



# North Eastern Geological Society

## Newsletter June 2024

### UPCOMING EVENTS

**June 15th** Long Houghton coast.  
Leader: Louise Golightley

**July 28th** From fire to ice, the development of the  
Till Valley. Leader: Ian Kille

**August TBC.**

September 14th **Geophysical research** at  
Houghall Leader: Chris Saville

### FIELD TRIP / LECTURE REPORTS

**Going down the drain. Water quality in a time of  
change. Dr Julia Knapp, Assistant Professor  
Durham University Department of Earth  
Sciences. 15th March 2024**

We are seeing an increased frequency of droughts and of floods (as I write this report one her lecture the news reports that the period of October to March was the wettest in 80 years and that we may now anticipate these episodes every twenty years)

Dr Knapp started her lecture with photos of the mass poisoning event in the River Oder on the Polish border in 2022 when somewhere close to 150 tonnes of fish were killed. There was speculation about chemical

discharges - heavy metal contamination was ruled out but there was interest in the possible role of a particular algal bloom<sup>1</sup>.

She told us that in the US the sea level has risen by a foot between 1920 and 2020 and she reminded us (anybody remember their O level chemistry?) that the amount of oxygen dissolving in water varies inversely with its temperature.

The IPCC<sup>2</sup> in its 6th assessment in 2022 contained far fewer references to water quality than to floods and droughts. In over 3000 pages there were 3785 mentions of flooding, 2955 of drought and only 285 of water quality. Dr Knapp commented that water quality remains “invisible”.

River water quality is shaped by the land’s connectivity with it in a changing climate.

**She began by exploring what water quality means.**

She highlighted the “relativity” of this when she pointed out that 1 in 9 people (around 2.2 billion people) do not have ready access to clean water while 1 in 3 (over 4 billion) did not have access to safe sanitation. In developing countries 80% of sewage is discharged untreated. Industries require 300-400 million tonnes of water and nitrates from agriculture remain one of the commonest contaminant.

Water quality was defined by Johnson in 1992 as a measure of the condition of water relative to the requirements of those using it. Freshwater

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<sup>1</sup> <https://www.theguardian.com/world/2022/aug/19/rare-golden-algae-may-have-caused-fish-deaths-in-oder-river-says-minister>

<sup>2</sup> Intergovernmental Panel on Climate Change

constitutes 2.5% of the water on the planet, itself comprising 68.7% captured in glaciers, 30% in groundwater and 1.2% in surface water. This 1.2% comprises 69% as ground ice/permafrost, 20.9% as lakes.

### **Why should we care?**

A. We need it to be available and usable.

1. Decreased quality threatens society through effects in agriculture, industry and domestic use (a nice point highlighted by the recent cryptosporidium contamination in South West Water's supply in Devon, and a case in the US where a leaking underground petrol tank contaminated the local supply).
2. Soil salinisation from rising sea levels in low lying areas together with adverse agricultural practices (improper irrigation practices, excessive groundwater extraction, and inadequate drainage systems) threatens the production of food to meet global needs.
3. Demands of thermonuclear power stations.
4. Costs of raising the potability standard of the supply may be increased.

B. It is an indication of the health of the environment

### **What affects the quality?**

Input - natural solutes/fertilisers/pesticides/contaminants such as animal waste(eg chicken farms on the Wye in the news recently) and industrial effluents/weathering products

Path - what is picked up en route, what kind of reactive material does the water encounter?

Travel time - there are benefits from water taking a longer rather than a shorter time to travel downstream

Prof Knapps commented wryly that as regards resilience of the system "we don't have a clue".

### **Climate change and water quality**

Effects range from gradual and persistent (leading to long term changes to ecosystems and subsurface structures - a continuous effect that is often marked) to extreme (short term hydrological and biogeochemical events appearing as discontinuous "jumps" in the environmental process that are much more apparent).

