rides and a small pond.

Site Name: St. Osyth Pit
Status: Site of Special Scientific Interest (SSSI) notified under Section 28
of the Wildlife and Countryside Act 1981
Local Planning Authority: Tendring District Council
National Grid Reference: TM 119170 **Area:** 0.067 (ha) 0.16 (ac)
Ordnance Survey Sheet 1: 50 000: 168, 169 **1: 10 000:** TM 11 NW
Date Notified (Under 1949 Act): - **Date of Last Revision:** -
Date Notified (Under 1981 Act): 1987 **Date of Last Revision:** -

Description and Reasons for Notification:
St. Osyth Pit comprises an important sequence of Pleistocene deposits related to the diversion of the Thames during the Anglian glacial period. The lower part of the succession consists of Thames gravel of the pre-diversion 'Kesgrave' type i.e. deposited before the Thames was diverted by Anglian ice. This is overlain by sand and very fine gravel, the composition of the latter showing it to be distal outwash (deposited by meltwater from ice which had therefore arrived in the Thames catchment). The recognition of a comparable sequence elsewhere and of its relation to the terraces of the Tendring Plateau has shown that the outwash at St. Osyth reflects a brief period when the Thames was actually blocked by ice. The site is therefore of considerable stratigraphic importance in reconstructing the events of the Anglian glacial period.

Site Name: Stour and Copperas Woods, Ramsey

District: Tendring

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Tendring District Council

National Grid Reference: TM 190313 and **Area:** 77.08 (ha) 190.46 (ac)
TM 202316

Ordnance Survey Sheet 1: 50 000: 169 **1: 10 000:** TM 13 SE and TM 23 SW

Date Notified (Under 1949 Act): 1953 **Date of Last Revision:** 1975

Date Notified (Under 1981 Act): 1984 **Date of Last Revision:** -

Other Information:

Most of Stour Wood is owned by the Woodland Trust and managed as a nature reserve by the RSPB. Parts of Copperas Wood is owned by the Essex Naturalists' Trust and part by the RSPB and managed as nature reserves by both bodies.

Reasons for Notification:

Stour and Copperas Woods together comprise the largest area of woodland in north-east Essex. They are ancient woods lying on glacial sands and gravels on the southern shore of the Stour Estuary between Wrabness and Ramsey. They have a coppice-with-standards structure and contain the only example in the county where coastal and woodland habitats meet. The woodland is mainly Chestnut *Castanea sativa* coppice with Pedunculate Sessile Oak *Quercus robur* and *Q. petraea* standards and some Ash *Fraxinus excelsior*. Hornbeam *Carpinus betulus*, Hazel *Corylus avellana* and Small-leaved Lime *Tilia cordata* form the other coppice species with Maple *Acer campestre* on the woodland edge. The chestnut stools are exceptionally large. Holly *Ilex aquifolium* and Butcher's Broom *Ruscus aculeatus* occur near the margins. Copperas Wood, whose seaward boundary is an eroding wooded cliff, contains in addition an area of Cherry *Prunus avium* and Aspen *Populus tremula*. The ground flora of the woods is dominated by Bramble *Rubus fruticosus agg*. with Bluebell *Hyacinthoides non-scripta*, Wood Anemone *Anemone nemorosa* and Honeysuckle *Lonicera periclymenum* widespread. There are large patches of Yellow Archangel *Lamiastrum galeobdolon* and Dog's Mercury *Mercurialis perennis* is found locally. Additional interest is provided by small seasonal pools which are colonised by Skullcap *Scutellaria galericulata* and Pendulous Sedge *Carex pendula*. The White Admiral butterfly *Limentis camillad* whose food plant is honeysuckle, has been recorded sparingly in recent years.

Site name: Stour Estuary

Status: Site of Special Scientific Interest (SSSI) notified under section 28C of the Wildlife and Countryside Act 1981 as inserted by Schedule 9 to the Countryside & Rights of Way Act 2000.

