

London and the Thames Valley - Geology

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[Jump to navigation](#) [Jump to search](#)

Recent surface deposits

Throughout the region, there are widespread but rather patchy surface deposits of relatively recent origin, formed over the past 2 to 3 million years and spanning the Ice Ages and Interglacial periods. These are known as superficial deposits, the most common of which were laid down by rivers, or in coastal areas, with some in the north-east of the region left behind by former ice-sheets. These superficial deposits mainly comprise gravels, sands, clays and peat layers which are soft and easily eroded as they have not been deeply buried and consolidated to form strong rocks. The most extensive are along the River Thames and its tributaries, these are commonly dug for sand and gravel. The thickness of these superficial deposits is generally less than 10 m and only locally exceeds 25 m.

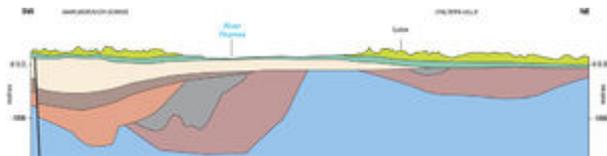
Geology at depth

Beneath the superficial deposits, or with just a cover of soil where such deposits are absent, are older rocks which geologists broadly split into two distinct types:

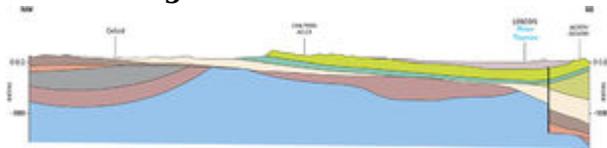
- The sedimentary bedrock geology is composed of quite hard rocks which were originally deposited a few hundred to tens of millions of years ago as layers of sediments in shallow seas, deserts and vast river systems in times when Britain lay closer to the Equator and the climate and landscape were very different from those of today.
- The basement geology, which underlies the bedrock, is over 360 million years old and mainly comprises harder, denser rocks which have been strongly compacted and folded. They include both rocks originally deposited as sediments and others that are products of volcanic activity or formed from the solidification of molten rock below ancient volcanoes.

In the course of the past 500 million years there have been periods when the area of the UK formed a landmass and was being eroded, and other periods when it was sinking and new layers of sediment were being deposited. The history of erosion and deposition has not been the same in all parts of the UK. In the London and Thames Valley region the oldest sedimentary bedrock layers are similar to rocks occurring at the surface in parts of northern England, and seen underground in the Kent coalfield. They include limestones, sandstones and shales, and were buried and deformed by the forces of continental plates moving against each other. They are referred to here as the older sedimentary bedrock.

Subsequently, a younger sequence of sedimentary rocks, including limestones, sandstones and clays, was laid down and are known as the younger sedimentary bedrock. These include Jurassic rocks, comparable to those seen along the coast of Dorset and north Yorkshire, and in southern parts of the area sediments were continuously deposited, including the widespread Chalk. Under London, however, deposition stopped and instead uplift and erosion took place for hundreds of millions of years. Deposition restarted when the sea flooded the landscape and Gault Clay and then the Chalk were laid down on a variety of older sedimentary bedrock and basement rocks. This situation where younger rocks rest directly on rocks of different older ages because of uplift and erosion is referred to by geologists as an unconformity.

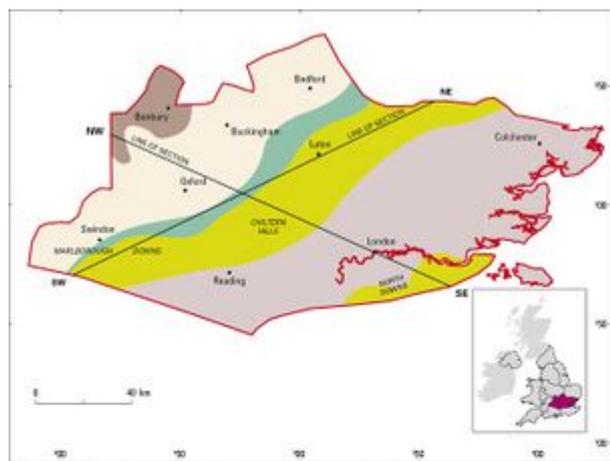


Schematic cross-section of the geology underlying London and the Thames Valley. The alignment of this section and key are shown in **Figure P902272**. P902271



Schematic cross-sections of the geology underlying London and the Thames Valley. The alignment of this section and key are shown in **Figure P902272**.

