The aquifers of the UK

An aquifer is defined as a permeable rock that stores groundwater and allows it to flow readily into a well or borehole. The water flows through the voids, or pore spaces, in the rock. The total volume of the pore space is referred to as the porosity and represents the total volume of water that the rock can store. This may be in the minute spaces between the grains of a sandstone, when it is referred to as intergranular porosity, or in the small cracks and fractures that are more usual in limestones and older compact rocks, which is termed fracture porosity. The pore spaces in an aquifer must be interconnected so that water can flow through the rock, in other words an aquifer must be permeable.

The principal aquifers of the UK are found in the lowlands of England. The most important are the Chalk, the Permo-Triassic sandstones, the Jurassic limestones and the Lower Greensand. They occur within the section of the geological sequence referred to as the Younger Cover, which ranges in age from the Permian to the Quaternary. Aquifers do occur in Devonian and Carboniferous strata of the underlying Older Cover but they are much harder and more compact rocks and are regarded as of secondary importance in terms of water supply. The older Silurian, Ordovician, Cambrian and Precambrian rocks generally have low permeabilities and may be regarded as an “impermeable basement” below the strata of the Older and Younger Covers. However, even in these hard rocks, fractures in the upper 50 to 100 metres of the saturated zone do provide small amounts of water to individual wells and springs.

As a result of earth movements, the Jurassic to Palaeogene sequence of eastern and southern England slopes (or dips) either to the east into the

Photograph taken with an electron microscope of a Permian sandstone showing the pore spaces between the grains. The porosity is about 30%.

An outcrop of the Chalk showing the interconnected network of fractures that gives the aquifer its high permeability.
North Sea Basin or to the south into the Anglo-
Paris Basin. Within this broad structural pattern
the subsidiary London and Hampshire basins are
very significant in the hydrogeological context;
each contains major aquifers.

The Chalk, which is a soft, white limestone
traversed by layers of flint, underlies much of
eastern and southern England. It is a unique rock
because it consists of minute calcareous shells and
shell fragments of plankton. These impart high
porosity to the matrix, but are so fine grained that
the water contained in the pore spaces of the
rock’s matrix is virtually immobile, being held by
capillary forces. Consequently the specific yield
(the water a rock yields when it drains naturally
or is pumped) is low, of the order of 1%. The
Chalk owes its prominent role as an aquifer to a
network of fine cracks that impart a high
permeability. Individual boreholes in the Chalk
can yield more than 10 million litres per day
(Ml/d), sufficient to provide for the needs of
about 70,000 people at 150 litres per person per
day.

The Permo-Triassic sandstones are mainly red
sandstones that originated in a desert
environment. They are found in a series of deep
sedimentary basins in western England and on

*Distribution of the principal aquifers in the Britain and Ireland.*

*Photograph taken with an electron microscope of
a sample of the Chalk showing the tiny shell
fragments of algae which make up most of the
rock. The porosity is about 45%.*
The eastern and western flanks of the Pennines. A deep basin lies below the Antrim basalts in Northern Ireland and small isolated basins are found in south-west Scotland. The packing of the quartz grains in the sandstones imparts a porosity of 30% and the specific yield can be as high as 20 to 25%. Much of the sandstone is a soft, compact rock that is only weakly cemented. Groundwater, therefore, can flow through the matrix but the presence of fractures enhances the permeability considerably. The sandstones are very permeable and yield a high proportion of the water that they store. Yields from large boreholes are as much as 5 to 10 Ml/d.

The Jurassic limestones are prominent aquifers in the Cotswold Hills, in eastern England and the North Yorkshire moors. They are represented by the Great and Inferior Oolites, the Lincolnshire Limestone and the Corallian limestones. They are relatively hard limestones with low specific yields but again an extensive fracture network, with fractures enlarged by solution, gives high permeabilities. The largest yields from individual wells in the UK are provided by the Lincolnshire Limestone; the initial natural artesian overflow from one borehole was more than 30 Ml/d.

The Lower Greensand flanks the Chalk in eastern England and encircles the Weald in the south-east of the country. The aquifer is not so productive as the sandstones of the Permo-Triassic but despite
this the specific yield of 10 to 20% and moderate values for permeability make it an attractive source of groundwater.

The sandstones and limestones of the Older Cover have a much longer history and in the past have been subjected to much more intensive earth movements, which are responsible for their lower porosity and permeability. Nevertheless, they do provide many local supplies. Aquifers in the Carboniferous are important in Northern England and the Central Valley of Scotland while the Old Red Sandstone is valuable in Caithness and along the Moray Firth.

Unlike much of the rest of the world, alluvial sands and gravels are not major aquifers in the UK, although wells and boreholes are sited in these deposits in many parts of the UK and supply individual needs.