National Grid Reference: TM 180330 Area: 2252.57 (ha)

Ordnance Survey Sheet: 1:50,000: 169 1:10,000: TM 03 SE, TM 23 SW, TM 13 SW & SE

Date notified: 9 April 2003

Reasons for Notification:

The Stour Estuary is nationally important for 13 species of wintering waterfowl and three species on autumn passage. The estuary is also of national importance for coastal saltmarsh, sheltered muddy shores, two scarce marine invertebrates and a vascular scarce plant assemblage. The Stour Estuary includes three nationally important geological sites. These provide exposures of early Eocene sediments containing the volcanic ash formations between Harwich and Wrabness. The same rocks are also important for the fossil fruits and seeds that they contain. At Stutton, much younger Pleistocene sediments have yielded an important and rich fossil vertebrate fauna.

General description:

The Stour Estuary forms the eastern part of the Essex/Suffolk county boundary. It is a relatively simply structured estuary with a sandy outer area and a muddier inner section. The six main bays, Seafield, Holbrook and Erwarton on the north, and Jacques, Copperas and Bathside on the south, encompass most of the intertidal flats. The mud is extremely rich in invertebrates and this, coupled with its relative lack of disturbance, enables the estuary to support an internationally significant assemblage of wildfowl and wading birds. The shoreline is one of the most natural in the region, often with low cliffs. Those at Stutton and Wrabness contain nationally important geological exposures. The main concentration of feeding birds tends to be in the bays. High tide roosts are located in various places, mostly on the sheltered parts of the northern shore and on the southern shore at Deep Fleet and the 'tidal bank' of Copperas Bay and Bathside Bay. The majority of the redshank Tringa totanus, black tailed godwit Limosa limosa islandica and dunlin Calidris alpina alpina feed in the muddier upper reaches, whereas most of the grey plover Pluvialis squatarola and knot Calidris canutus islandica congregate towards the seaward end. Curlew Numenius arquata, ringed plover Charadrius hiaticula and turnstone Arenaria interpres feed throughout the estuary. Wigeon Anas penelope graze on the beds of eelgrass Zostera spp. and green algae Enteromorpha spp. and winter in large numbers on a par with nearby Hamford Water. Pintail

Anas acuta congregate with the wigeon after arrival at Holbrook Bay, reaching peak numbers in mid-October and again in January-February. They prefer the upper and middle reaches where the very fine sediment favours their method of feeding and their major roost is on the saltings of Stutton Mill Creek. Shelduck Tadorna tadorna breed around the estuary and are present throughout the year apart from the August moult: maximum numbers occur in January. Shelduck also favour areas of high invertebrate density and concentrate in the upper reaches, roosting on the saltmarsh with other dabbling ducks. Wintering brent geese Branta bernicla bernicla, feeding on eelgrass and green algae, prefer the lower reaches of the Essex shore. The wintering herd of mute swans Cygnus olor feeds on the waste from the maltings at Mistley; their numbers peak in January and again in August when they are more widespread throughout the estuary, feeding particularly in Holbrook Bay. The shoreline vegetation varies from oak-dominated wooded cliffs, through scrub-covered banks to coarse grasses over seawalls, with reed-filled borrow dykes behind. The higher saltmarsh is dominated by saltmarsh grass Puccinellia maritima, sea purslane Atriplex portulacoides, with sea aster Aster tripolium, annual sea-blite Suaeda maritima and sea-lavender Limonium vulgare are scattered throughout, together with the scarce lax-flowered sea-lavender L. humile. Adjoining lower areas are colonised by clumps of sea lavender, perennial glasswort Sarcocornia perennis and cord-grasses Spartina spp. which grade through pure stands of cord-grass into large expanses of mud. These are colonised by green algae and eelgrasses.

Wintering and autumn passage birds

Thirteen species of wintering wildfowl and wader occur in qualifying numbers within the Stour Estuary: grey plover, knot, dunlin, redshank, black-tailed godwit, great crested grebe Podiceps cristatus, cormorant Phalacrocorax carbo, mute swan, dark-bellied brent goose, shelduck, pintail, ringed plover and curlew. Ringed plover, dunlin and redshank are regularly found using the Stour Estuary on autumn passage in nationally important numbers.

