The Hampshire Basin and adjoining areas

This account provides a broad perspective of the geology of the Hampshire Basin and adjoining areas, which covers the greater part of central southern England including the counties of Hampshire and the Isle of Wight together with significant parts of Wiltshire, Dorset and West Sussex. It is limited to the south by the coast of the English Channel. The region is principally rural with major urban areas concentrated on the southern coast including Bournemouth, Poole, Southampton and Portsmouth with smaller market towns inland including Dorchester, Yeovil, Salisbury, Devizes, Winchester, Andover and Basingstoke. Figure 1 provides a geological sketch map of this region showing the rock types occurring in relation to the major towns and cities. Geologically the region forms the western part of a deep basin filled with sediments laid down in ancient seas. This account outlines the geology of the region to a depth of at least 1 km and summarises the current and historical use of the geological resources in the area.

The region is generally low-lying with ridges, rising up to 300 m. The greater part of the region is drained into Poole Bay and the Solent by the Frome, Stour, Avon, Test and Itchen rivers. Geologically the region is well known at shallow depths due to the many quarries, shallow boreholes and coastal cliffs. The Chalk is particularly well known due to the large number of wells bored to depths of about 100 m into this major aquifer to provide drinking water.

The area is also traversed by a closely-spaced network of exploration survey lines and many deep boreholes designed originally to investigate the oil and gas resources of the region. The regularly-spaced boreholes provide valuable information about the geological layers at depth with more than 250 of these being over 150 m in depth and with a significant number reaching depths in the range 1500 to 3000 m. Geophysical seismic surveys provide information on the rocks between these boreholes by sending sound waves through the ground. Together these data provide a reasonably good understanding, to considerable depth, of the extent and variability of the rock units, and their structure. Understanding is improving all the time as a result of continued interest in oil and gas exploration, particularly in the south and west of the region. Concealed coal deposits are not known at depth within the region and consequently no deep mining has occurred.

Geologically 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 are associated with the major river valleys and the coast of the Solent. These superficial deposits mainly comprise thin clays, silts, peats, sands and gravels. The deposits are generally between 5 and 10 m thick. Over the highest Chalk downlands stony clay cover,
usually less than 5 m thick, is also present. This region lay beyond the extent of the ice-sheets that have dominated the evolution of the British landscape over the past 2-3 million years.

**Figure 1** Geological sketch map and key showing the range and distribution of different rock types in the Hampshire Basin, in relation to the major towns and cities. The extent of the region is identified on the inset map of the United Kingdom.
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 400 million years old and mainly comprises harder, denser rocks which have been strongly compacted fractured and folded. They include both rocks originally deposited as sediments and others that are products of volcanic activity. Basement rocks do not occur within the top 1 km in this region and so are not considered further in this account.

Although basement rocks underlie the whole region at depth, the very deepest boreholes have only been drilled deep enough to penetrate the older sedimentary bedrock similar to that encountered at the surface within the adjacent regions. The older sedimentary bedrock was laid down between 400 and 290 million years ago and underlies the whole of this region at depths of between 1.5 and 3.0 km. Knowledge of these rocks and their distribution is only known in outline; but the depth at which they occur means that they are not considered further in this account, which focuses on the rocks in the top 1 km.

Figures 2 and 3 are vertical sections through the geology, referred to as geological cross-sections, which illustrate the variations across the region.

In overall form the region is a large down-fold (syncline) that forms the Hampshire Basin. Erosion of this down-fold has resulted in the oldest rocks being found around the margins and the youngest lying in the centre of the basin. Along the northern, eastern and western flanks of this down-fold the sedimentary layers are gently inclined inwards but on the southern edge the basin is bounded by a narrow zone in which the rocks layers are steeply inclined. This is shown in the spectacular cliffs on the Isle of Wight and westwards into the Isle of Purbeck, Lulworth Cove and on to Durdle Door. At the very northern edge of the region another narrow zone of steeply folded rocks is present in the Vale of Pewsey area (Figure 1).
The interpretation of the boreholes, exploration survey data and surface outcrop shows that, from the surface the region is underlain by a vast thickness of younger sedimentary bedrock comprising five major layers related to stages in the infill of a deep sedimentary basin (Wessex Basin). This layered sequence is present across the region with the older lower layers tending to be more heavily folded and faulted.

To distinguish between the two basins that have been mentioned, the Wessex Basin is a large deeply buried basin covering southern England that has sunk and filled with sediment over a very long period whereas the Hampshire Basin is a major down-fold (syncline) of these sedimentary layers that happened much later and is expressed at the surface and confined to this region. The principal layers comprising the younger sedimentary bedrock are now described for this region as a whole.
Younger Sedimentary Bedrock
The youngest part of the sedimentary bedrock is composed of sediments laid down between 60 and 35 million years ago in shallow seas and around their margins. These (Palaeogene) sediments are preserved in the core of the down-fold of the Hampshire Basin. Their distribution is restricted to the northern half of the Isle of Wight (Figure 4) and parts of the adjacent mainland comprising an area running from Dorchester, through Ringwood to Salisbury and then to the area north of Southampton and Portsmouth on to Bognor Regis in the east. They comprise up to 700 m of generally soft alternating layers of clay, silt and sand with thin limestones in the deepest parts of the down-fold on the Isle of Wight. To the north the layers thin rapidly towards the margin of the basin. These deposits rest on the Chalk throughout.

