Welcome to the Brecks Earth Heritage Trail

90 million years of geological history - 18 sites to visit

The Brecks area has a fascinating Earth heritage. Its rocks, soils, sediments and landforms tell a story of environmental change over many thousands of years. They provide vital evidence for ancient wildlife and some of the earliest human settlement in Britain. The natural forces of wind, ice and water have all played a role in shaping the physical and cultural landscape of the Brecks we see today.

The Brecks Earth Heritage Trail will introduce you to 18 points of interest chosen for their publicly accessible geodiversity. You can visit them in any order. They range in time from the Cretaceous period to the 20th century, taking in quarries and flint mines; doline lakes and periglacial ponds; bricks and building stones - there is even a bit of Earth heritage art!

1. Brandon Park
2. Brandon Flint Mine Pits
3. High Lodge, Santon Downham
4. Botany Bay Brickpit, Weeting
5. Broomhill Pit, Weeting
6. Grimes Graves
7. Lynford Water
8. St Helen's Well, Lynford
9. Barnhamcross Common, Thetford
10. Knettishall Heath
11. Lackford Lakes
12. Rampart Field, Icklingham
13. Beeches Pit, West Stow
14. Wordwell All Saints’ Church
15. Maidscross Hill, Lakenheath
16. Devil’s Punchbowl, Croxton
17. Cranberry Rough, Hockham
18. Thompson Common

Further information
See the Trail web pages at http://www.breakingnewground.org.uk/earthheritagetrail/.
You can download PDF copies of this book and an introductory Trail leaflet.
The Brecks Earth Heritage Explorer smartphone app (available for Android and iPhone) is also available for download - scan the QR code here for a direct link to the page.

See the back pages of this book for more information about Brecks Earth heritage.
Introducing the Brecks
One of the great natural areas of Britain

The Brecks (otherwise known as the Breckland) covers some 940 km² (370 sq m) in Norfolk and Suffolk. It has one of the driest, most continental climates in the UK. It is a place of strange beauty and hidden stories that go back to the Stone Age, and has a distinctive Earth heritage.

Ancient heathland once covered a huge area, created by the axes of prehistoric farmers and the nibbling teeth of sheep and rabbits. ‘Brecks’ were temporary fields cultivated for a few years and then allowed to revert to heath once the soils became exhausted. Sands storms were once a regular occurrence, such as one which engulfed Santon Downham in 1668.

Over many centuries Brecks heaths and wetlands became home to a distinctive range of plants and animals. The contrasting chalky and sandy soils have contributed to much biodiversity.

Over the last hundred years the ancient character of the Brecks has changed. The large-scale pine plantations of Thetford Forest and the use of modern farming technology have transformed much of it into more productive land. The remaining stretches of heath, and the more open parts of the forest, are now vital areas for wildlife conservation. The Brecks is an ideal area for quiet recreation, and the forests now welcome over 1½ million visitors each year.
Origins of the landscape

The Brecks Earth Heritage Trail is about environmental history set against a backdrop of deep time. The area's rocks, sediments, landforms and soils preserve a physical record of past environmental conditions and wildlife, including ancestral human life.

The geological story of the Brecks begins in the Cretaceous period. A bedrock of chalk was deposited about 90 million years ago. It is an important aquifer, containing a huge reserve of groundwater which feeds agriculture and the public water supply as well as rivers and springs. It gives a calcareous character to the soils in many places, and is an historic source of raw flint nodules.

The geological story of the Brecks continues in the Pleistocene period. The now-vanished Bytham River flowed through the southern half of the area about 1/2 million years ago. Its headwaters lay in the West Midlands, and evidence for its passing can be seen in a distinctive suite of exotic rock-types brought here in the river's bedload. They can often be seen in local walls.

The Anglian glaciation set the scene for today's landscape about 450,000 years ago. Massive ice sheets bulldozed their way across the area, flattening the chalk hills and depositing a range of sediments, including sands, gravels and a chalky-sandy till, a mixed deposit which now forms the Brecks plateau.
After the Anglian ice sheet retreated, rivers developed on the glaciated landscape. The climate warmed up into the Hoxnian interglacial period about 420,000 years ago. Wildlife and vegetation returned, and the human species *Homo heidelbergensis* colonised the area. They left traces of their passing in the form of flint tools and even evidence of their camp fires, as at Beeches Pit, Icklingham.

There followed several warm and cold climatic cycles, each one lasting many thousands of years. With each cycle the land surface was eroded, and sediment and soil moved downslope into the valleys. River terraces were formed, as benches along valley sides marking former floodplain surfaces. About 160,000 years ago, another glaciation (the Saalian) left its mark on the Brecks; patchy spreads of sand and gravel along the margins of Fenland are thought to be the remains of deltas formed at the ice-front, as at Maidscross Hill, Lakenheath.

The Brecks has several nationally important sites where geology and archaeology come together to tell the story of the environment and early human settlement.

A fascinating range of wildlife, was able to colonise the area during the warmer (interglacial) or milder (interstadial) climatic periods. It included the Neanderthaler and earlier Heidelberger human species.

Evidence for past life is preserved in river valley sediments or in hollows in the chalk. As well as flint tools, we have bones, teeth and tusks, plant remains and preserved pollen, snail shells, beetle remains and other fossils. All these have been uncovered by quarrying or research excavations.

The last glacial period, known as the Devensian, was at its coldest 20,000 years ago, when an ice sheet lay along the north Norfolk coast. The Brecks was then a chill, periglacial wilderness, with permanently frozen subsoil.
The Devensian period ended about 10,000 years ago. Distinctive landforms such as ground-ice depressions (pingos) and patterned
ground (soil stripes) are a legacy of periglacial conditions, as are the layers of coversand (windblown sand and silt) deposited from dust
storms blowing across the sparsely vegetated ground.

Topsoil in the Brecks has been unstable in more recent centuries, due to the effects of arable cultivation, sheep farming and rabbit
warrening on fragile soils. Shifting sand sheets and mobile dunes were active in the Brandon area in the 17th century.

The Brecks is an area with a distinctive biodiversity and cultural history. Understanding Earth heritage helps explain these as well as
the origins of the landscape. New research techniques such as LiDAR mapping are revealing geological landforms in fascinating detail.
A recent LiDAR survey of the Brecks has revealed much new information - see https://goo.gl/QmGFuH.

A LIDAR digital terrain map of the Little Ouse valley in the Santon Downham area showing details of landforms dating back to the last ice age,
including dry valleys, river terraces flanking the valley and a notable meander bluff. The floodplain has developed over the last 10,000 years on a
foundation of earlier meltwater river gravels.
Brandon Park is public access land - see Ordnance Survey Explorer map no.229 'Thetford Forest in The Brecks' for details (OS grid ref c.TL 778 844). It is best accessed from Brandon Country Park, where there are car parking, visitor centre, café and restroom facilities.

The heathland of Brandon Park today is a reminder of the open Brecks landscape of sheepwalk and rabbit warren over 200 years ago. The sandy topsoil was unstable and prone to blow, forming areas of shifting dune. Brandon Park is part of this ‘sand flood’ story, and fossil dunes can be found in the forest.

In 1820, Edward Bliss tamed the sandy wilderness by planting eight million trees here to create a park. In 1935 most of this area became part of Thetford Forest and was planted with pine trees. About 15 years ago, some 35 hectares (86 acres) of forest were restored to heath, allowing heathland wildlife to flourish. A Tomorrow’s Heathland Heritage wildlife panel explains the story (map site B).

Where are the sands and where is the warren? Are not these scenes to my memory foreign? Rabbits and conies were lords of the soil, Deep sands made the traveller’s journey a toil.
A poem by Lord Eldon, c.1830.
A mere desert
Brandon Park is part of the ‘sand flood’ story of past centuries. Overgrazing by sheep and rabbits from Mediaeval times onwards destabilised the dry, sandy topsoil and, coupled with a cold, dry period known as the Little Ice Age (1550-1850), created ‘desert’ conditions which lasted for several centuries. “Nothing was to be seen on either side but sand and scattered gravel without the least vegetation; a mere African desert”, wrote William Gilpin, when passing through Brandon in 1769. When the wind blew, the loose sand formed into dunes that moved across the open landscape, spoiling farmland.