#### Gradual effects

1. A rise in temperature means that less oxygen is contained in a given volume of water. Prof Knapps told us that reduced oxygen levels have been noted in lakes in temperate latitudes.
2. She described the deep and superficial runoff paths for water from the land and how the mineral "washout" from ordinary rainfall (associated with magnesium, calcium and silicon) which has soaked more deeply into the land differs from that seen after inundations which rinse through superficial layers and bring with them more iron, manganese, carbon, nitrogen and phosphorus.

The mineral content of the superficial layer is more sensitive to changes in the climate and additionally the concentration of these in solution increases with the rise in temperature.

3. Bedrock weathering beneath the water table is the origin of soils where water enters fractures and over long periods breaks up the rock to form soils and releases minerals into the groundwater. Soils develop because of the weathering of materials on Earth's surface, including the mechanical breakup of rocks, and the chemical

weathering of minerals. Soil development is facilitated by the downward percolation of water.

It has been reported that there is a correlation between climate change and seasonal variation on arsenic content in groundwater level. The decrease in water level increases oxidation and mobilization of arsenic in the groundwater and leads to concentrations (sometimes very much) above the recommended 10mcg per litre.

### Extreme effects

The increased temperature leads to:

↑ temp leads to ↓ oxygen ↑ metals ↑ salinity  
↑ carbon ↑ nitrates

Floods are associated with erosion, landslides (recent news of horrific consequences in New Guinea underline this) and sediment flushing, along with waterborne disease. Floods connect rivers to upland areas where “stored legacy” changes may be flushed out. Shallow flow paths are a feature of the run off of the excess together with anoxic damage to the ecosystem of agricultural land (as occurred with one farmer featured in the national news earlier this year).

Fire destroys the above ground biomass, while below ground the soil and rock may be affected by the extreme temperature (and of course peat may continue to burn for some time). Loss of biomass alters the way rain runs off the landscape, increasing what Prof Knapp called soil’s hydrophobicity. Hydrophobic soil is formed when a fire disperses waxy compounds found in the uppermost litter layer consisting of organic matter. This feature in turn itself affect the way water runs off the land.

So there we have it Prof Knapp concluded. Temperature increase, precipitation increase and increased concentrations of carbon, nitrogen and

phosphorus. There is a need for greater understanding of how things work, of the dominant processes in extreme events to enable useful forecasting with associated relevant anticipation and preparation. We need more data.

This was sobering stuff (as if all the other climate change information we receive is not). We thanked Dr Knapp for her thought provoking presentation.

**Durham Cathedral - a geologist’s view led by Brian Young, formerly of the British Geological Survey. 20th April 2024**

We met close to the front of this great building and were soon taken in hand by Brian. Why does the cathedral look the way it does? He invited us to look at it as rearranged geology

The site? A loop on the Wear carved out during and as a result of glaciation and its related debris - previously the river had run northwards and joined the Team river to join the Tyne. Its course was diverted by debris and subsequently carved the canyon around the site of the cathedral.

The selection of the cathedral as the site of St Cuthbert’s shrine is well documented. The body of the saint travelled from Lindisfarne to various sites, spending around a hundred years in Chester le Street before arriving in Durham in 995. A church was built around it but after the Norman Conquest a cathedral church was commenced in 1093 to be built around the shrine to St Cuthbert and was completed within a remarkable 40 years.

Brian advised us that perhaps 300 people worked on the building at the height of its construction and it was at the time a show piece of the “cutting edge” in construction. The pointed rib arches evident in the vaulted structures are the earliest surviving use of this form.

The original building is built on a bedrock of sandstone (forming part of the middle coal measures) with no foundation and has not moved. A site for the stone used has been located across the river at a spot now occupied by allotments so it seems it did not travel far and a putative route of transport has been traced in the existing street pattern. The stone is identified as low main post sandstone. Local quarrymen or miners have named a number of distinct sandstone units within the Pennine Middle Coal Measures Formation. These include (from the lower part of the sequence upwards) Durham Low Main Post and Seaton Sluice Sandstone, High Main Post Sandstone, Seventy Fathom Post Sandstone, Grindstone Post Sandstone and Clousden Hill Sandstone.