In some places in the south and west of the region, the younger sedimentary bedrock extends to more than 1 km depth. However, in most of the region the older sedimentary bedrock and basement rocks occur within 500 m of the surface, and lie as shallow as 150 m in some north-eastern parts. **Figures P902271** and **P902250** are vertical sections through the geology, referred to as geological cross-sections, and illustrate these variations.



Age (My)	Map/Section Descriptor	Geological sub-units	Text sub-units	Text Descriptor
50-65	Palaeogene Sediments	Bracklesham Group London Clay Lambeth Group and Thanet Formation	Low permeability clay. Varied sediments	Younger Sedimentary Bedrock
80-145	Upper Cretaceous Sediments	Chalk Group	White Limestone a major aquifer	
Lower Cretaceous Sediments	Upper Greensand, Gault Clay and Lower Greensand Wealden Group	Low permeability clay and Sandstone aquifer Sandstones interlayered with low permeability clays		
145-200	Middle - Upper Jurassic Sediments	Portland and Purbeck Groups, Kimmeridge and Arundell clays, Corallian Group, Oxford Clay and Oolite groups	Shelly limestone aquifers and low permeability clays	Older Sedimentary Bedrock
Lower Jurassic Sediments	Lias Group	Red desert mudstones and sandstone		
200-250	Triassic Sediments	Mercia Mudstone Group Sherwood Sandstone Group	Sandstones and mudstones, minor coals Grey Limestone aquifer	Basement Rocks
310-350	Carboniferous Rocks	Coal Measures Carboniferous Limestone		
390-420	Devonian Rocks			
420-600	Lower Palaeozoic Rocks			

Geological sketch map showing the range and distribution of different rock types in the London and Thames Valley region, in relation to major towns and cities. The extent of London and Thames Valley region is identified on the inset map of the United Kingdom. P902272

The younger sedimentary bedrock occurs at the surface and dictates the broad variations in geography and land use across the region. It is composed of varied rocks formed from about 50 to 250 million years ago, mainly as sediment layers in shallow seas or on extensive coastal plains. While harder and more consolidated than the superficial deposits, many of the younger sedimentary bedrock are quite soft and easily eroded. The youngest, uppermost layers occur in the centre of the London Basin and are dominated by clays. The Chalk, which forms the surrounding Chiltern Hills, the North Downs and the downlands of Berkshire, north Hampshire and Wiltshire, also extends at depth beneath the London Basin forming a down-folded, basin-like form that geologists call a syncline (see **Figure P902250**). In the Upper Thames Valley, the younger sedimentary layers are tilted gently towards the south-east, descending beneath the Chalk. Progressively older rocks occur at the surface towards the north-west.

The older sedimentary bedrock is preserved in troughs or basins resting on the even older basement rocks and concealed beneath the younger sedimentary bedrock. Elsewhere, basement rocks lie directly below the younger sedimentary bedrock because the older sedimentary rocks had been eroded away before the younger sedimentary rocks were laid down.

There is significant regional variation in the nature and thickness of the younger sedimentary bedrock, which is now described for each of the three geographical divisions of the region. The structure and composition of the older sedimentary bedrock and basement also varies across the region but in a different pattern, so it is described separately for the region as a whole.

Younger sedimentary bedrock

London Basin

The London Basin is a low-lying relatively flat area extending from Berkshire and northern Hampshire eastwards through northern Surrey, Greater London and Essex. The younger sedimentary bedrock layers of the London Basin (Palaeogene sediments) are mainly composed of clay, with some sand and localised layers of gravel. The sequence is dominated by the London Clay, which is up to 150 m thick in the Greater London area. Beneath the London Clay, there are patchy layers of sands, clays and gravels (Lambeth Group and Thanet Formation). These are as much as 40 m thick in Essex but reduce westwards to as little as 20 m in western Berkshire. Where the London Basin is deepest, particularly in the area of the Surrey heathlands west of London, the London Clay is covered by younger layers of sands, silts and clays (Bracklesham Group), which are up to 140 m thick. Commonly, water can percolate between the grains of the sand and gravel deposits in sufficient quantity to be useful as a local drinking water supply. Deposits like this are known as aquifers. The Chalk and Gault Clay are about 300 m thick and underlie the whole basin resting directly on basement rocks of the London Platform.