Coastal saltmarsh of East England

The saltmarshes of the Stour Estuary form an integral part of the estuarine system and are an essential feeding and roosting habitat supporting the nationally and internationally important numbers of waterbirds. The Stour has two of the three basic saltmarsh communities characteristic of south-east and east England. These are formerly grazed saltmarshes with saltmarsh-grass Puccinellia maritima and sea aster Aster tripolium often in extensive pioneer-and mid-marsh zones, and ungrazed and lightly grazed saltmarshes, typically with sea-purslane Atriplex portulacoides being dominant. Sheltered muddy shores (including estuarine muds). The mudflats of the Stour Estuary also form an integral part of the estuarine system and are an essential feeding and roosting habitat supporting the nationally and internationally important numbers of waterbirds.

In addition the estuary represents a good example of a sheltered muddy shore (including estuarine mud) within the Area of Search. Also present is a nationally important community of tide-swept lower shore mixed substrata with sponges, ascidians and red algae. The site contains good examples of mixed substrata and estuarine muds for the Area of Search. Many of the individual biotopes in the Stour are highly rated, often as a result of their relatively high species richness and large extent. Both of these habitat features are nationally restricted. There is an extensive area of estuarine sediments and the expected range of zonation of mixed substrata and estuarine sediments are present, including a clear variation in the composition of sediment communities along the salinity gradient up the estuary.

Scarce marine invertebrates

The site contains nationally scarce species at two locations within the estuary. These species are starlet sea anemone Nematostella vectensis and tentacled lagoon worm Alkmaria romijni. Of the ten estuaries in the Area of Search, the Stour is the only one to contain N. vectensis. Both species are listed in Schedule 5 of the Wildlife & Countryside Act 1981, as amended.

Scarce vascular plant assemblage

The site also exceeds the national threshold site-index value for a scarce vascular plant assemblage of saltmarsh, mudflats and shingle. This includes lax-flowered sea-lavender Limonium humile, dwarf eelgrass Zostera noltii, golden-samphire Inula crithmoides, hoary mullein Verbascum pulverulentum, curved hard-grass Parapholis incurva, sea barley Hordeum marinum, divided sedge Carex divisa, marsh-mallow Althaea officinalis, dittander Lepidium latifolium and perennial glasswort Sarcocornia perennis.

Geological exposures

The Eocene stratigraphical and palaeobotanical interests of the Stour estuary are formed by the cliff and foreshore exposures at Wrabness, on the southern shore of the estuary. The Pleistocene interest is exposed in the low cliffs forming the northern shore of the estuary, to the south of the village of Stutton. The upper part of the Eocene Harwich Formation and the lower few metres of the Walton Member of the London Clay provide the best onshore exposure of the Harwich Formation. A complete sequence of ash bands is present from the Harwich Stone Band to the top of the formation. At least over 30 separate ash layers occur. It is therefore the most important site in southern England at which pyroclastic Palaeogene deposits may be found. The ash bands occur throughout some 10 metres of clay and silty clay deposited in an offshore shelf environment. The succession has been dated using both the dinoflagellates from the sediments and magnetostratigraphic techniques making use of iron-rich minerals in the ashes. Both indicate that the succession is contemporaneous with the inshore Oldhaven Beds of Kent, whilst the magnetostratigraphic evidence and the composition of the ashes provide a correlation with the lower part of the Balder Formation in the North Sea.

The exposure of the Harwich Formation at Wrabness is of national importance as it provides the most complete succession of volcanic ashes attesting to the influence of early Eocene volcanism in southern England. The same Eocene sediments contain an important fossil flora. Although the fossil fruit and seed flora from Wrabness is limited by comparison with coeval sites elsewhere in England, the importance of the Wrabness flora is in its mode of preservation. Here, some of the fruit and seeds are preserved in concretions as opposed to the pyritic or carbonaceous preservation that occurs elsewhere in the Thames Group. This form of preservation is particularly important, as much of the histological detail has been retained. Such detail would have been obscured by the growth of pyrite. The preservation of these plant organs in concretions has also protected them from the distortion that would have occurred as a result of shrinkage in a carbonaceous preservation or through compression on burial. Wrabness has a great potential to provide new and significantly different insights into the structure and anatomy of the fossil floras of the Thames Group. Contrastingly, the sedimentary sequence and fossil assemblage at Stutton is an important record of rising Mid-Pleistocene sea-level. The cliff and foreshore sequences at Stutton contain a rich and varied record of Mid-Pleistocene interglacial mammal, molluscan and pollen assemblages. The freshwater ‘brickearths’ of Stutton have yielded a vertebrate fauna, generally attributed, on the evidence of pollen spectra and non-marine molluscs, to the Ipswichian interglacial. The fauna includes insectivores represented by the common shrew and water shrew, rodents including an extinct species of water vole, field vole, northern vole, woodmouse and beaver, whilst lions represent the carnivores. Other large mammals include the straight-tusked elephant (extinct) and mammoth (extinct), horse, giant deer (extinct), red deer and ox or auroch. Palaeolithic artefacts have also been recorded.

