



# Manchester Geological Association

President: Niall Clarke MSc

June 2021

[www.mangeolassoc.org.uk](http://www.mangeolassoc.org.uk)

Founded 1925



## Quick Diary

### Virtual Meetings

- |             |   |
|-------------|---|
| 14 July     | A journey through the ancient rivers exposed along the Jurassic coast of Yorkshire. Jonathan Redfern    |
| 13 October  | Holiday Geology   |
| 13 November | Broadhurst Day, a tribute to the late Tony Adams  |
| 4 December  | Early Hominins  |
| 2022        |   |
| 15 January  | Geological Skills   |
| 9 February  | AGM and Presidential Lecture. Niall Clarke  |
| 16 March    | Mires, meteors and mass extinctions: what does coal tell us about deep time climates? Dr Rhodri Jerrett |

# Who's Who in the MGA

## Officers

**President: Niall Clarke MSc**

Vice-President: Dr Margaret Hartley

General Secretary: Sue Plumb BSc

Membership Secretary: Niall Clarke MSc

Treasurer: Jennifer Rhodes BA

Indoor Meetings Secretary: Vacant

Field Excursions Secretary: Peter del Strother MBE Mphil

Newsletter Editor: Lyn Relph BSc (Hons)

Webmaster: Peter Giles MSc

Other elected members of Council

Prof. Ray Burgess

Nicola Fowler BSc (Hons)

Peter Gavagan BSc (Hons)

Penny Heyworth Mphil

Ken Jacobs

Ex officio members of Council

The Immediate Past President, Manchester Geological Association: Prof. Cathy Hollis

RIGS Representative: Dr Chris Arkwright

The Association's representative on the North West Geologist's editorial team: Peter del Strother MBE Mphil

President of the Student Geological Societies of the University of Manchester

MGA Archivist: Dr Derek Brumhead MBE

## MGA email addresses

To contact our President: [president@mangeolassoc.org.uk](mailto:president@mangeolassoc.org.uk)

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# Borehole geology and public water supplies – part 2

This article is an edited down version of the Presidential Address made to the 2021 AGM. I hope members find it interesting and the links to some of the references used in the talk useful. The address looked at the contribution groundwater makes to the public water supplies in the north west and some of the issues faced. In the first part we looked at the influence of mining and geochemical variability on groundwater. In this second part we look at the geology of the Fylde Permo Triassic aquifer and the connectivity with surface waters and the role of faulting.

## The Fylde Permo-Triassic aquifer

The previous two examples were of locally significant boreholes. This third example is of north west strategic regional significance in terms of public water supply.

The cross section in Figure 5 is taken from the BGS report *Preliminary assessment of the environmental baseline in the Fylde, Lancashire. Groundwater Programme Open Report OR/18/020*