In the 1660s, Thomas Wright wrote about a ‘Sand-Floud’ that had originated in the Lakenheath and Wangford area and eventually engulfed the village of Santon Downham, almost blocking the Little Ouse river. A brown stone in the south-west corner of St Mary’s Church wall is said to mark the height it reached by the sand. The shifting dunes must have passed through the area of Brandon Park. A few active dunes survive today at Wangford Warren nature reserve.

Sandy soils and dunes
You can find relict dunes, perhaps several centuries old, in the Park and surrounding forest (map sites C and D). They are now stabilised by vegetation, but the loose soil at White Hill (map site A) shows how vulnerable the bare land would have been to wind erosion in the past. Many white flints lie scattered about; fresh flint is black, but it may change colour over thousands of years due to the effects of weathering and groundwater.
The soils here are acidic and poor in nutrients; humus and iron minerals are washed downwards to form a cemented horizon in the subsoil - the classic sandy heathland soil type known as a podzol. You can see a trench showing a podzol soil profile nearby in the forest (map site E). The University of East Anglia uses it to teach soil science.

Find out more
- Tourist information Brandon Country Park Visitor Centre, Bury Road, Brandon IP27 0SU - [http://www.brandoncountrypark.org.uk/](http://www.brandoncountrypark.org.uk/)
- Information about the 1660s sand flood at Santon Downham - [http://www.santondownham.org/history/sand-flood/](http://www.santondownham.org/history/sand-flood/)
2 Brandon Flint Mine Pits

Discovering the evidence for Brandon’s historic flint mines

Surviving remains of flint mine pits are best seen at Session Heath - see Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (c.TL 795 847). NB they are on private land, but visible from the publicly accessible forest track. They are best accessed by footpaths from Brandon Country Park or High Lodge Visitor Centre, where there are car parking, leisure, café and restroom facilities.

When struck, flint readily produces sparks. For over a century Brandon was the capital of the gunflint industry; it supplied the British Army at the Battle of Waterloo. Raw flint was extracted from mines in the chalk bedrock at Lingheath and Brandon Park, where flint beds yielding high-quality nodules lie close to the surface.

The geological story of flint

The chalk strata in the Brandon area are about 90 million years old. Flint is a mineral formed within the chalk. It may form as nodules by partial replacement of the chalk by silica, e.g. filling the shapes of fossil worm burrows; it may also form as sheets, e.g. filling joints and bedding planes between rock layers.

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| 13. |
| Hard Chalk. |

| 14. |
| Soft, White Chalk. |

| 15. |
| Wall Stone. |

| 16. |
| Soft Chalk, with Horns. |

| 17. |
| Soft, White Chalk. |

| 18. |
| Third Pipe-Clay. |

| 19. |
| Hard Chalk. |

| 20. |
| Floor Stone. |

Part of the sequence of chalk and flint beds in the Brandon area. The miners gave familiar names to each horizon.

Fresh flint is black in colour, with a white, chalky skin or cortex. When broken and weathered, it takes on a surface patina with range of colours, including white, red, yellow, orange or pale blue. This is because it is a slightly porous material and may be altered by minerals dissolved in surrounding groundwater.

Flints are found all over the Brecks, and often show a long history of transformations. The ones exposed longest to weathering have the deepest patinas. Some of them show evidence of having been rolled and abraded in glacial melt-waters or beneath ice sheets; others have dimples in their cortex (potlid fracturing) caused by periglacial frost action.

A flint showing heavy staining, weathering and ‘potlid’ fracturing.

Image © BGS GeoScenic P205615

The Lingheath flint pits, 1931.

Image © BGS GeoScenic P205615

Fresh flint nodules bedded in the wall of a Brandon chalk quarry.
Flint mining
A hundred years ago, Lingheath was a lunar landscape of chalk mounds and flint pits. The miners would dig their pits or ‘burrows’ and pile up chalk spoil in a horseshoe shape around the hole; the entrances typically faced south to capture more daylight. The land has now been reclaimed for farming, but grassed-over remnants of the old pits can still be seen in the forest at Session Heath (see map sites A and B). You can work out where the entrances were.

Flint knapping
Once extracted, the flint was taken to workshops in Brandon, where it was broken into manageable chunks (a process known as quartering), then flaked and knapped into gunflints. The industry dwindled and died out in the mid-20th century. One of the last places it took place was in the sheds behind the Flintknappers Arms pub. For more information about this historic industry visit Brandon Heritage Centre (map site C) or Thetford Museum.

A building resource
The debris from the flint industry used to be piled up at the eastern end of town. Some of it went as ballast for the railway; some went to build local walls, for example at Gashouse Drove (map site D). Some cottages in Brandon are made from specially squared flints.

Find Out More
- Brandon Heritage Centre, George Street, Brandon IP217 0BX – for opening times see http://www.brandonsuffolk.com/brandon-heritage-centre.php
- The Brecks leaflet ‘From Flint Axe to Gunflint’ available at Brandon Country Park Visitor Centre and other local outlets.
- Find out more about flint at the Breckland Society’s information page - http://www.brecsoc.org.uk/projects/breaking-new-ground/flint-in-the-brecks/
- Historic account of the gunflint industry: ‘On the manufacture of gun-flints’ by S Skertchly (HMSO, 1879) – download PDF copy (7.6 Mb) from https://archive.org/details/onmanufactureofg00skerrich/
High Lodge is the Forestry Commission’s main visitor centre for Thetford Forest. It is signposted from the B1107 Brandon-Thetford road - see Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (OS grid ref c.TL 811 851). Car parking charges apply via toll road. The surrounding forest is public access land.

The High Lodge Forest Centre includes a towering sculpture by Julienne Dolphin-Wilding (map site A). ‘Earth Matrix’ is 12 m (39 ft) high and made of flint, gravel, concrete and steel, and was installed in 2004. It gives an artistic interpretation of the layers of geological time beneath our feet, with help from a nearby explanation panel. It is well worth seeing.

What the miners saw

Victorian geologist SBJ Skertchly wrote a classic account of the Brandon gunflint industry, and compiled a geological column of his own 14 m (46 ft) deep. It shows the strata encountered by local miners. Among them was the ‘dead lime’, a layer of chalk fragmented by frost in the Ice Age, and productive flint bands such as the Toppings and Wallstone.
**A Breckland soil**
High Lodge Forest Centre offers a variety of paths and cycle ways, and one of them, the Fir Trail, passes close to a trench used by the University of East Anglia to teach soil science. It is located near a holly bush (map site B). It shows a sandy loam disturbed by frost action during the last Ice Age. Soils like this are characteristic of plateau sites in the Brecks, where glacial till deposits overlie Chalk bedrock. They are about 7 m (21 ft) deep in this area.

**Jurassic seas**
The Forestry Commission surfaces its trackways with a variety of geological materials. Flint gravel is commonest, but there are also more exotic rock types, including:
- ginger-coloured Cretaceous Carstone from West Norfolk, about 110 million years old;
- pale yellow Jurassic oolitic limestone from Northamptonshire, about 175 million years old.

A keen eye can spot fossil brachiopods, corals and bivalves in the limestone; it was laid down in a warm, shallow sea in which Ichthyosaurus and Plesiosaurus swam.

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**Find Out More**
- ‘Matrix Revealed’ – more details about the sculpture on the Forestry Commission website - http://www.forestry.gov.uk/forestry/infd-8kdcsf
- The Forestry Commission web page for High Lodge Forest Centre http://www.forestry.gov.uk/highlodge
- Tourist information at Brandon Country Park Visitor Centre, Bury Road, Brandon IP27 0SU - http://www.brandoncountrypark.org.uk/
- An account of the local gunflint industry: ‘On the manufacture of gun-flints, the methods of excavating for flint, the age of Palæolithic man, and the connexion between Neolithic art and the gun-flint trade’, by SBJ Skertchly (HMSO, 1879) – download a copy from https://archive.org/details/onmanufactureofg00skerrich/
A remote brick pit in the forest, and find-spot for a massive Palaeolithic handaxe

The site is on public access land and marked ‘Bromehill Cottage’ on Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (c.TL 805 890). Take special care at the A1065 if approaching the site from the west, as it is a fast, busy road.

A mile’s trek through Thetford Forest brings you to a remote place named Botany Bay. It is a Victorian brick-making site, and includes a wooded brickearth pit, a dilapidated kiln structure with scatters of broken bricks, and the forlorn remains of Bromehill Cottage. Apart from being a reminder of local industrial history, Botany Bay is also interesting as a historic site of Palaeolithic archaeological research.