Figure 4  A general view of the Palaeogene sediments at Alum Bay on the Isle of Wight, looking east from the Needles.

The next major layer is the Chalk (Figure 5), which is a very fine-grained white or pale grey limestone, which often contains nodules of flint, a very hard form of silica. 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. 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. The Chalk has the largest surface outcrop of any of the layers within the region, including the Dorset Downs, through to Salisbury Plain, the Andover or north Hampshire Downs, the area around Alton and Petersfield, Ports Down and the westernmost part of the South Downs. The Chalk has a maximum thickness of around 400 m in the core of the Hampshire Basin down-fold where it lies beneath the overlying sediments.
Beneath the Chalk are sedimentary rocks deposited between 145 and 100 million years ago in shallow sea and lagoon environments (Lower Cretaceous sediments). The layers include limestones, mudstones and beds of mineral salts. The sequence is thin in the west and north, with as little as 100 m present from surface within the cores of the Kingsclere, Shalbourne and Vale of Pewsey up-folds and from Devizes as a narrowing strip southward through Warminster to the margins of the Dorset Downs. Small detached patches occur north of Lyme Regis. These layers are much thicker (where the Lower Greensand, Wealden and Purbeck groups are also present) between Lulworth (Figure 6) and Swanage and in the southern part of the Isle of Wight (Figure 7), up to 1100 m have been encountered in boreholes. These rocks are not seen at the surface in the east of the region but similar thick sequences are known to be represented beneath the Chalk.

Figure 5  The Needles composed of steeply inclined Chalk seen from Scratchell’s Bay.
Figure 6  Stair Hole, adjacent to Lulworth Cove in Dorset, looking towards the east, On the right at the foot of the cliff Portland Stone and Purbeck Limestone have been breached by the sea which is making a cove.

Figure 7  A panorama of the Lower Greensand Group (Lower Cretaceous Sediments) in Chale Bay on the southwest coast of the Isle of Wight looking southeastward towards St Catherine’s Point.
The next major layer is made of three parts each comprising thick mudstones containing thin limestones and sandstones overlain by shelly and sandy limestones. These rocks are seen at the surface along the Jurassic Coast World Heritage Site in the west of the region between Portland and Lyme Regis and inland west of Yeovil and through Wincanton, Frome and Trowbridge to Chippenham. This sequence was deposited between 205 and 145 million years ago, the mudstones being laid down in deep seas whilst the limestones were deposited in shallow tropical reef environments. The mudstones include the Lias, Oxford and Kimmeridge clays and are each between 250 and 400 m thick. The intervening three limestone units are the Oolite, Corallian and Portland groups each about 100 m thick. In total the sequence is up to 1400 m thick beneath south Dorset and the western parts of the region and becomes thinner beneath the younger units towards the north and east. For example, about 600 m is present in the north of the Isle of Wight where many of the upper layers were removed by erosion before the overlying rocks were deposited.

The three major mudstones are rich in organic material and represent potential sources of oil and gas where they have been deeply buried and heated. The intervening limestones are more porous than the clays and therefore can potentially act as reservoir rocks if the oil and gas migrates away from the clays. These limestone units also form important building stone resources where they occur at surface as for example in the Portland and Purbeck districts of south Dorset.

The oldest rocks of the infill of the Wessex Basin are between 290 and 205 million years old (Triassic sediments) and were deposited on an extensive desert landscape at or close to the equator, they are predominantly red in colour (Figure 8). These rocks do not occur at surface in the region but they are known from deep boreholes throughout. A maximum of about 1600 m of this sequence is encountered in the vicinity of Lyme Regis, in Dorset. To the north and east these layers are much thinner and occur at depths in excess of 1500 m beneath north and east Hampshire.

These red rocks can be divided into three units:
The most widespread and youngest is a series of red mudstones, called the Mercia Mudstone, which was deposited in shallow seasonal lagoons and on broad river floodplains in a desert landscape. They contain significant beds of rock salt. The maximum thickness of these mudstones of about 450 m is proven in boreholes in south Dorset but they are known to thin to about 100 m over much of the remainder of the region.
Beneath the mudstones lies a layer of sandstones, the Sherwood Sandstone, up to 250 m thick, that was deposited by large seasonal rivers crossing an arid desert plain. They are encountered at depth south of a line from Wincanton to Portsmouth and are thickest beneath the southwest of the region. They form the major oil and gas reservoir which is exploited at Wytch Farm south of Poole. Towards the west they are also a major aquifer.

The lowest and oldest unit (Aylesbeare Group) is only known from boreholes in west and south Dorset and was deposited mainly as large sand river channels and flood deposits and rock screes in a desert. The rocks comprise thin red sandstones and thick mudstones with significant layers rich in pebbles and boulders. In total this unit is up to 800 m thick in south Dorset around Lyme Regis and it is also found in the northwest of the region beneath the area round Devizes and Frome.
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