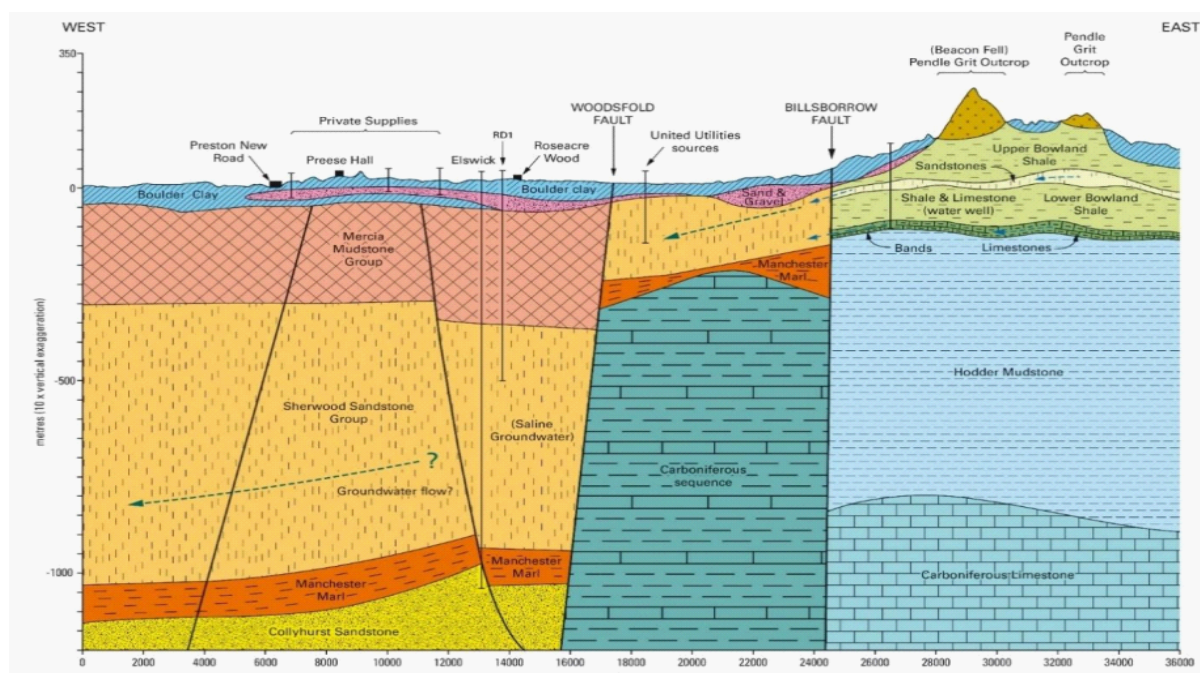


Figure 5 A cross section of the Fylde

Public water supplies come from the fault bounded block to the centre of the diagram. The Sherwood Sandstone Group forms a thick aquifer bounded in large part but not everywhere at the base by mudstones of the Permian Manchester Marl. The top of the sandstone aquifer in the area where drinking water is abstracted is generally confined by clayey beds within the overlying Quaternary. However, to the west of the Woodsfold Fault it is quite different; the aquifer is confined above by Triassic sediments of the Mercia formation and the Manchester Marls are up to 110m thick.

The Triassic Sherwood Sandstone Group, is a product of mixed aqueous and aeolian deposition under desert conditions; precise correlation of beds within the sequence is difficult because it is unfossiliferous. It is typically a fine to medium grained sandstone, with sporadic layers of coarse sand, clastic marl flakes and importantly in terms of retarding flow, thin beds of red silty mudstone. The sandstone has good intergranular porosity but is locally fissured. All of this has bearing on the characteristics of the aquifer.

Quaternary deposits can be upwards of 60m thick, so not insubstantial and they contain aquifers in gravel and sand units of Devensian age. The cross section in Figure 6 illustrates this.