Brickmaking
Scattered debris shows that both red and white bricks were made at Botany Bay. Iron-rich brickearth makes reds, while chalk-rich brickearth makes whites. There also strange, dark, vitrified bricks with a fused fabric showing evidence of intense heat, and some show evidence of distortion. Collapsed remains of the kiln suggest it had a rectangular design, and may have been of updraught Scotch type; these were difficult to regulate, and over-firing sometimes occurred.

Remains of the kiln.

A kiln waster. There are undistorted examples of vitrified bricks from Botany Bay in a wall beside the Forestry Office at Santon Downham.
The geology

Ice Age deposits of a sandy clay suitable for brick-making (i.e. a brickearth) were dug here in the 19th century. They were found in a hollow over 7 m (23 ft) deep; this may have formed through solution and collapse of the underlying chalk bedrock which lies close to the surface in this area. As the hollow deepened over thousands of years, sands, gravels and clays were washed into it, along with a variety of flint tools discarded on the local land surface.

Palaeoliths

Victorian workmen found Palaeolithic handaxes and scrapers in the brickearth. They belong to the Acheulian tradition, and were probably made some time between 280,000 and 420,000 years ago by Homo heidelbergensis (the ancestor of ourselves and the Neanderthals). Similar palaeoliths have been found in the Thetford and Brandon area, for example Broomhill (Trail site 5) and St Helen’s Well (Trail site 8), and it is likely that people found that the beds of high-quality flint exposed along the Little Ouse valley were ideal for tool-making.

Find Out More

- For local facilities, see the Forestry Commission website http://www.forestry.gov.uk/forestry/BEEH-A5UJDH/
- For more archaeological information about the site see Norfolk Heritage Explorer http://www.heritage.norfolk.gov.uk/record-details?MNF5695-Post-medieval-brick-kilns-gun-flint/
- Tourist information at Brandon Country Park Visitor Centre, Bury Road, Brandon IP27 0SU - http://www.brandoncountrypark.org.uk/
- Details about brick making in the English Heritage Teacher’s Kit - https://goo.gl/LIAcVv
Broomhill Pit is a wooded dell on the northern slopes of the Little Ouse valley. It is sometimes known as the Railway Pit. It began life as a gravel quarry dug to supply ballast when the nearby railway line was built in about 1845. Many flint handaxes were found here in the 19th century, making this site one of an important cluster of local Palaeolithic sites.

The geological story

The pit was once over 9 m (30 ft) deep. There is some geology visible today, particularly where trail bikers have made scars around its edge - these show chalky gravel. 19th century records state that the pit once reached as far down as chalk bedrock. A layer of gravel containing flint boulders lay above that, an outwash deposit of the Anglian glaciation, about 440,000 years old. A thick layer of chalky gravel was seen above this, perhaps deposited by the ancestral Little Ouse in one or more later cold periods.
**Palaeolithic tools**

Broomhill was one of the sites investigated by pioneering archaeologists JW Flower and JG Evans in the 1860s, when looking for evidence of the earliest human occupation of Britain. This site has yielded a rich assemblage of over 80 Palaeolithic handaxes; these were found in the chalky gravels, and are therefore older than this deposit. They are stained brown and most are in a water-worn, rolled condition, suggesting a period of river transport from an eroded site further up the valley. Many of them are of pointed type, similar to those found at other local sites. At an informed guess, they were made about 400,000 years ago, during the Hoxnian Interglacial period, probably by *Homo heidelbergensis*.

A handaxe from Broomhill, now in the Sedgwick Museum, Cambridge.

Image courtesy Sedgwick Museum of Earth Sciences, Cambridge, D.759

A handaxe of pointed type from Broomhill.

Find Out More

- For local facilities, see the Forestry Commission website [http://www.forestry.gov.uk/forestry/BEEH-A5UJDH](http://www.forestry.gov.uk/forestry/BEEH-A5UJDH)
- Local tourist information at Brandon Country Park Visitor Centre, Bury Road, Brandon IP27 0SU [http://www.brandoncountrypark.org.uk/](http://www.brandoncountrypark.org.uk/)
6 Grimes Graves, Weeting

Exploring a heritage of chalk and flint and a periglacial story of patterned ground

The site is managed by Historic England. It is marked on Ordnance Survey Explorer map no. 229 ‘Thetford Forest in The Brecks’ (grid ref TL 818 899), and signposted from the A1065 and A134. There is a Visitor Centre with museum displays and restroom facilities. Car parking charges apply when driving onto the site.

Grimes Graves is an attractive area of chalky grassland pockmarked with the evidence for over 430 prehistoric flint mine pits. It is one of the best places in Britain to see the links between geology and archaeology. The earliest pits were dug as vertical shafts in late Neolithic times, about 4,600 years ago, to reach rich seams of flint nodules. There are history displays in the visitor centre, and two of the mines are open to view.

The geological story

Grimes Graves is sited on Chalk bedrock of Turonian age, laid down about 90 million years ago in the Cretaceous period. Several flint-rich horizons occur in the Chalk at this level, and the thickest of them known as the Brandon Series. With some effort, miners could access the flint here and in other places in the Brecks where the Brandon Series lies close to the surface (in historic times this included Lingheath - see Trail site 2). The fact that the prehistoric miners knew where to dig suggests they may have had a practical understanding of the local geology. Each pit could yield up to 60 tons of flint.

When you visit the mines at Grimes Graves, take a look at the walls of the shaft as you descend the ladder. The uppermost layers of chalk are crumbly and look somewhat like cottage cheese; this is due to the effects of frost shattering during the Ice Age. The chalk lower down was not reached by the frost and is tough and blocky. It contains several flint layers. The best of these was the productive ‘floorstone’, lying over 9 m (30 ft) down at the bottom of the shaft; it was reached by outward-radiating galleries. There are also some thin ‘marl’ bands made of clayey material; these are the result of fellouts of volcanic ash in the Cretaceous ocean.
Ice Age stripes
Looking north-westwards across the shallow valley from Grimes Graves, you can see an area of periglacial patterned ground (sites A and B on the map; NB they are in the Danger Area; please stick to public access areas and the designated footpath for your own safety). Plants of sandy and chalky soils are growing side by side as ‘vegetation stripes’. These are the result of ice age processes over 10,000 years ago, when repeated freezing and thawing churned the subsoil into a contrasting sandy and chalky pattern, forming polygons on level ground and stripes on sloping ground. In this way, alternating stripes of chalk downland and acid heathland can be seen growing close together – a speciality of the Brecks landscape.

Local wildlife
The skull of a beaver was excavated from a pit fill in 1914; it may have been brought here from the Little Ouse valley. Quantities of red deer antler were also found at Grimes Graves, used as miners’ picks and hammers.

Find Out More
• The Historic England website for Grimes Graves
  http://www.english-heritage.org.uk/visit/places/grimes-graves-prehistoric-flint-mine/
• The Wikipedia page for Grimes Graves, including archaeological details
  https://en.wikipedia.org/wiki/Grime%27s_Graves
• For local facilities, see the Forestry Commission web pages for the Santon Downham area at
  http://www.forestry.gov.uk/forestry/EnglandEastAngliaNoForestThetfordForestParkSantonDownham
• Tourist information at Brandon Country Park Visitor Centre, Bury Road, Brandon IP27 0SU
  http://www.brandoncountrypark.org.uk/.
7 Lynford Water

Flooded gravel pits with a remarkable story of Neanderthals and mammoths

The site is public access land marked as ‘Gravel Pits’ on Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (c. TL 820 946). There is a free parking area signed ‘Lynford Water’. A set of interpretation panels explain the site’s wildlife and history.

Lynford Water is an area of flooded gravel pits in the Wissey valley now managed for recreation by the Forestry Commission, including an area of sandy beach. It is the closest the Brecks comes to having a seaside. 60,000 years ago it was a very different place, a chilly, open ‘mammoth steppe’ landscape with a very different wildlife and a population of Neanderthal humans. The evidence was found in an excavation here in 2002, at the eastern end of the site (see map site A).

The Wissey valley 60,000 years ago

The floor of the Wissey valley is underlain by sands and gravels deposited by meltwater torrents during the most recent ice age, the Devensian cold period. There are also organic-rich muds deposited in a channel of the ancient Wissey, and it was here that distinctive Neanderthal ‘bout coupé’ handaxes were found, associated with remains of at least 11 woolly mammoths. Although there is no definite evidence that humans killed the mammoths, it is possible that they scavenged the carcasses, removing limbs to be eaten elsewhere. Interestingly, a stone has been found that may have served for striking sparks to make fire. Such finds have made Lynford one of the most important Earth heritage sites in Britain.