Our guide pointed out the triforium (the gallery above the side aisles) and explained how the vault we see has a wooden roof above it. He described how the lime mortar used was only really usable and "binding" in warmer temperatures, which makes the forty year construction even more remarkable.

He pointed out the chevrons in the pillar designs and described the structure of these pillars with rubble infill. Many of the windows are clearly later revisions with their fine tracery work. Attention to colour regularity in the sandstone was not a priority leading as we saw at one point to what are handsome variegations in the appearances of the walls, where modern repairs now stand out all the more with their uniform colour.

We looked at the flooring in the choir which includes a black marble, probably of Irish origin (perhaps Kilkenny Marble?). We were reminded of the skill these builders must have had in levelling the floor and setting the pillars vertically.

The cathedral had a major refurbishment in the the 19thC - the elaborate clock of the 15th/16thC was considered too frivolous and was removed, to be returned in the 1930s.

We then looked at one or two parts of the cathedral in more detail. The pulpit is part of the 19th C refurbishment and includes Devonian limestone, not a true marble, popular at that time, with detail including alabaster, serpentinite (from the Lizard, also Ayrshire), lazulite (Afghanistan) and Egglestone limestone. This last, long recognised as an attractive building material, had many merits over other building materials: it could be extracted in large blocks, had an attractive colour and was suitable for carving. John Leland on his tour of Britain in the sixteenth century wrote *'About a quarter mile beneath Eggleston is a faire quarrie of black marble spotted with white, in the very ripe (edge) of the Tees.'*

Of course we saw plenty of evidence of Frosterley Marble used here - our guide explaining that it was available from the 12th C, and that it has been used as far afield as Sydney. He mentioned that its widespread use was linked to the dissemination of Christianity as it was much in demand in the medieval period for decoration in churches - it was used in the pulpit base at the cathedral in Mumbai.

The Victorian pavement of the choir was the next area to receive our attention. Serpentinite features here once more. The cylindrical piers in the choir are furnished with spiral patterns, supposedly providing a link with the spiral columns used in front of the altar at St Peter's in Rome. There is evidence to suggest that medieval builders used spirals to highlight areas of special sanctity.

We took in the Neville Reredos built in 1380 possibly in celebration of the English victory at

Neville's Cross in 1346. The work has been executed in a Jurassic limestone from northern France which was suitable for the fine detail required. The screen was adorned with more than one hundred statues but these were removed and hidden by the monks at the time the reformation. It would have painted and gilded, offering a dramatic aspect to the visitor.

Adjoining the choir on the south side is the substantial tomb of Prince Bishop Tomas Hatfield who died in 1381. A capable man, with no small opinion of his capabilities, he wished to be interred as close to the high altar as possible.

Standing back to take in the broader view once more it was explained to us that the cathedral was built from east to west, perhaps minimising the disturbance to the flow of pilgrims to St Cuthbert's shrine at the eastern end.

The Lady Chapel at the west end of the building was added in the later 12thC. As women were not permitted beyond a defined line (we stood, all of us, on the "wrong" side of it) this was provision for them. Unlike the main cathedral it is built with foundations as it is at the edge of the bedrock - we saw evidence of this in one slightly distorted arch. The Purbeck marble used in its columns has been degraded in part by pollution.

The Nine Chapels eastern extension was built in the 13th century. Brian pointed out the use of Frosterley marble in the columns and how the quality of the stone used varied.

Along the way he reminded us of the role of clerics in the first use of the word "*geologia*" by the cleric Richard de Bury (1287-1345) relating this to the knowledge and study of the laws of the earth and distinguishing it from "*theologia*" the knowledge and study of things divine.