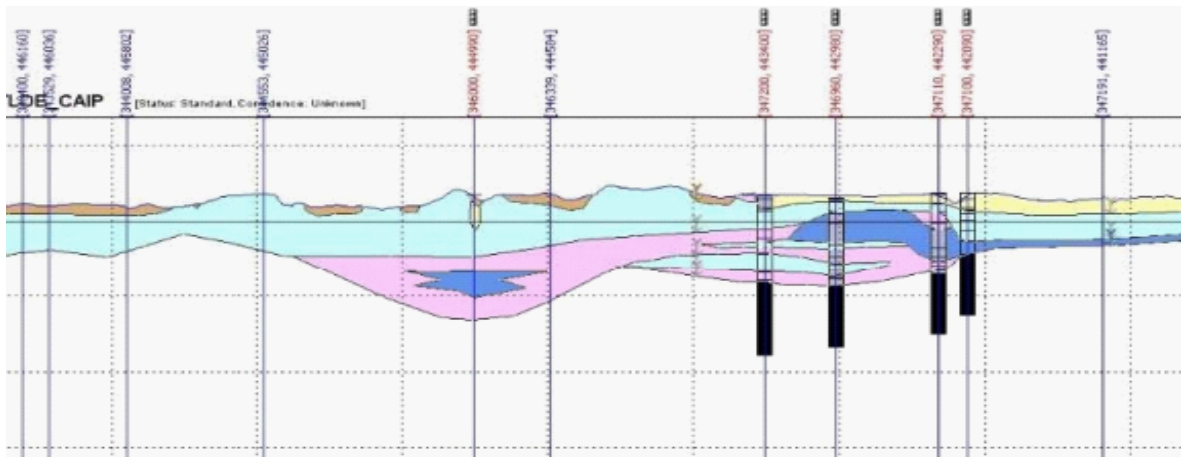


Figure 6' The Quaternary of the Fylde (sands and gravels -purple, till -light blue, clays and silts dark blue and peat, brown).

Where these overlie the Sherwood Sandstone the Quaternary aquifers do act to recharge the Permian aquifer. Where the confining boulder clay layer is locally thin or absent, we can have groundwater flows between river beds and the sandstone aquifer; providing pathways for a significant component of recharge and river/groundwater interaction. So, the Quaternary has an important bearing on both the aquifer recharge and the interaction with surface water. Therefore, how the aquifer is managed in terms of abstraction directly influences the water available in rivers especially the Wyre and some of its tributaries. At times of low flows there is an obvious issue in terms of the ecology and compliance with the Water Framework Directive.

Looking more closely at the area where public water supplies are abstracted (the fault bound block in Figure 5) the aquifer potential of units on either side of the Billsborough Fault is illustrated in Figure 7. The map is taken from the BGS Geonindex website.



Figure 7 Stratigraphy and aquifer potential. Public water supplies are abstracted from within the red oval.

The Carboniferous consists of the Bowland Shale Group, which is likely to be effectively impermeable, and the sandstone-grit-shale sequence of the Millstone Grit Group. Within the Millstone Grit Group, the sandstone units will act as localised aquifers separated by shales/mudstones, the groundwater movement being predominantly by fissure flow. The thicker sandstone/grits (e.g. Pendle Grit) are displaced by faulting, creating isolated aquifer units. These beds are brought into contact with Sherwood Sandstone in places along the Hillsborough fault (Figure 5). In these locations, flows from Carboniferous sandstone aquifers to the Sherwood Sandstone were thought to occur.

Horizontal permeability in the sandstone is restricted perpendicular to faults. This is seen by slow or limited response of boreholes in the area to major abstraction. Vertical permeability within the Sherwood sandstone is restricted by the thin mudstone beds.

During the original field studies of the Fylde aquifer, it was concluded hydraulic continuity existed between the Fylde aquifer and the Carboniferous. This model then allowed for substantial inflows from the Carboniferous as the major, recharge source to the Sherwood Sandstone, with abstractions from the aquifer being balanced by inflows from the Carboniferous. This led to the designation of the Sherwood sandstone as essentially of infinite capacity, leading to what are now seen as generous abstraction licences. In the 1990s<sup>1</sup>

<http://www.environmentdata.org/archive/ealit:920/OBJ/19001203.pdf>, on the contrary, evidence from borehole responses across the boundary concluded that inflow from the Carboniferous is small if at all and does not significantly contribute to sandstone recharge in the Wyre catchment.

A study by the EA concluded low permeability across faults is the result of impermeable rocks being juxtaposed with the aquifer across the fault, but also, especially where there has been syndepositional movement, mud rich layers within the sandstone essential smearing and sealing the aquifer at the fault and this combines with post deformation fluid movement which deposits cements along the fault, again sealing it. However, post lithification movement also creates small scale faulting within the aquifer which has the opposite effect i.e., increasing permeability, all be it locally. These faults are primarily along bedding plane surfaces. These are aeolian and river deposits so the bedding planes are complex and don't extend laterally for more than a few hundred meters at most. You can see quite a complex picture is building up of how faulting of different scales and timings effect permeability positively and negatively and also aquifer recharge.

Of course, another consequence of this anisotropy is the need to ensure the observational boreholes are measuring the same thing as the abstraction boreholes are taking water from. In the Fylde this has been found not always to be the case, contributing to the over abstraction problem.