Evidence for the Neanderthals (Homo neanderthalensis) is scattered around East Anglia in the form of flint tools of the Mousterian industry. No skeletal remains have ever been found in the region. Neanderthals seem to have evolved about 300,000 years ago from Homo heidelbergensis as a cold climate-adapted species of human; meanwhile our own ancestors were evolving in Africa.
The ‘mammoth steppe’
The muds also contained fossil remains of local plants and animals, adding to the picture of life on the Devensian ‘mammoth steppe’. Bison, reindeer and woolly rhinoceros browsed the tough herbage, preyed on by carnivores including wolf and hyaena. Small mammals included ground squirrel and tundra vole. Rushes and sedges abounded along the river bank, and there was a rich aquatic plant life, including stonewort and water buttercup. The landscape had very few trees.

Periglacial pingos
A feature of the Devensian landscape may be seen nearby on the edge of the floodplain. A group of wet hollows in the woods (map site B) are the remains of periglacial ground-ice depressions. These would have formed more than 10,000 years ago, where blisters or mounds of ice known as pingos developed in the subsoil over active springs. These frost mounds would have expanded in winter then melted in summer, eventually leaving the depressions we see today. For more information about their formation see the Trail site 18 Thompson Common.

Chalk Rock springs
Cretaceous Chalk forms the bedrock of the Brecks; it also stores ground water as the region’s most important aquifer. It used to supply Lynford Hall from a borehole (map site C). As well as containing layers of flint the Chalk has bands of harder rock, and these may often restrict the passage of water. A hard band called the Chalk Rock horizon outcrops at Lynford along both sides of the Wissey valley, and it produces springs and wet flushes in the landscape. It is likely to have fed the ground-ice depressions on the valley floor.

Find Out More
- The Lynford archaeological report on the Historic England website (20 Mb download).
- Wikipedia information about Neanderthals
  https://en.wikipedia.org/wiki/Neanderthal
- Forestry Commission web pages for Thetford Forest, including Lynford Stag and Arboretum
  http://www.forestry.gov.uk/forestry/BEEH-A5UJDH
- The Ancient Human Occupation of Britain project - https://goo.gl/jcaS1G
8 St Helen’s Well, Santon

Earth heritage in the Little Ouse valley, with chalk springs and river terraces

The site is on public access land and marked on Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (c.TL 840 874). It is best approached from the picnic areas at Two Mile Bottom (TL 848 877) or Santon (TL 826 874). Take special care on the A134, as it is a fast, busy road.

St Helen’s Well (Tanner’s Well) is a natural spring in the amphitheatre setting of an old chalk and flint pit. It is sited just east of the hamlet of Santon in the Little Ouse valley. Water rises here directly from the Chalk bedrock. The Mediaeval site of St Helen’s Church is an interesting historical feature close by.

Chalk in the landscape

The historic site of St Helen’s Well itself is gone, destroyed by the chalk pit, but it would have centred on a valley-side spring. The same water bubbles up here today as it did in Mediaeval times, where the slope of the valley side intercepts the local water table in the bedrock.

Chalk is the bedrock underlying the Brecks. It is about 90 million years old in the Santon area, and belongs to the Turonian Stage (first identified at Tours, in France). It was laid down in a subtropical sea in a ‘greenhouse’ world, with no ice at the poles – something to think about. The beds here are a similar horizon to those mined for flint at Grimes Graves.

A fossil Spondylus spinosus shell, typical of the local Chalk.
A Victorian chalk pit
The pit was dug for chalk and flint in the 19th century, and had an access canal for barges, which you can see entering the pit under the railway line. The chalk was transported away by river, and used to build roads, embankments and the nearby railway (opened 1845). Hard blocks of ‘clunch’ were used to build the columns in St Mary’s Church, Thetford, and doubtless other local buildings and walls. The flint was sold for building purposes and making gunflints.
Palaeolithic finds
Examples of Palaeolithic flint tools have been found in the gravels at St Helen’s Pit. As at other sites in the Little Ouse valley such as Broomhill (another Trail site), these are likely to have been incorporated into the gravels after being washed off a land surface where they had been discarded, or having been drawn into them by the churning effects of frost action.

River terraces
St Helen’s Church once stood just west of the chalk pit, and is marked by bumpy ground and an interpretation panel. The site gives fine views over the Little Ouse valley, including the remains of river terraces.

These are remnants of former floodplains, laid down during cold climatic periods when huge volumes of meltwater were seasonally available to shift sediment from exposed, barely vegetated land surfaces down into valleys.

Floodplains built up, but were later dissected by river downcutting, to leave isolated benches along the valley sides: these are the terraces.

Successive cold periods led to a ‘staircase’ of terraces in the Little Ouse valley, sides, each visible as spreads of sand and gravel with subtle breaks of slope between them. The British Geological Survey has identified a sequence of three here. Can you spot some of them in the terrain round Little Lodge Farm?

Find out more
- Local history displays at Brandon Heritage Centre
- For local facilities, see the Forestry Commission website
  [http://www.forestry.gov.uk/forestry/BEEH-A5UJDH](http://www.forestry.gov.uk/forestry/BEEH-A5UJDH)
- For more archaeological information see Norfolk Heritage Explorer
  [http://www.heritage.norfolk.gov.uk/record-details?MNF5684-Site-of-St-Helen%27s-Church-Santon](http://www.heritage.norfolk.gov.uk/record-details?MNF5684-Site-of-St-Helen%27s-Church-Santon)
- Local geology and archaeology displays at Ancient House Museum of Thetford Life
- Tourist information at Brandon Country Park Visitor Centre, Bury Road, Brandon IP27 0SU
Fascinating facets of Earth heritage to explore on this Brecks heath

Barnhamcross Common is a classic Brecks heathland that has been the focus of much ecological restoration work in recent years. The key to its wildlife value lies in three soil types found here - each linked with a story of landscape change. It is good place to see Ice Age patterned ground, where varieties of plant life can be linked to variations in subsoil geology. The Common is designated a Site of Special Scientific Interest, particularly for its plant life.

Vegetation stripes
Chalk lies near the surface on the higher ground of the Common, covered by a layer of windblown sand. This gives rise to calcareous sandy soils. During the last ice age, over 12,000 years ago, frost action churned the subsoil in periglacial conditions, separating it into contrasting bands of chalky and sandy soil on slopes. You can see these on some Google Earth aerial photos, particularly in the 2005 ‘historical imagery’ view. Today, plant life reflects these contrasts, best seen in May or June on open ground in the south-western part of the Common the area (see map site A). Another place to see these ‘Breckland stripes’ is at Thetford Heath, about 2.5 km (1.5 miles) away to the south-west (OS grid ref TL 844 797). These are best viewed from the road.
A river terrace
The land east of the A134 road has areas of sandy and gravelly soils (map site B). This is an area of river terrace, a former floodplain of the River Little Ouse laid down by meltwater torrents in the last cold period (the Devensian). It has been dug in many places for sand and gravel, leaving hummocky terrain and habitat suitable for plants of well-drained, acidic soils.

The Little Ouse has cut into the side of the terrace at the south-eastern end of the Common. You can see flint-rich gravels in this area, where human activity has made scars in the terrace surface.

A exposure of terrace gravels beside the river.
Wet fen
There is a marshy area with peaty soils at the southern end of the Common. It is part of the river's present-day floodplain. It was probably a permanent area of wet fen in past centuries, before the water levels in the valley were lowered by drainage improvements. Commoners are likely to have extracted peat here for fuel.

A wet area on the Little Ouse floodplain.

A dry valley
There is a shallow dry valley in the centre of the Common. It is underlain by permeable, sandy soils that cannot hold flowing water today, so how was the valley formed? Perhaps at a time when the ground was more solid, perhaps when frozen during the Ice Age, or when groundwater levels were much higher in the underlying chalk, and springs were more active.

A view over the dry valley.