Other information:

This site has been renotified to include Bathside Bay and part of Copperas Bay. The SSSI is part of the Stour and Orwell Estuaries Wetland of International Importance under the Ramsar Convention and the Stour and Orwell Estuaries Special Protection Area under the EEC Council Directive on the Conservation of Wild Birds (79/409/EEC). The Stour Estuary is listed as a site of national importance in A Nature Conservation Review (Ratcliffe, 1977).

Site Name: Upper Colne Marshes

District: Colchester and Tendring

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981

Local Planning Authority: Tendring District Council/Colchester Borough Council

National Grid Reference: TM 022232 **Area:** 114.10 (ha) 281.94 (ac)

TM 050209

Ordnance Survey Sheet 1: 50 000: 168 **1: 10 000** TM 02 SW

TM 02 SE

Date Notified (Under 1949 Act): - **Date of Last Revision** -

Date Notified (Under 1981 Act): 20.5.1992 **Date of Last Revision** –

Other Information:

This is a new site. A small section was previously notified as part of the Colne Estuary SSSI.

Description and Reasons for Notification:

The Upper Colne Marshes lie along both sides of the River Colne and Roman River, south east of Colchester. The site consists of grazing marshes with associated ditch and open water habitats, a series of tidal salt marshes behind old flood defence walls following a number of breaches, the sea walls themselves, and a small area of intertidal mud. It is considered to be of special interest as it supports an outstanding assemblage of nationally scarce plants and an unusual diversity of brackish ditch-types. Additional interest is provided by the terrestrial and aquatic invertebrates found within the site, and breeding and wintering birds. The grazing marshes and sea walls are unimproved neutral grassland, much of which is species rich. The dominant grasses are Creeping Bent *Agrostis stolonifera*, Sea Couch *Elymus pycnanthus*, Meadow Barley *Hordeum secalinum*, Red Fescue *Festuca rubra*, and the nationally scarce SeaBarley *Hordeum marinum*. Another nationally scarce species, Stiff Saltmarsh-grass *Puccinellia rupestris* is locally frequent on the top of the sea walls. Other characteristic species include Mouseeared Hawkweed *Hieracium pilosella*, Knotted Bur-parsley *Torilis nodosa*, Spiny Rest-harrow*Ononis spinosa*, Narrow-leaved Bird's-foot-trefoil *Lotus tenuis*, Hairy Buttercup *Ranunculus sardous* and Strawberry Clover *Trifolium fragiferum*, together with the nationally uncommon Divided Sedge *Carex divisa*, locally dominant Slender Hare's-ear *Bupleurum tenuissimum* and Dittander *Lepidium latifolium*.