Now in the current, revised model, sustainable groundwater abstractions are viewed as being limited by flow through the Quaternary deposits. This is borne out by evidence from boreholes in the Quaternary which show that Sherwood sandstone abstraction is met partly from increased flows from the drift. Any deficit in vertical flow through the Quaternary is compensated by leakage from the surrounding rivers system. The impacts of groundwater abstractions on the environment are therefore more pronounced and compliance with the objectives of the water framework directive made more challenging.

This has an important bearing on the sustainability of currently licensed groundwater abstractions and the effectiveness of the existing licence conditions to adequately protect the aquatic environment. The action plan to address this is available at [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/300485/LIT7917v1\\_161231.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/300485/LIT7917v1_161231.pdf).

To summarise this plan; the resource is recognised as a key element of a sustainable water supply to the north west at a strategic level. The groundwater resource is over licensed but the model of the aquifer is not sufficiently accurate to dictate a sustainable operating regime for the abstraction of public water supplies. This needs to be resolved to comply with the Water Framework Directive. The EA would like to restrict licences but in cooperation with major abstractors. Further modelling is

<sup>1</sup>

committed to better understand groundwater flows and what influences them. There can't be an effective sustainable plan based on an incorrect understanding of the aquifer.

In conclusion:

- Groundwater accounts for 10% of the water consumed in the north west – translating to c. 700,000 population.
- An important and somewhat hidden contribution, primarily in Cheshire, Lancashire and north and west Cumbria.
- The principal aquifer is the Permo-Triassic Sherwood Sandstone and the Carboniferous Coal Measures and Millstone Grit and other Permo-Triassic sandstones and marls are locally important secondary aquifers. The Quaternary aquifers play an important role in recharging Permo-Triassic aquifers.
- Aquifers are heterogenous bodies, boreholes have individual characteristics to be addressed when sourcing public water supplies.
- Faulting plays an important role in aquifer permeability, even where intergranular flow is dominant.
- Aquifer protection is key as aquifers are vulnerable catchments with long recovery times – if at all.
- The Water Framework Directive, the EA river basin management planning approach, combined with water company water resource management expertise and targeted investment, is delivering long term sustainability.

1. The Fylde, Lancashire: Summary of the Quaternary Geology Groundwater Programme Open Report OR/16/013

2. <http://www.environmentdata.org/archive/ealit:920/OBJ/19001203.pdf>

3. Structural controls on groundwater flow in the Permo-Triassic

4. Sandstones of NW England. K. J. SEYMOUR, J. A. INGRAM & S. J. GEBBETT From: BARKER, R. D. & TELLAM, J. H. (eds) 2006. Fluid Flow and Solute Movement in Sandstones: The Onshore UK Permo-Triassic Red Bed Sequence. Geological Society, London, Special Publications, 263,169-185.

## OTHER SOCIETY EVENTS

**BCGS** <http://bcgs.info/pub/>

**See website for trip information, which will depend on Covid-19 restrictions.**

**Yorkshire Geological Society** <http://www.yorksgeolsoc.org.uk/>

**27 June,  
24 & 25 July** The Lower Cretaceous rocks of Claxby, Lincolnshire & Claxby Ironstone Mines  
Geology & Archaeology - 'Ever the Twain Shall Meet'

**Leeds Geological Society** <http://www.leedsga.org.uk/>

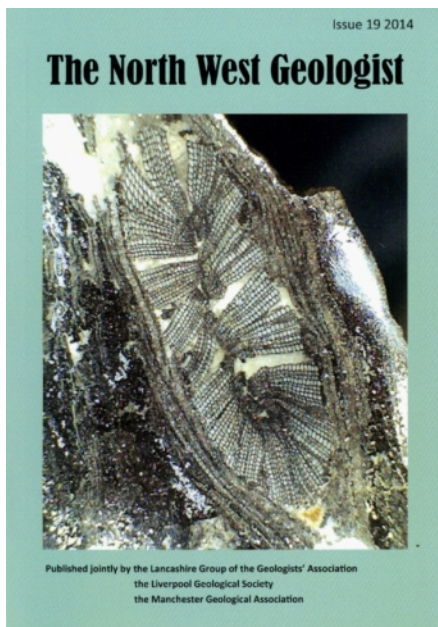
**7 October** Volcanoes from Space - Satellite Measurements of Magma