The Chalk Downlands

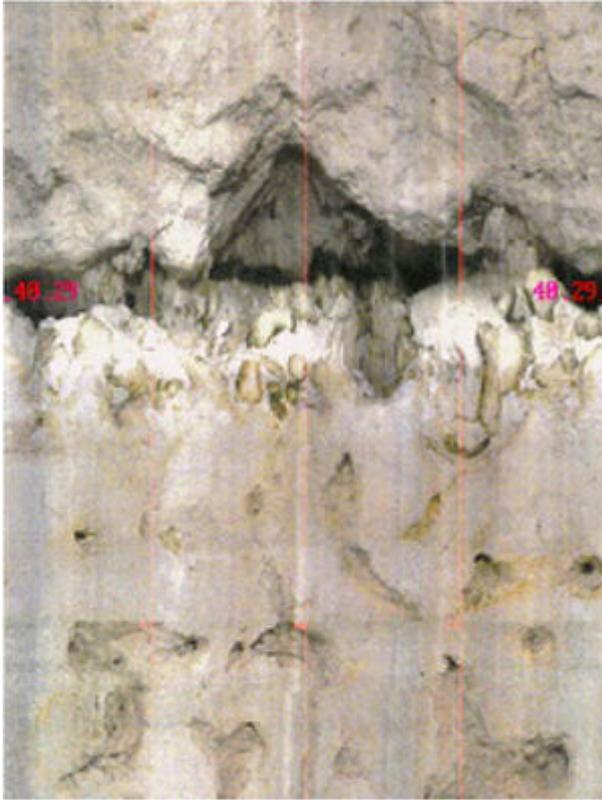


Chalk quarries in the face of the North Downs, near Dorking, Surrey. P209845.

The London Basin is surrounded to the south by the North Downs of Surrey and west Kent (**Plate P209845**), extending westwards into the downlands of northern Hampshire, and to the north by the Chiltern Hills and the Berkshire Downs, extending westwards into the Marlborough Downs of Wiltshire. All these areas of downland are formed by the Chalk, which is a very fine-grained white or pale grey limestone. The Chalk often contains nodules of flint, a very hard form of silica.



Chalk with flints beneath Palaeogene sediments, in a road cutting near Newbury. P535262.



Water-filled fissures and pores dissolved in the Chalk, seen in a borehole, Height of image about 50 cm. P902287.

As mentioned above the Chalk (**Plate P535262**) forms a continuous layer beneath the London Basin. It extends to depths of as much as 500 m in west Surrey and is typically about 200 m thick, although it reaches 275 m in east Essex.

The Chalk is the most important aquifer, or source of underground water, in southern England. Most of the water flow in the Chalk is not through the pore spaces between the grains of the rock but along fine fractures within it (**Plate P902287**). These fractures are both horizontal and vertical and connect together to make pathways for water to flow through. Because the Chalk is composed of calcium carbonate which can be slowly dissolved by groundwater, the fractures become wider over long periods of time leading to the quite rapid flow of water through some parts of the Chalk. Where the Chalk is covered by the younger sedimentary layers of the London Basin the thick clays form a barrier to the movement of groundwater, preventing both the upwards movement of water out of the Chalk and downwards percolation into the Chalk.

The Upper Thames Valley

The River Thames crosses the Chalk Downlands through the Goring Gap south of Oxford. To the north-west the Upper Thames valley and its tributaries drain a broad area of clay vales separated by ranges of hills, including part of the Cotswolds in Oxfordshire and Northamptonshire.



Bedded limestones in the Great Oolite, Oxfordshire. P211894

The Upper Thames Valley area is underlain by varied deposits that originated as sediments on the ancient sea floor, and which now form successive layers beneath the Chalk. This sedimentary sequence includes four major layers composed mainly of mudstone (Gault Clay, Kimmeridge and Amphill clays, Oxford Clay, and the Lias and Mercia Mudstone groups), separated by layers dominated by sandstone, siltstone or limestone (Upper and Lower Greensand, the Portland, Purbeck, Corallian, Great and Inferior Oolite groups (**Plate P211894**), the Sherwood Sandstone Group and some un-named Permian sediments). Some of these intervening layers form aquifers of regional or local importance, and are characterised by flow between the rock grains or along fractures, or both. In some limestones (Corallian Group), the groundwater can be salty and some salt springs support rare and protected habitats. The mudstones are clays which have been consolidated into harder rocks over millions of years: they form very effective barriers to the movement of water between the various aquifer units in this area.