Find out more
- Thetford's Great Heritage website, including tourist information - http://www.thetfordsgreat.org/
10 Knettishall Heath

‘Breckland stripes’ and the story of a vanished mighty river

The site is on public access land - see Ordnance Survey Explorer map no.230 ‘Diss & Harleston’ (grid ref c.TL 954 805). It is signposted from the A1066, and managed by the Suffolk Wildlife Trust with a ranger service, waymarked trails, car parks and restroom facilities.

Knettishall Heath is a tract of Brecks heathland on the edge of the Little Ouse valley. It is developed on a mosaic of chalky, sandy and peaty soils, which have influenced the variety of plant-life. It is a good place to see distinctive ‘Breckland stripes’ related to periglacial processes active in the subsoil during the last Ice Age. Two small pits have geological stories to tell stretching back over a half a million years.

**Ancient river deposits**

Most of the Heath is underlain by sandy and gravelly sediments of glacial origin, and support acidic heathland with heather and bracken. These sediments can be seen in two small pits in the middle part of the Heath, south-west of Hut Hill tumulus. Take a look at the eastern one (map site A): it has an abundance of tough, quartz-rich pebbles of brown and purplish-coloured quartzite, and also white vein quartz.

These distinctive pebbles originated in the Permo-Triassic Bunter Beds of the Midlands. They were brought here as bedload of the mighty Bytham River that flowed through the Brecks a half million years ago. It was destroyed when the Anglian ice sheet arrived, about 450,000 years ago.

An outcrop of current-bedded sands in the western pit.

**Glacial sands and gravels**

The other pit lies about 100 metres away to the west, at a slightly lower level. It has far fewer quartzose pebbles and is rich in flint. The sediments may be outwash sands and gravels from the Happisburgh glaciation, predating the Anglian. You can see sand beds probably laid down by a meltwater river, and also a clay-rich till deposited beneath the ice sheet. The mixed gravelly material lying on top is probably the result of sludging of superficial deposits down-slope during the last ice age. The outcrop of sand is peppered with small holes. These are most likely to have been made by the ground-nesting solitary bee species *Andrena*, which favours warm, dry environments.
Breckland stripes
Chalk bedrock comes close to the surface at the western end of the Heath; it is covered by a superficial layer of sand. This is the place to see ‘Breckland stripes’, where frost action in the last Ice Age churned the subsoil into alternating chalky and sandy patterned ground. Contrasting calcareous and acidic plant communities are growing here side by side on gently sloping ground south of the road. They are best seen in May and June (map site B).

A trench has recently been dug across some stripes, revealing the geological patterning in the subsoil. This can be seen at the western end of the Heath. Please do not disturb ground-nesting birds on surrounding land; it is important to keep dogs on a lead.

River terrace
The Little Ouse has a wide floodplain here, underlain by dark, peaty soils, the remains of former wet woodland and fen. It is flanked on either side by flat stretches of sandy land, e.g. the middle of the heath west of the main car park. This may be the remains of a river terrace, a former floodplain deposited during the last ice age when the river flowed at a higher level. Another interpretation sees it as the remnants of a former lake bed, formed when meltwaters backed up in the Little Ouse valley due to an ice sheet occupying the Fens.

Find out more
• The Suffolk Wildlife Trust’s web pages about the Heath http://www.suffolkwildlifetrust.org/knettishallheath
• The wildlife of the Heath explained in the SSSI document on Natural England’s website http://www.sssi.naturalengland.org.uk/citation/citation_photo/1002559.pdf
• Local geology and archaeology displays at Ancient House Museum of Thetford Life http://www.museums.norfolk.gov.uk/Visit_Us/Ancient_House/index.htm
• Evolution of the landscape of the Little Ouse valley is discussed in ‘From Brandon to Bungay’ by Prof RG West - see the Find Out More page below for further details.
11 Lackford Lakes

Old gravel pits with a story of life in the last ice age

The site is marked as ‘Lackford Wildfowl Nature Reserve’ on Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (grid ref c. TL 800 706). It is signposted from the A1101, and managed by the Suffolk Wildlife Trust, with a visitor centre and wildlife trails.

Lackford Lakes is a former sand and gravel quarry. It is now a Suffolk Wildlife Trust nature reserve with many waterside paths and bird watching hides. 40,000 years ago it was a very different environment. Palaeolithic flint tools and fossil remains of Ice Age wildlife have been recovered from the valley floor, giving insights into life during the last cold period, the Devensian. We hope this story will add an extra dimension to your visit.

Arctic fauna

The floor of the River Lark valley is wide here, and is underlain by thick layers of sand and gravel washed down the floodplain by seasonal meltwaters in cold conditions. Beetle fossils preserved in peaty deposits uncovered by quarrying include the tiny rove beetle *Boreaphilus henningianus*, found today in the mountains of Scandinavia and northernmost parts of Eurasia. There were also cold climate molluscs.

See the Suffolk Mammoth Trail panel for more wildlife information (map site A).
A scene in the Lark Valley about 40,000 years ago.

**Arctic visitors**
Greenshank, goldeneye and whooper swan are species that migrate to northern Europe to breed. They visit Lackford Lakes in winter, bringing on their wings a memory of places where the ice age still lingers. They may have bred here during at least some of the Devensian, when conditions were right, as the polar climatic front lay further south at this time.

**Neanderthal hunting ground**
Fossils of woolly mammoth, bison and red deer were found in the large pit (map site B). Plant remains indicate an open marshy environment, with a few Scots pine, spruce and alder trees. Mosses have been radiocarbon dated to about 29,000 years old. Palaeolithic flint tools are evidence that early humans hunted here, probably Neanderthals visiting in summer.

Find out more
- Suffolk Wildlife Trust's web pages about the Lackford Lakes reserve
  http://www.suffolkwildlifetrust.org/lackfordlakes/
- The reserve's wildlife explained in the SSSI document on Natural England's website
  http://www.sssi.naturalengland.org.uk/citation/citation_photo/2000068.pdf
- Local geology and archaeology displays at Mildenhall Museum
  http://mildenhallmuseum.co.uk/collections/prehistory/
- Local geology and archaeology displays at West Stow Visitor Centre
  https://www.weststow.org/west-stow/
Rampart Field is an area of heathland and scrub woodland including Town Pit, a disused gravel pit last worked in the 1950s. It has a special place in the history of science, as one of the first sites ever investigated for evidence for Palaeolithic human settlement in Britain. It is now part of the West Stow Heath Site of Special Scientific Interest (SSSI) designated for its wildlife value.

Great antiquity
Pioneering researchers Joseph Prestwich (geologist) and John Evans (archaeologist) visited here in 1860, looking for evidence that flint implements were definitely associated with extinct ‘antediluvian’ animals. A year earlier Darwin had published his ‘Origin of Species’, and the finds at Rampart Field would help demonstrate the great antiquity of humankind. Several artefacts were found, although mammal fossils proved frustratingly scarce, just elephant bones and a reindeer antler.

Evans featured an Acheulian-type handaxe from Town Pit in his book ‘Ancient Stone Implements of Gt Britain’ (1897). He noted that “The surface of the flint has been much altered in character, having become nearly white, and quite lustrous”.

Areas of gorse scrub occupy the former quarry, with contrasting areas of grassy heath developed on more calcareous soils. Seen here, meadow saxifrage Saxifraga granulata is making a fine show on disturbed ground, May 2015.
Geological research
Evans noticed that the gravel at Rampart Field was different from the glacial gravels found elsewhere in the Lark valley. Researchers have since re-investigated the site, trying to discover more about its geological history. In 1993 they found chalk rubble underlyng gravelly deposits containing a flint scraper tool. The gravels may have been deposited by meltwaters from an ice sheet occupying Fenland about 160,000 years ago during the Saalian glaciation. They contain a distinctive assemblage of quartz-rich pebbles that were brought to the area by a powerful but now-vanished river about ½ million years ago. Known as the Bytham River, it eroded and transported quartz and quartzite pebbles from 200 million year-old Permo-Triassic rocks in the Midlands.

Elements of a lost landscape: the Bytham and Pro-Thames rivers were destroyed by the advancing Anglian ice sheets, some 450,000 years ago.

A brown quartzite boulder near the northern boundary of the site is likely to be a glacial ‘erratic’, transported to the area by the Anglian ice sheet about 450,000 years ago. It is probably a form of silcrete, a silica cemented sandstone, thought to have come from the King’s Lynn area.

