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Geological aspects of Shropshire groundwater investigation

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SKINNER, A. (1981). Geological aspects of Shropshire groundwater investigation. *Proceedings of the Shropshire Geological Society*, **1**, 6-8. Of concern to hydrogeology are grain size, porosity and permeability. Also of interest are faults and aquifer geometry, changing their thickness and affecting the amount of storage capacity in the ground. The most striking feature of North Shropshire is the range of sandstone hills running east-west, north of Hodnet, and their sudden displacement 8 km down the A49, where the outcrop of Keuper Waterstones (now called the Bromsgrove Series) suddenly appear at Grinshill.

The Wem map has large expanses of superficial deposits of the Ice Age, largely boulder clay (till) interspersed with outwash gravels and sands. Where great thicknesses of clay exist, the ability of rainfall to infiltrate the sandstone and provide a water supply is much reduced. The River Tern area north of Wellington was looked at in detail, showing two main faults: the Hodnet Fault and the Preston Brockhurst Fault, both trending northeast-southwest. At Ellerdine, 8 km north of Wellington, the IGS map shows Keele Beds, Bunter Pebble Beds, and Lower Mottled Sandstone which is basal Bunter Sandstone. The second area was in the catchment of the River Perry.

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There are three principal rock formations which provide aquifer rocks *viz.* Cretaceous chalk, Jurassic limestone, Triassic sandstone, from which water is abstracted for private and public water supply in the UK. There are other rock types which provide local, small aquifers, but the bulk of the public supply is taken from these three.

The proportion of public water supply taken from geological formations varies across the country. In the south east it is 80%, largely from chalk and greensands; in Wales it is only 3-4% because there are few aquifer rocks; and in the Midlands it is 39%, which is a typical figure for most of England and Wales.

Geologists are therefore needed in the water industry, because over one third of the public water supply is derived from geological formations and the water industry needs to be informed and to have specialists to advise it. However the employment of geologists in the water industry is largely an innovation of only the last 10-15 years.

The 'tools of the trade' are largely centred around those which drill holes in the ground. There are basically two types of hole, one through which water is abstracted for supply and the other which is drilled to establish formations and to enable decisions to be made on the availability of water. Three types of drilling rig are used to drill different sizes of hole: large diameter (1.3 metres) for pumping; small diameter for strata proving or for domestic or agricultural water supply; very small diameter, usually drilled in soft deposits, useful for investigating drift deposits.

A pen recorder is used to record the measurement of water levels in boreholes, since it is important to study fluctuations especially in times of drought. In the case of artesian boreholes where water is under pressure, the recorder is placed in a pipe extending up to several metres above ground.

Hydrogeologists are also interested in the quality of the ground water, which depends on chemical composition of the rocks, so frequent samples are taken for chemical analysis.

The oil industry is also involved in drilling holes in the ground, which are called wells and not boreholes as they are in the water industry, and certain techniques have been adopted from the oil industry, especially down hole logging. This is a geophysical technique which involves lowering a *sonde* down a borehole to measure the properties of the rocks in terms of their water-yielding properties.

Other geophysical surveys are carried out on the surface and again the same techniques are used in both oil and mineral surveying. The one most commonly used is a resistivity survey, where wires are laid out in a grid, connected to rods located in the ground; the electrical current flowing between the rods is a measure of the properties of the rocks underneath.

Seismic surveys are also carried out, but only small charges are used. The main disadvantage is that a long straight piece of land is needed.

Turning to the part of North Shropshire which is the subject of a groundwater investigation, the Wem one inch sheet showing solid and drift geology clearly highlights two aspects of geological inquiry in Shropshire, of particular interest to hydrogeologists, namely drift deposits and faults. When one looks in detail at the area of Triassic sandstones over much of North Shropshire, the stratigraphic variation is small, in contrast to the wide variety of rock types found in South Shropshire. However, age, date, fossils, etc. are of little concern to hydrogeologists; much more important are grain size, porosity and permeability. Also of great interest are faults and aquifer geometry. Faults throw aquifers about, change their thickness and affect the amount of storage capacity in the ground. It is therefore important to know the three dimensional picture of the rocks underground, and how it changes with depth, otherwise it possible to drill boreholes into inadequate aquifers, thus developing short-term resources.

The most striking feature of North Shropshire is the range of sandstone hills running east-west, north of Hodnet, and their sudden displacement 8 kilometres down the A49, where the outcrop of Keuper Waterstones (now called the Bromsgrove Series) suddenly appear at Grinshill.

The Wem map has large expanses of blue colour, indicating the widespread superficial deposits of the Ice Age, largely boulder clay (till) interspersed with outwash gravels and sands. These deposits are of great interest because, where great thicknesses of clay exist, the ability of rainfall to infiltrate the sandstone and provide a water supply is much reduced. It is therefore important to know the detailed geology of the superficial deposits in order to know how much water will be available. The drift geology is very complex and its depiction on maps by lack of intensive survey is quite inadequate, because again a three dimensional picture is needed.