The youngest of the mudstone layers is the Gault Clay and is up to 100 m thick where it comes to the surface in the Upper Thames Valley, generally diminishing eastwards to about 50 m in Essex and north Kent. It occurs beneath the Chalk down to as low as 440 m below sea level in the deepest parts of the London Basin. The other mudstone intervals are also thickest in the west of the region, where they are between 100 and 230 m thick near the surface, but together with the intervening sandstone, siltstone or limestone layers, they become thinner to the east.

In the far west of the region, the younger sedimentary bedrock includes some very thick sedimentary sequences that come to the surface to the west of the London and Thames Valley region. At depth under northern Wiltshire, these formations comprise more than 400 m of sandstones, siltstones and mudstones but like the overlying rocks, become thinner eastwards. They are largely absent from the area east of Oxfordshire.

Rocks of similar age to those occurring in the Upper Thames Valley region also occur to the south of the London Basin, in the Weald, where they are generally thicker than those found in the Upper Thames Valley. They do extend northwards beneath the Chalk of the North Downs, but then they rapidly become thinner and die out beneath south London.

Older sedimentary bedrock and basement rocks



The extent of the London Platform.
P902530.

The older sedimentary bedrock is preserved at depth in concealed troughs or basins found in the Bedford–Hitchin area where the Carboniferous Limestone dominates and between Banbury in the north and Newbury and Reading in the south. Here the Carboniferous Limestone is overlain by thick Coal Measures composed mainly of sandstones, siltstones, mudstones and thin coals. These rocks also include igneous rocks formed by the cooling of molten rock from deep in the Earth either at surface as volcanic lava or under the ground as igneous intrusions. They are similar to those found at the surface in the South Wales Coalfield and are probably more than 1000 m in thickness.

Basement rocks underlie these basins, and elsewhere in the region, for example around and north of London, they rest directly below the younger sedimentary bedrock. The basement rocks are generally harder and less porous than the overlying rocks and mainly comprise grey and red slates, mudstones and sandstones (Devonian rocks and older rocks). The layers have been distorted by earth movements, in places tilting at steep angles. While the rocks themselves are less porous than the younger sediments they are cut through by fractures that do contain groundwater and include ancient geological faults where the rocks on each side of the fracture have moved relative to one another.

Most of the Thames Valley overlies an uplifted block of these old rocks called the London Platform (**Figure P902530**). Here basement rocks occur at less than 500 m depth; indeed, in the northeast of the region, they are within about 150 m of the surface. The London Platform has been an area of geological stability for at least 250 million years. One consequence of this is that the younger bedrock formations found at surface in the Upper Thames Valley, and layers of a similar age at depth in the Wealden region (to the south), thin quickly towards the London Basin where they are mainly absent. Only the Chalk and the Gault Clay immediately below it form continuous layers across this London Platform.

In marked contrast to the London Platform, the younger sedimentary bedrock immediately to the south is founded on a distinctive basement rocks more comparable to the rocks occurring at the surface in Devon. Folded and faulted basement rocks of this type extend only a short distance into the southern fringe of the Thames Valley region, where they are found at depths of more than 500 m. This fringe is marked at the surface by features such as the Hog's Back ridge of western Surrey.

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Category:

- [London and the Thames Valley - summary](#)

Navigation menu

Personal tools

- Not logged in
- [Talk](#)
- [Contributions](#)
- [Log in](#)
- [Request account](#)

Namespaces

- [Page](#)
- [Discussion](#)

Variants

Views

- [Read](#)
- [Edit](#)
- [View history](#)
- [PDF Export](#)

More

Search

Navigation

- [Main page](#)
- [Recent changes](#)
- [Random page](#)
- [Help about MediaWiki](#)

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- [What links here](#)
- [Related changes](#)
- [Special pages](#)
- [Permanent link](#)
- [Page information](#)
- [Cite this page](#)
- [Browse properties](#)

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