Find out more
• The wildlife explained in the SSSI document on Natural England’s website http://www.sssi.naturalengland.org.uk/citation/citation_photo/1001970.pdf
• Information about nearby West Stow Anglo-Saxon Village and Country Park https://www.weststow.org/west-stow
• Local geology and archaeology displays at Mildenhall Museum http://mildenhallmuseum.co.uk/collections/prehistory/
13 Beeches Pit, West Stow

A site with evidence for the earliest use of fire in Britain

The site is on public access land in the forest, marked on Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (c.TL 798 719). Please access the site from the Icknield Way Path by using the line of the field’s boundary hedge as your guide. It is surrounded by broad-leaved trees. Please do not disturb any of the geological features you see, as this is a site of ongoing scientific research.

Beeches Pit is an old brick pit with an interesting history. It is the site where evidence for the earliest use of fire in Britain has been found, along with Palaeolithic flint tools. It dates back some 400,000 years to the Hoxnian interglacial period. The site is a designated Site of Special Scientific Interest (SSSI) for this reason, and is the subject of geological and archaeological research by Liverpool University, among others.

The geological story
The geology and archaeology of Beeches Pit was first noticed by SBJ Skertchly in the 19th century. He saw about 3.7 m (12 ft) of “loams with carbonaceous seams” containing fossil shells, and he recorded flint tools and mammal bones. Researchers in the 1970s investigated an outcrop of tufa, a chalky sediment deposited around springs. It contained a remarkable assemblage of fossil molluscs that was typical of the Hoxnian warm period that followed the Anglian ice age.

Further investigations in the 1990s showed that there was a water body here, with swampy areas where yellowish-brown clays and dark organic-rich muds were deposited, and also the springs giving rise to the tufa deposits. Local wildlife included bison, deer, rhinoceros, frog and vole.

Dipping organic silty clay beds of Hoxnian age. It is likely that they are dipping because the underlying chalk beds have collapsed due to the formation of a doline or solution hollow.

The quest for fire
The excavations provided fascinating detail about early human occupation at this site during the Hoxnian. They found evidence that people came here on repeated occasions to camp. Dark, carbon-rich patches indicated hearth sites at several levels in the geological sequence – the earliest evidence for fire use in Britain. Knapped flint tools of the Acheulian industry were scattered around these patches, some showing signs of burning. Some cores and flakes could be refitted together, showing that knapping took place on site.
Beeches Pit is a valuable window into the world of our ancestors, probably *Homo heidelbergensis*, an ancestor of ourselves and the Neanderthals.

Find out more

- A research paper summarising the archaeology of Beeches Pit
- A Forestry Commission web page for the West Stow area
  [http://www.forestry.gov.uk/forestry/england/eastanglia/forest/foresthetford/forestpark/weststow](http://www.forestry.gov.uk/forestry/england/eastanglia/forest/foresthetford/forestpark/weststow)
- An overview of the geology and local wildlife in the SSSI document on Natural England’s website
- Information about nearby West Stow Anglo-Saxon Village and Country Park, including local geology and archaeology displays
  [https://www.weststow.org/west-stow](https://www.weststow.org/west-stow)
- Local geology and archaeology displays at Mildenhall Museum:
  [http://mildenhallmuseum.co.uk/collections/prehistory/](http://mildenhallmuseum.co.uk/collections/prehistory/)
All Saints Church, Wordwell

A church with Norman stone carvings and a variety of local and exotic stone types

The church is marked on Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (grid ref TL 828 720). It is kept open April–October, otherwise the key is locally available - call 01223 324442 to arrange access. Please note parking is severely limited beside the B1106 – it is safest to pull up onto the verge, or park elsewhere and walk along local footpaths.

All Saints is a redundant church which is a treasure trove of geological and archaeological features. It dates back to about 1100, and was partly remodelled in the mid 19th century after a period of dilapidation. Inside, its imaginative Romanesque stone carvings are very special and well worth seeing. Outside, the walls contain an interesting variety of geological materials.

Upon this rock

The panels above the north and south doors have spectacular carvings of mythic scenes. They are made from Jurassic oolitic limestone imported from quarries in the East Midlands such as Barnack (near Peterborough) and Ketton (Rutland), presumably carried by boat along Fenland waterways and up the River Lark. The Norman chancel arch was also made of this material. Finer-grained Caen limestone was used for the mid 19th century pulpit and reredos in High Gothic style.

The sculpted tympanum over the south door.

Mid-Victorian use of Caen stone.

A sponge fossil Exanthesis flexuosa in flint.

Fossil-rich oolitic limestone in a window sill.
The north wall is a good example of Norman rubble building work, in typical horizontal courses. The majority of the stone is locally-sourced flint with a white skin or cortex, as found when fresh from its native chalk, but you can also see a variety of exotic stone types, whether ‘erratics’ transported to this area by natural forces (rivers, ice sheets) or rocks imported by human activity – or a combination of both. They are all bound together with lime mortar made from chalk ‘burnt’ in local kilns. As an inspection of grave mounds in the churchyard will show, chalk bedrock lies close to the surface here. In the 19th century, a chalk pit and kiln were located only a few hundred yards away to the south-east, at Limekiln Plantation (see map).

Exotic rock
Examples of non-local rocks used in the building fabric include
- Purple and brown Bunter quartzite, originally from the Midlands;
- Lumps of chalk clunch, probably from Burwell in Cambridgeshire;
- Jurassic limestones and mudstones from the East Midlands;
- Lava imported from Niedermendig in the Rhineland;
- The volcanic rock andesite, perhaps from Scotland or North Wales.

The west end and bell-cote were remodelled in Victorian Gothic style by the architect S.S. Teulon in 1868. His choice of rounded flint cobbles contrasts with the rougher flint rubble used in the rest of the church.

Find out more
- Information about the Romanesque carvings
  http://www.crsbi.ac.uk/site/369/
- Historical information on the Suffolk Churches website
  http://www.suffolkchurches.co.uk/wordwell.htm
- All Saints’ is managed by the Churches Conservation Trust
  https://www.visitchurches.org.uk/visit/church-listing/all-saints-wordwell.html
Maidscross Hill is a heathland area with old chalk and gravel workings. It is a Local Nature Reserve and SSSI designated for its wildlife value, particularly plant life. The patches of chalky and sandy topsoil are habitat for an interesting range of Breckland species, some rare. The site gives views over RAF Lakenheath airfield and the western Brecks landscape.

The site is public access land marked on Ordnance Survey Explorer map no.228 ‘March & Ely’ (grid ref TL 726 825). The car park is at the far end of Cemetery Road. There are public information panels about Brecks heritage and links between soils and wildlife.

Shifting gravels
Layers of sand and gravel cover the chalk. They are part of a complex geological story. As well as local flint, they contain pebbles of quartz and Bunter quartzite, originally brought to East Anglia from the Midlands by the now-vanished Bytham River, which passed through here over ½ million years ago. The course of the river was destroyed by the advancing Anglian ice sheet when it occupied the Fenland basin about 450,000 years ago. Some remaining patches of river gravels were later reworked by meltwater rivers draining another ice sheet that entered the Fenland basin about 160,000 years ago during the Saalian glaciation, and were deposited at Maidscross Hill as part of a delta. Geological structures indicate that the water flowed towards the south-east.

Chalk rubble lies close to the surface, particularly near the top of the hill. It can sometimes be seen here in the sides of freshly-cut ditches and trenches. Periglacial frost action in the subsoil during the last ice age churned the chalk/sand interface into interesting patterns.

The geological story
The hill is founded on an upstanding mass of Cretaceous chalk. It is a glacially-eroded bit of the chalk scarp landscape which stretches from north Norfolk down to the Chilterns and beyond.

Chalk rubble lies close to the surface, particularly near the top of the hill. It can sometimes be seen here in the sides of freshly-cut ditches and trenches. Periglacial frost action in the subsoil during the last ice age churned the chalk/sand interface into interesting patterns.

Flint and quartzite pebbles brought to the surface by rabbits.

A vanished landscape – the conjectured course of the Bytham River about 500,000 years ago. It passed through a gap in the chalk hills south of Lakenheath before continuing to the North Sea.
Brecks heathland plants thrive on the open disturbed ground.

**Links with wildlife**

The soils of Maidscross Hill are sandy, with much chalk rubble close to the surface. This gives rise to an interesting variety of plants of both calcareous and acidic heathland, with rarities including sand catchfly *Silene conica*, sickle medick *Medicago falcata* and Breckland thyme *Thymus serpyllum*.