The grazing marshes within the SSSI are managed in a variety of ways leading to subtle differences in botanical communities. For example, Wivenhoe Marsh has not been grazed for many years and is now dominated by Dittander. Parts of the Hythe Marshes have been cut for turf in the past, and this has resulted in a more level habitat, though still with Sea Barley and Hairy Buttercup. On less modified parts of the marsh, ant hills produced by the Yellow Meadow ant *Lasius flavus* are present: these provide a well-drained micro habitat which supports a number of different plants including the nationally scarce Upright Chickweed *Moenchia erecta*. The water courses which run through the grazing marshes range from fresh water to almost fully saline in nature. Where the water is fresh, the dominant plants include Common Reed *Phragmites australis*, Reed Canary-grass *Phalaris arundinacea*, Floating Sweet-grass *Glyceria fluitans*, Hard Rush *Juncus inflexus* and Jointed Rush *Juncus articulatus* together with False Fox-sedge *Carex otrubae* and Hairy Sedge *Carex hirta*. In those dykes with a significant salt water content, Sea Club-rush *Scirpus maritimus* is dominant, and the nationally scarce Brackish Water-crowfoot *Ranunculus baudotii* is frequent. A recent assessment of these ditches in relation to others in Suffolk and Essex suggests that this site is one of the two best in North Essex for its range of brackish ditchplant communities. A freshwater pond by Hythe Marshes is of additional interest with dense stands of Greater and Lesser Reedmace *Typha latifolia* and *T. augustifolia*. Salt marsh is the other major habitat type within the SSSI. There are small areas of primary saltmarsh outside the sea wall especially on the north bank of the Colne. This marshland is dominated by Common Saltmarsh-grass *Puccinellia maritima*, Sea Aster *Aster tripolium* and Common Sealavender *Limonium vulgare* with the nationally uncommon Lax-flowered Sea-lavender *Limonium humile* and large stands of Sea Wormwood *Artemisia maritima*. In places the marshes show a natural transition to a high marsh community dominated by Common Reed and Sea Club-rush and then to a natural scrub community with Blackthorn *Prunus spinosa*. It is one of very few sites in Essex where such a transition can be observed. The largest areas of salt marsh are secondary, that is they have formed in the twentieth century following sea wall breaches allowing tidal inundation of former grazing marsh. In terms of their plants they are similar to the primary marsh although with an increased dominance of Sea-purslane *Halimione portulacoides*. Additional interest in this complex of coastal habitats is provided by invertebrates and birds. The nationally scarce Roesel's Bush-cricket *Metrioptera roeselii* is abundant throughout and a number of other uncommon insects have been recorded, including the ground beetle *Pterostichus macer*. Dragonflies and damselflies are characteristic of the fresh and brackish water and the diverse butterfly fauna includes the Essex skipper *Thymelicus lineola* and Common blue *Polommatus icarus*. Breeding birds on the site include Redshank *Tringa totanus*, Lapwing *Vanellus vanellus*, Shelduck *Tadorna tadorna*, Reed Bunting *Emberiza schoeniclus* and Reed and Sedge Warblers *Acrocephalus* *scirpaceus* and *A. schoenobaenus*. Many other species use the marshes for winter feeding and on migration, including waders and wildfowl on the undisturbed mudflats at the mouth of the Roman River. Barn Owls *Tyto alba* and kestrels *Falco tinnunculus* regularly hunt over the grazing marshes, a reflection of the richness of the habitat for small mammals.

Site Name: Weeleyhall Wood
District: Tendring
Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981
Local Planning Authority: Tendring District Council
National Grid Reference: TM 159210 **Area:** 31.0 (ha) 76.6 (ac)
Ordnance Survey Sheet 1: 50 000: 168 **1: 10 000** TM 12 SE
Date Notified (Under 1949 Act): 1974 **Date of Last Revision** –
Date Notified (Under 1981 Act): 1985 **Date of Last Revision** –

Other Information:
This site is part of the former SSSI known as Tendring Woods. It is a nature reserve owned and managed by the Essex Naturalists' Trust.

Reasons for Notification:
Weeleyhall Wood is one of the largest ancient woods in the Tendring peninsula. It contains one of the best examples in Essex of base-poor springline alder woodland, a type of woodland which is rare in the county, as well as good examples of lowland hazel-pedunculate oak and some wet ash-maple woodland, and chestnut coppice-with-standards derived from these last two. The diversity of woodland types reflects the varied soils: sandy loams and gravels overlying London Clay, and soils derived from loess which are moderately to strongly acidic. Two streams arise from springs and flushes at the intersection of the sand and gravel with the underlying clay. The woodland consists mainly of Pedunculate Oak *Quercus robur* standards over a coppice layer of Hazel *Corylus avellana* with some Sweet Chestnut *Castanea sativa* originating from nineteenth century plantings. Mature Alder *Alnus glutinosa* coppice occurs in the damper areas along the stream valleys, together with some Ash *Fraxinus excelsior*. Birch *Betula spp*. is locally abundant in the western part of the wood, where Field Maple *Acer campestre* also occurs in small numbers. The predominant ground flora consists of a mosaic of Bramble *Rubus spp*., Bluebell *Hyacinthoides non-scripta* and Bracken *Pteridium aquilinum* covering large areas, with smaller quantities of Wood Sage *Teucrium scorodonia*, Honeysuckle *Lonicera periclymenum*, Wood Sorrel *Oxalis acetosella*,