The River Tern area north of Wellington was looked at in detail. Starting with the geological survey map and using additional information from boreholes and geophysical surveys a three dimensional picture is constructed. This shows two main faults: the Hodnet Fault and the Preston Brockhurst Fault, both trending northeast-southwest, and a subsidiary fault. These are the same trends and stress patterns as exist in South Shropshire, but they are not as obvious. The dotted fault lines on the Geological Survey map indicate their speculative nature but this is not good enough for hydrogeologists, who need to know exactly where the faults lie. Because it is necessary to know the thickness of strata within the fault blocks, an isopachyte map was drawn for the sandstone. This shows that the thickness varies from 30 metres to 240 metres over a short distance, indicating a significant feature controlling the base of the lower Mottled Sandstone. A minimum thickness of 30 metres is needed for a significant water supply aquifer.

To illustrate the significant detailed changes that can be mapped by intensive investigative techniques, two areas were examined: before and after.

Firstly, at Ellerdine, 8 km north of Wellington, the IGS map shows Keele Beds, Bunter Pebble Beds, and Lower Mottled Sandstone which is basal Bunter Sandstone. This would indicate a continuous depositional sequence from older Keele Beds to Younger Lower Mottled Sandstone, with Bunter Pebble Beds somehow stuck in by some strange process, since they are stratigraphically above the Lower Mottled Sandstone. In order to find the best site for a borehole, geophysical surveys were carried out together with investigative drilling. The results showed a different configuration of strata to that previously mapped; the outcrop of Keele Beds was larger and no Pebble Beds were found.

The second area was in the catchment of the River Perry. Here the IGS map shows Carboniferous strata forming high ground to the west, then the subdivisions of the Triassic F_1 Lower Mottled Sandstone, F_2 Bunter Pebble Beds, F_3 Upper Mottled Sandstone, F_4 Keuper Sandstone, F_5 and F_6 Keuper Marls, and up to 300 feet of overlying drift.

Prom preliminary studies, there was reason to believe that the F_6 Keuper Marls lay further to the west. A geophysical survey was carried out and resulted in a revised picture: F_1-F_3 were classified together, because for all practical purposes there are no recognisable distinctions between the various members, e.g. the Pebble Beds have no pebbles and their geological properties of hydrogeological interest are no different from those of the rock units above or below. The

Keuper Marl overlying the sandstone is now shown in a different location, 2 km further west, confirmed by a borehole sunk in F_6 (formerly F_3), and a new fault was discovered.

Hydrogeologists need to produce drift maps in order to know the thickness of superficial deposits to drill through before meeting the sandstone and the type of deposits - clay, sand - and what the recharge characteristics are.

A lot of work has been carried out on the drift deposits, especially in the catchment of the River Perry between Shrewsbury and Ellesmere. Both boreholes and geophysical surveys have been used to amass data on superficial deposits.

The study in this area shows the thickness of Pleistocene drift deposits over the sandstone to vary from less than 10 metres to over 100 metres. The drift is thicker in the west than the east, and striking linear features show up. If the data is used to draw a contour map of the sandstone surface this shows up the Pre-Pleistocene topography. There is a vast thickening of drift along the line of the River Severn, which is the line of the proto-Severn pre- Ice Age drainage pattern, with the base of the pre-glacial drainage channel now below sea level. The drift pattern also shows the line of the proto-Dee and a link with the proto-Severn.

The elucidation of the geology, faults and drift is a very complex problem. For the Perry area a fence diagram has been constructed. This is built up from information from boreholes and geophysical surveys and provides a three dimensional view, which is a compilation of cross sections at right angles to each other, showing the rock units, drift and faults and the saliferous horizons of the Mercia Mudstones, the northern extensions of which form the Cheshire saltbeds.

Some of this data has now been made available through Birmingham University, who carry out most of the geophysical surveys, to those wishing to study the Pleistocene deposits. An unfortunate aspect of being a professional geologist is that one's time is necessarily devoted to the strict objectives of study and much of the incidental information produced cannot be taken full advantage of.

Slides of various rock types were discussed and borehole cores of the rocks were available for examination. The specimens were:

1. Bunter Sandstones, well indurated with characteristic bedding features, homogenous but with subtle changes in grain textures, with a leaching band picking out the bedding.
2. Triassic Sandstone from the Perry Area, very much more indurated and finer grained than '1.', with large areas of calcite cement. Most of the Triassic sandstone has silica cementation stained with oxides of iron, but occassionally calcite cement is found. This rock would not be a good aquifer because the small grains arc too tightly packed.
3. Mudstone, Keuper Marl from the Perry area, taken from close to the saliferous horizon and showing net veining with gypsum.
4. Sandstone, firmly cemented, fine grained with delicate sedimentary features, not good for water supply characteristics.
5. Sandstone, medium grained, pellets of mudstone have been washed out leaving voids, again not good for water supply.
6. Sandstone, well cemented with vertical fracture, a good specimen for water supply characteristics, fractures are needed for flow pathways.
7. Gypsum from the saliferous horizon.
8. Sandstone from strata in the Bridgnorth area, highly porous, course grained, lightly cemented - a good aquifer rock.

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D.M.J.