The site is also noted for its ground beetles (carabids). Several rare species typical of dry, open, disturbed ground have been found in the gravel pit at the bottom of the hill.

Biting stonecrop *Sedum acre*, an attractive plant of thin, dry soils.

A local wall recaps the geological story on Maidscross Hill. Seen here at the gateway to Lakenheath Hall (grid ref TL 714 835), brown Bunter quartzite pebbles are overlying blocks of chalk clunch.

**Dunes**

Maidscross Hill gives panoramic views over RAF Lakenheath airfield. A century ago it was a great rabbit warren developed on an open expanse of sandy heathland. The surface layers were wind-blown coversand, in places forming semi-mobile dunes. A few similar dunes survive at nearby Wangford Warren, although the site is not open to visitors.

Find out more

- Local geology and archaeology displays at Mildenhall Museum [http://mildenhallmuseum.co.uk/](http://mildenhallmuseum.co.uk/)
- Tourist information at Brandon Country Park Visitor Centre, Bury Road, Brandon IP27 0SU [http://www.brandoncountrypark.org.uk/](http://www.brandoncountrypark.org.uk/)
The Devil’s Punchbowl, Croxton

A classic ‘Breckland mere’ formed over a chalk solution hole

The site is marked on Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (grid ref c. TL 878 892). There is a car park near the road. The Punchbowl is on private land but is viewable from the public footpath. Ringmere and Langmere (part of the Norfolk Wildlife Trust’s East Wretham Heath reserve) are also worth visiting, some 3 km (2 miles) to the east.

The Punchbowl may look like a meteorite impact crater but it originated as a depression formed by dissolution of Chalk bedrock over thousands of years. The water levels in it are linked to the rise and fall of groundwater. It is one of a local group of ‘Breckland meres’, including nearby Ringmere and Langmere, all designated Sites of Special Scientific Interest (SSSI).

Doline development

Chalk bedrock acts as an aquifer, holding massive amounts of groundwater. Chalk is prone to dissolve, particularly in cold climatic periods, so underground cavities may develop and later collapse. These may lead to the appearance of solution holes and depressions (dolines) at the surface. This process is explained on a site panel on the western lip of the Punchbowl. The British Geological Survey map 174 (Thetford) shows a cluster of dolines in this part of the Brecks; this is likely to be the result of local fissuring patterns in the bedrock.
Aquifer activity
Water levels in the Devil's Punchbowl go up and down with the seasons, and often cheat expectations – surprisingly full in summer or unexpectedly dry in winter. The water is linked to levels in the Chalk aquifer; it may be recharged by winter rain, but take several months to trickle through to fill the basin. Have a look at nearby Fowlmere (see map): sometimes there are marked differences in water level between the two lakes, showing that they have separate hydrological systems.

The complex of glacial deposits overlying the chalk is likely to influence groundwater flow at the Punchbowl. Clay layers will prevent the passage of water, while sands and gravels will act as conduits or reservoirs. Sand-filled solution pipes extending down into the chalk will also act as conduits.

Find out more
- Information about the Stanford Training Area SSSI, which includes the Punchbowl:
  http://www.sssi.naturalengland.org.uk/citation/citation_photo/1000005.pdf
- See other ‘Breckland meres’ at the Norfolk Wildlife Trust’s East Wretham Heath nature reserve:
- The Forestry Commission web page for Thetford Forest:
  http://www.forestry.gov.uk/thetfordforestpark
- Local geology and archaeology displays at Ancient House Museum of Thetford Life:
  http://www.museums.norfolk.gov.uk/Visit_Us/Ancient_House/index.htm
17 Cranberry Rough, Hockham

Lake muds tell a 10,000 year-old story of environmental change

The southern half of Cranberry Rough is public access land - see Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (grid ref c. TL 933 937). However please do not enter the site in the bird breeding season. You can visit by walking along the old railway track. Do not stray off the footpath: much of the site is dangerous swamp. There are two interpretation panels beside the track. Another footpath approaches the south-eastern end of the site, starting from Puddledock at Hockham.

Cranberry Rough is one of the wildest parts of Norfolk. Its alder carr swamp has a primaeval feeling.

A late Devensian lake

Hockham Mere was the largest of the ‘Breckland meres’ which include Fowlmere and Langmere; they formed over 10,000 years ago, probably by dissolution and collapse of the underlying chalk bedrock. Boreholes have shown that the lowest layer of sediment is sand and silt, washed or blown in off bare land surfaces at the end of the last ice age (the Devensian period). Since then the basin has been filled with over 9 m (29 ft) of mud, with a layer of recent peat on top.

In the 1940s, Cranberry Rough was the site of pioneering investigations into fossil pollen preserved in the mud. Researchers were able to analyse a record to plant life stretching back to the Devensian. First of all, there was patchy silver birch and Scots pine forest surrounding the lake. Thick forests of hazel, oak, alder and elm grew as the climate warmed up. The lake muds were rich in water plants such as bogbean and holly-leaved naiad.

Diagram showing pollen concentrations between 2,000 and 10,000 years ago.

Cranberry Rough is mostly a wilderness area of swamp and carr woodland; the remainder is damp meadows. In Tudor times, it was a large lake called Hockham Mere, fed by springs at its western end and deepest at its eastern end. It was drained over the next two centuries, and eventually turned into the swampy land we see today. It is a designated Site of Special Scientific Interest (SSSI) for its wildlife, and has recently seen much scrub clearance work in its southern area.

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In the 1940s, Cranberry Rough was the site of pioneering investigations into fossil pollen preserved in the mud. Researchers were able to analyse a record to plant life stretching back to the Devensian. First of all, there was patchy silver birch and Scots pine forest surrounding the lake. Thick forests of hazel, oak, alder and elm grew as the climate warmed up. The lake muds were rich in water plants such as bogbean and holly-leaved naiad.

Diagram showing pollen concentrations between 2,000 and 10,000 years ago.

Cranberry Rough is mostly a wilderness area of swamp and carr woodland; the remainder is damp meadows. In Tudor times, it was a large lake called Hockham Mere, fed by springs at its western end and deepest at its eastern end. It was drained over the next two centuries, and eventually turned into the swampy land we see today. It is a designated Site of Special Scientific Interest (SSSI) for its wildlife, and has recently seen much scrub clearance work in its southern area.

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Peat bog and fen-carr

Old maps show that Hockham Mere had dried up by the mid 18th century, thanks to a network of drainage ditches. Parts of the western end had become an acidic peat bog, with sphagnum moss, hare's-tail cotton-grass, royal fern and cranberry. Sedge peat followed by fen-carr peat had developed in other areas – this is what is being deposited here today.

Sphagnum and cranberry in core samples are evidence for the presence of acidic peat bog in recent centuries. Cranberry was last recorded here in the 1980s, but is believed to have since died out. Image courtesy Beverly Curl

Recently restored wetlands and grazing meadows.

Find out more
- Explore the Cranberry Rough area – Forestry Commission information and map http://www.forestry.gov.uk/forestry/infd-6eyev4
- The Forestry Commission web page for Thetford Forest http://www.forestry.gov.uk/thetfordforestpark

A peopled landscape

Local finds of flint tools (blades, scrapers, microliths and axes) show that the Mere attracted human settlement in Mesolithic times. Layers of charcoal particles have been found in the sediment, and there are evidence for camp fires or local episodes of forest burning; they have been dated using the radiocarbon technique. A rise in grass pollen shows that clearings in the forest had certainly been made by Neolithic farmers about 5,000 years ago. The local economy seems to have been a pastoral one until cereals began to be cultivated more extensively in the late Iron Age and Roman periods, about 2,000 years ago. Some of the Breckland heaths are thought to have been formed by this time.

Two interpretive panels explain the site's heritage. They are located beside the old railway line.

Image courtesy Beverly Curl
Ancient periglacial ponds with a beetle species surviving from the last ice age

Thompson Common is marked on Ordnance Survey Explorer map no.229 ‘Thetford Forest in The Brecks’ (grid ref c. TL 934 958). However it is private land, and is only accessible by designated footpath (map site A). The ponds on Stow Bedon Common can be seen from the disused railway line footpath (map site B). There is a handy car park just off the A1075 at TL 940 966 (see map).

Thompson Common is a classic site for seeing periglacial ground-ice depressions over 10,000 years old. These form a cluster of natural ponds on the Common dating back to the last ice age. Because the physical landscape here has been unchanged for so long it also has provided extraordinary habitat continuity for wildlife. The site is designated a Site of Special Scientific Interest (SSSI).