Yorkshire Fog *Holcus lanatus* and Creeping Soft-grass *Holcus mollis*. The alder valleys support a rich ground flora which includes Moschatel *Adoxa moschatellina* and Opposite-leaved Golden Saxifrage *Chrysoplenium oppositifolium*, the former in exceptional abundance. The wood also contains the largest Essex population of Climbing Corydalis *Corydalis claviculata*. Four species of fern are present, including the uncommon Scaly Male-fern *Dryopteris pseudomas* and Narrow Buckler-fern *D. carthusiana*. Additional interest is provided by two ponds and damp, grassy rides whose rich flora includes Waterpurslane *Peplis portula*. There are also two small mixed plantations.

Site Name: Wivenhoe Gravel Pit
District: Tendring
Status: Site of Special Scientific Interest (SSSI) notified under Section 28
of the Wildlife and Countryside Act 1981
Local Planning Authority: Tendring District Council
National Grid Reference: TM 050236 **Area:** 2.1 (ha) 5.1 (ac)
Ordnance Survey Sheet 1: 50 000: 168 **1: 10 000** TM 02 SW, TM 02 SE
Date Notified (Under 1949 Act): Date of Last Revision: -
Date Notified (Under 1981 Act): 16.01.92. **Date of Last Revision:** -

Description and Reasons for Notification:
Localised exposures in this part of the Wivenhoe gravel workings reveal organic sediments of interglacial origin interbedded with early Thames gravels. The gravels comprise the Wivenhoe Gravel Member of the Kesgrave Sands and Gravels formation, the pit representing the typesite of this unit. The interglacial sediments contain well-preserved pollen, plant macro-fossils and beetle remains. They appear to represent a temperate interval closely pre-dating the Anglian Glacial Stage, when the most extensive ice development in Britain took place, diverting the Thames and causing major changes in the geomorphology of south-eastern England. Interglacial sediments such as these provide the main evidence for dating the various early Thames gravel aggradations. The sediments at Wivenhoe have great scientific potential for improving the record from this part of the Pleistocene in Britain and for providing valuable correlation with the much better established continental sequence, particularly that in the Netherlands.

GLOSSARY OF TERMS

Anastomosing : Intertwining multichannel pattern; braided rivers at times of lower flow have mid-stream gravel bars around which the water flows. At times of flood the bars are covered by water, but the anastomosing pattern characterises the braided river.

Anglian: A Pleistocene glaciation (ice age) in Britain and Ireland typically dated to about 450,000 years ago.

Bronze Age: The period from about 2,000 BC, when bronze-working first began in Britain, until about 700BC when the use of iron begins.

Clactonian: A Lower Palæolithic culture represented by the flint implements found at Clacton, Essex

Colluvium: A loose deposit of rock debris accumulated through the action of gravity at the base of a cliff or slope

Cromerian: A stage (and the corresponding age) in the Lower Pleistocene, and also of the first (antepenultimate) interglacial in Britain.

Cropmarks: Variations in the sub-soil caused by buried archaeological features resulting in differential crop growth visible from the air.

Devensian: The most recent Pleistocene glaciation (ice age) in Britain, dated to c. 15,000-20,000 years ago

Geodiversity: the variety of rocks, fossils, minerals, landforms and soils, and all the natural processes that shape the landscape

Geomorphology: The branch of geology dealing with the origin, evolution, and configuration of the natural features of the earth's surface or a particular region of it.

Glacial: Characterized by the presence of ice

Head: An unsorted slope deposit that forms under cold-climate environments. Material will tend to flow downhill due to the repeated freezing and melting of the soil in a process known as solufluction.

Hoxnian: An interglacial in Britain of the Middle Pleistocene, dated to around c.400,000 years ago (MIS stage 11)

Interglacial: Lying between glacial periods; formed or occurring between two such periods. Often characterised by warm climatic conditions.

Ipswichian: A recent interglacial in Britain within the Pleistocene, dated to around c.100,000 years ago (MIS stage 5e)

Iron Age: The period from about 700 BC when iron-working arrived in Britain until the Roman invasion of 43 AD.