**GeoLancashire** <https://geolancashire.org.uk/lectures-and-excursions/>

**There are no events currently available due to Covid-19 restrictions.**

**OUGS North West Branch** <https://ougs.org/northwest/>

**There are no North West Branch events currently available to be listed.**



## *The North West Geologist* – the time to write is **now**

We aim to publish an edition of our journal every two years. The latest edition was published in September 2020, so that means that the next is due in late summer 2022.

### **Could you contribute an article? Ideas for articles might include:**

- a field excursion report, with photographs
- a description of an interesting geological location you have visited,
- a field guide to a local area you know well which has interesting geology
- a notable rock specimen, mineral or fossil you have collected
- a report of a holiday to a place with interesting geology
- a geological collection in a museum you have visited
- a visit to a quarry, a mine, or other geology related site
- an article about a mineral and its use in the modern world

Articles need not be very long. We ask for a minimum of 300 words. A variety of short articles would be welcome.

The text should be produced in a word processing package such as Word. Please do not send as a PDF as this is less easily editable.

Images, figures and tables should be sent as separate files in jpeg., tif., or similar format so that, once typeset, they can be inserted into the text at the appropriate place. Captions for images, figures and tables should be included at the end of the text.

We are also looking for an attractive image to enhance the front cover. As you will see above, the last three issues have had geological specimens but a 'geological' landscape image or view of a rock face . . . the choice is endless

Why not have a go? If you look inside NWG 21 you will find further advice, but you can email me at [northwestgeologist@gmail.com](mailto:northwestgeologist@gmail.com) and I will be delighted to help.

Jennifer Rhodes  
Editor: North West Geologist

# Manchester Geological Association

## Virtual and Outdoor Meetings

**Wednesday, 14 July 2021 A journey through the ancient rivers exposed along the Jurassic coast of Yorkshire;** virtual excursion.

Jonathan Redfern

Jonathan is a Professor in the department at Manchester University and Head of Petroleum Geoscience and Basin studies etc. You can find more about him on the Manchester University website.

<https://www.research.manchester.ac.uk/portal/jonathan.redfern.html>

## Indoor Meetings 2020

**Wednesday, 13 October 2021 Holiday Geology**

La Palma

Basque Country

North Wales Manganese Mineralisation and mining

Ken Jacobs

Peter Bennett

Lyn Relph

**Saturday, 13 November 2021 Broadhurst Day, a tribute to the Late Tony Adams**

**Saturday, 4 December 2021 Early Hominins**

Denisovans

Dr Katerina Douka

Neanderthals

Prof. Tom Higham

**Saturday, 15 January 2022 Geological Skills**

**Wednesday, 9 February 2022 AGM and Presidential Lecture** Niall Clarke

**Wednesday, 16 March 2022 Mires, meteors and mass extinctions: what does coal tell us about deep time climates?** Dr Rhodri Jerrett

**Expressions of interest** please to [outdoors@mangeolassoc.org.uk](mailto:outdoors@mangeolassoc.org.uk) for a field excursion around Ingleton Waterfalls Walk. It is a great walk but not for the faint-hearted. It is 4½ miles with more than 300 steps – would anyone be interested? Two links to help you decide: <https://getlost.blog/ingleton-waterfall-trail/> and <https://www.ingletonwaterfallstrail.co.uk/>

## Bring Your Own Reusable Mugs

Would Members please bring a cup to use for tea/coffee when attending lectures, where refreshments are provided. It would be much appreciated. The MGA will be using biodegradable cups when our supply of polystyrene ones runs out, but these do cost more.

**Front Cover.** The Giants Causeway, Northern Ireland; a reminder of when we were free to roam!