This was some tour and Brian pointed out at the outset that we would be hearing only a small part

of what was to be learned in examining the fabric of the cathedral. He is clearly an enthusiast and it was apparent what great reserves of knowledge were available for him to draw upon in revealing the story of these stones. He was thanked for the illuminating tour he had given us.

### **Kepier Woods and Bishop Middleham Quarry Nature Reserve. 12<sup>th</sup> May 2024**

#### **Karl Egeland-Erikson**

This trip has an excellent set of materials prepared by the leader (Karl Egeland- Erikson); this report concentrates on the members experiences. Starting from the Belmont car park the large group carefully made their way to the route down to the River Wear. We quickly became aware of a thick, massive 'post' (known as a bed today) that formed the southern bank of the river. The rock was a fairly uniform sandstone with wide jointing and extremely well-developed cross bedding structures reflecting the deltaic environment of their formation.



**A sense of scale of the quarrying may be gauged by the depth from the riverbank of the quarry face which was present through much of the length of the walk.**

The exposures were near continuous with multiple abandoned quarries with what members took to be the remains of a waggon way type structure on the river bank. Discussion established the rock formed some 315Ma, a little north of the equator. The characteristics indicated that the environment of formation was a major delta draining a large continental mass. The river appears to have meandered producing a variety of cross bedding structures. The crust was clearly subsiding as the materials were all of shallow water origin, the cause of this may well have been crustal loading due to the mass of sediment but also possibly some tectonic processes. The 'post' is known as the Durham Low Main Post.

There were thin, patchy coal lens towards the end of the exposures we viewed. This bed is interpreted as a closing phase of a massive cyclothem. Iron concretions supported a tropical origin of the sediment whilst one exposure of a coarse conglomerate gave testimony to a fast-flowing current. Careful examination revealed grain size variations suggesting variations in the current flow. Karl developed the research of this sequence to suggest it represented the infill of a sedimentary basin developed with the formation of supercontinent Pangea. A glacial episode could account for the cyclicity of a cyclothem at the time of formation. Discussion on the origin of the gorge like structure of the R. Wear at this locality proposed a process similar to that seen at Claxheugh rock, (Sunderland) due to overflow waters from a large glacial lake during the recent glaciation. The meandering course could indicate a sea level control that restricted the downcutting action for the recent river. Other suggestions were made! Members also took pleasure in identifying a few plant species in the area: Hazel, pendulous grass, barren strawberry being examples.

The group had lunch and moved on to the Bishop Middleham area where an inter-war magnesium limestone quarry was explored.

Geologically the area was interpreted as an inland lake with evaporation encouraging precipitation of lime rich sediments. The water became very alkaline allowing dolomitisation to develop. The resultant rock proving to be exceptionally effective for many civil engineering activities.



Karl outlining the features of the quarry exposures.

In the quarry two sides displayed quite different lithologies, the thin bedded area indicating shallow water environments with ripples and rarely some oolitic textures. The other side displayed more massive bedding suggesting deeper water formation. The quarry was affected by multiple faults, ground water had followed some to de dolomitise the rock. This facies was more resistant than the dolomitised sediments. Today the quarry is an SSSI, members enjoyed identifying some lime loving species. Expert study of the area indicates that four facies can be described: dolomitic limestone, dolomite - thinly and thickly bedded, topped by more dolomite which has a more yellow appearance than the lower layers which vary from buff brown to grey. Interpreting the environment of formation suggests: Sedimentation in lagoonal desert environments. Other desert environments are recognised.

The party thanked Karl for another exceptional day 'in the field'. NEGS members were reminded that the next trip is to the Northumberland coast on June 15.

## **ADMINISTRATION**

The newsletter aims to provide a record of lectures and field trips for the benefit of members and visitors to the website. Members can email the editor at [huttonsedgewick@gmail.com](mailto:huttonsedgewick@gmail.com)

<http://www.negs.org.uk>