Ma: million years

Marine oxygen isotope stages (MIS)-The sediments from ocean floors have been found to contain an important globally valid record of Quaternary climatic fluctuation, based on oxygen isotopes within the hard shells of marine planktonic animals that are present in these deposits. Oxygen can exist in three isotopic forms (^{16}O, ^{17}O, ^{18}O). Most oxygen exists as ^{16}O, the most common, or ^{18}O, the ratio between the two being 500:1. As part of the hydrological cycle of evaporation, cloud formation, rain and return of water by rivers to the oceans, during glacial episodes, more and more of the water removed from the oceans gets locked up in global ice and is delayed in its return to the oceans. At such times, because of the preferential evaporation of water containing ^{16}O, the ocean water becomes depleted in the light isotope relative to its condition during interglacials. This effect can be measured by analysing the oxygen isotope content of the calcium carbonate in the shells of planktonic micro-organisms called foraminifera, which are common constituents of ocean floor sediments. It is assumed that their composition is in equilibrium with the sea water at the time they were alive. The results are expressed as a ratio between the two isotopes. It is a measure of global ice volume and, at the same time, an indirect measure of both eustatic sea level and climate. The variations in the ratios between the types of oxygen can be plotted and an oxygen isotope curve drawn up (Fig. 5). The swings on the curve are numbered, the colder periods (^{18}O-rich) being given even numbers and the warmer periods odd.

Oscillations within a warm or cold period are given letters, a-c-e being warmer and b-d-f colder.

Medieval: This is the period between the Norman Conquest of England in 1066 and the dissolution of the monasteries in 1538.

Palaeoenvironmental: Material which provides evidence of an environment at a period in the past.

Palaeolithic: The Palaeolithic period covers the time span from the initial colonisation of Britain, *c*. 700,000 years ago to the end of the last ice age *c* 10,000 years ago.

Post-medieval: The period from 1538-1900

Red Hill: A Late Iron Age or Roman salt making site.

River terraces- River terrace sequences are relatively flat platforms, usually underlain by (or composed of) fluvial sediments and usually occurring on the slopes of river valleys. They are interpreted as fragments of former valley bottoms, or floodplains (since these are where river sediments accumulate) that have been left above river level by fluvial down-cutting. The downcutting occurs in pulses, each pulse being followed by accumulation of sediment. This process creates a sequence of platforms/terraces, the lower the terrace, the younger its age. In more detail, where the sequence is complete, each terrace comprises a cold-warm-cold sandwich of deposits formed by a sequence of lower and upper cold-climate gravels between which temperate-climate, often fossiliferous, sediments occur. These climatic cycles are argued to occur in synchrony with glacial-interglacial climatic cycles described by the MIS record. The driving force for the downcutting is progressive uplift of the land. However, the pulsed reaction to this uplift, rather than continuous downcutting, is because the rivers generate sufficient power to downcut only at certain points in the MIS climatic cycle, when water volumes are high and the protective effects of vegetation are at a minimum.

Roman: The period of Roman occupation from 43AD through to 410AD.

Saxon: The period of Saxon occupation from 410 to 1066.

Scheduled Monument: (Formerly Scheduled Ancient Monument): A site of nationally archaeological importance protected under the 1979 Ancient Monuments and Archaeological Areas Act.

Soil formation: Soils are formed by the breakdown of groundsurface materials and by the passage of groundwater downwards (occasionally upwards by evaporation) through that material. As the water moves down it moves finer material such as clay and silt with it and it also combines with humic material and minerals such as iron and aluminium and moves them downwards also. This downward transfer of material is described as translocation and the translocated material is deposited or precipitated out at a lower level. This creates soil horizons, the ‘donor’ zone being an eluvial horizon and the recipient zone an illuvial or ‘B’ horizon. Water can move down through sands relatively quickly, so soil horizonation develops rapidly, but in clays, progress is slow and horizonation is poorly developed. The amount of water and air present also affects the soil forming process. Where there is a balance of water and air in the soil, the translocated minerals will oxidise. This iron is precipitated out in its ferric form (Fe_2O_3), which we know as rust, giving soil its brown colour. In saturated conditions, the iron forms in its ferrous state (FeO), which is a blue-grey colour and the soil is described as being gleyed. The iron can switch between the two forms, if it is subject to periodic saturation followed by dry conditions, giving a mottled effect.

Stratigraphy: the order and relative position of the sediments deposited over geological time

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