The Great Eastern Pingo Trail

This is a walking trail starting at the car park near Thompson Common. It heads SSW along the old Great Eastern Railway line as far as Hockham Heath. It then turns NNW up Peddars Way towards Thompson Water, then back home via Thompson Common. It covers 8 miles (12.9 km), and passes through many interesting facets of the Brecks landscape, including Stow Bedon Common (see map site B) and Cranberry Rough. For more information see ‘Find out more’ below.
Ice age beetles

The ponds at Thompson Common have a rich biodiversity, and are unusual for containing many rare and notable species. Some beetle species, for example *Hydroporus glabriusculus*, are more typically found in Scandinavia, suggesting they may be a relict population dating back to the last ice age. If so, the Common may have continuously provided their habitat for over 10,000 years!

Frost mounds

The ponds formed where blisters of ice developed in the subsoil in periglacial conditions. These frost mounds expanded in winter then collapsed in summer, gradually widening. It is difficult to classify these ancient landforms. They may be relict lithalsas, where ice lenses formed from water bodies in gravelly subsoil, or perhaps pingos of ‘closed system’ type, which are formed by pressure of water trapped under frozen ground; some may be palsas, formed by ice that developed in blanket peat.

Find out more

- The Norfolk Wildlife Trust’s web page about Thompson Common, including information about parking and access http://www.norfolkwildlifetrust.org.uk/wildlife-in-norfolk/nature-reserves/reserves/thompson/
- You can see more periglacial ponds at other publicly-accessible sites in the Brecks, including Foulden Common [OS grid ref TF 765 005; 52.5712 0.5997], Hockham Frost’s Common [TL 945 935; 52.4638 0.7632] and Hockham Hills & Holes [TL960911; 52.4754 0.8846].
The Brecks has many Earth heritage features besides the 18 listed in this book, which were chosen from inside the ‘Breaking New Ground’ project area. Here are a few more publicly-accessible examples from within or just outside the area. The Ordnance Survey maps referred to are listed at the bottom of the page.

**Aspal Close, Beck Row**  
[Grid ref TL 700 775 - OS map 226]  
Well-preserved periglacial hillocks and hollows. This type of hummocky ground is well developed along the Fenland edge, where blisters of ground ice developed in gravelly sand overlying saturated chalk during the last ice age. The site is a Local Nature Reserve and County Wildlife Site.

**Cavenham Heath**  
[Grid ref TL 755 725 - OS map 226]  
Classic Brecks sandy heath, developed on an expanse of sands and gravels. Mapped by the British Geological Survey as a spread of two ice age river terraces, but may also be the dissected bed of a meltwater lake developed when glacier ice occupied the Fenland basin about 160,000 years ago. A SSSI designated for its heathland wildlife.

**Foulden Common**  
[Grid ref TF 001 760 - OS maps 229 & 236]  
A cluster of ramparted ground-ice depressions, likely to have formed as pingo under periglacial conditions during the last ice age. The site is a SSSI.

**The Hockham Stone**  
[Grid ref TL 953 926 - OS map 237]  
A glacially-transported erratic boulder of Spilsby Sandstone (Cretaceous) originated in Lincolnshire. It is ritually turned over to mark notable events in the life of the parish. It has been designated a County Geodiversity Site.

**Icklingham Plains**  
[Grid ref TL 757 735 - OS maps 226 & 229]  
Rare examples of inland dunes formed from wind-blown coversand. The sand originated during the last ice age, and was then remobilised in more recent centuries. The site is linked with Cavenham Heath SSSI.

**St Lawrence’s Church, Lackford**  
[Grid ref TL 798 703 - OS map 229]  
Various locally-sourced stone types have gone into building this 14th century church, including Bunter quartzites. The interior has spectacular arcading sculpted from Burwell Rock, a fine but tough chalk ‘clunch’ from Cambridgeshire.

**Market Weston Fen**  
[Grid ref TL 983 787 - OS map 230]  
A valley fen nature reserve with several attractive periglacial ground-ice depressions. They formed over a series of springs fed by chalk-rich groundwater. The site is a SSSI.

**Mildenhall High Lodge**  
[Grid ref TL 738 754 - OS map 226]  
A former brick pit and famous site of Palaeolithic investigations since Victorian times. Flint tools were found in clayey silts washed into a chalk solution hollow underlain by glacial till. The sequence is overlain by Saalian glacial outwash gravels dated about 160,000 years old. The site is a geological SSSI.

**River Blackwater, Saham Toney**  
[Grid ref TF 888 004 - OS map 237]  
Gravels beneath floodplain alluvium have yielded two fine Neanderthal handaxes in river dredging spoil. NB the site is only viewable from Church Lane.

**List of OS Explorer 1:25,000 scale maps**

- 226 Ely & Newmarket, Mildenhall and Soham
- 229 Thetford Forest in the Brecks
- 230 Diss & Harleston, East Harling & Stanton
- 236 King’s Lynn, Downham Market & Swaffham
- 237 Norwich, Wymondham, Attleborough & Watton
Local groups
Breckland Society http://www.brecsoc.org.uk
Geological Society of Norfolk http://www.norfolkgeology.co.uk/
GeoSuffolk http://www.geosuffolk.co.uk/index.php/breckland

British Geological Survey maps
Bury St Edmunds https://goo.gl/e1k4gf
Thetford https://goo.gl/GR5aOb

Museums
Ancient House Museum of Thetford Life https://goo.gl/Pef34i
Brandon Heritage Centre https://goo.gl/VFd5u0
Mildenhall Museum https://goo.gl/4fTaym
Swaffham Museum http://www.swaffhammuseum.co.uk/

Archaeological heritage information
Norfolk Heritage Explorer https://goo.gl/qQS5iz
Suffolk Heritage Gateway https://goo.gl/DeubLL

Books
‘Flint in the Brecks’ by A Mason & J Parry (Breckland Society, 2016) - download from https://goo.gl/UrhhCw
‘On the manufacture of gun-flints’ by SBJ Skertchly (London, 1879) – download from https://goo.gl/o12OHz

About Breaking New Ground
In March 2014 the Heritage Lottery Fund awarded nearly £1.5 million to the Breaking New Ground Landscape Partnership. This enabled a £2.2 million scheme to deliver a range of heritage and landscape projects in the Brecks (aka Breckland) natural area of Norfolk and Suffolk, between 2015 and 2017, within a target area focused around the market towns of Thetford and Brandon. There have been 37 projects covering four themes:

- A Home to Many - working to improve areas for the benefit of wildlife, so special species can continue to thrive.
- A Window to the Past - linking communities to the area’s rich history and heritage, by bringing the stories of the past to life and making new discoveries.
- A Place to Explore - improving access to The Brecks, both physical and digital, in a number of exciting ways.
- A Future for All - raising knowledge, understanding and appreciation of the Brecks through education & skills training.

For more information about Breaking New Ground, see http://www.breakingnewground.org.uk/what-is-bng-2/.

Front cover credits
Images on front cover: Mammoth steppe courtesy Beverly Curl; Lynford handaxe courtesy John Lord; Brandon Gravel Hill handaxe from J Evans 1897; chalk diagram from SBJ Skertchly 1879. Other images courtesy T. Holt-Wilson.

Publication details

Norfolk Geodiversity Partnership - https://sites.google.com/site/norfolkgeodiversity/
The NGP is a forum for individuals and organisations interested in conserving and enhancing Norfolk’s Earth heritage.
The Brecks area has a fascinating Earth heritage. Its rocks, soils, sediments and landforms tell a story of environmental change over many thousands of years. They provide vital evidence for ancient wildlife and some of the earliest human settlement in Britain. The natural forces of wind, ice and water have all played a role in shaping the physical and cultural landscape of the Brecks we see today.

The Brecks Earth Heritage Trail will introduce you to 18 points of interest chosen for their publicly accessible geodiversity. You can visit them in any order. They range in time from the Cretaceous period to the 20th century, taking in quarries and flint mines; doline lakes and periglacial ponds; bricks and building stones - there is even a bit of Earth heritage art!

You can use this publication as a field guide. It includes simple maps and other resources for discovery. It is backed up by a smartphone app, a leaflet and web pages available from Breaking New Ground - http://www.breakingnewground.org.uk/.