

**QUATERNARY OF HS2  
JOINT MEETING - QRA ENGINEERING RESEARCH GROUP  
AND ENGINEERING GEOLOGY GROUP OF THE GEOLOGICAL SOCIETY**

**Thursday 15<sup>th</sup> and Friday 16<sup>th</sup> June 2023, Birmingham and Midland Institute**

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The aim of this meeting was to showcase the wealth of data collected by the HS2 scheme, the role that (Quaternary) geoscience plays in major engineering schemes and to explore the research potential of engineering geology datasets collected for the scheme. It brought together people from both industry and academia and made visible geological findings that hadn't previously been public. The meeting was part of HS2's Learning Legacy commitment with a contribution from the QRA Engineering Research Group. HS2 is the largest infrastructure project in the UK for a generation and provides a unique opportunity to access and learn more about a huge range of both Quaternary and non-Quaternary geology. The route crosses multiple glacial limits (insert number and age based on your preferred stratigraphic interpretation!), significant river systems (Warwickshire Avon, Trent)

and large tracts of periglacially altered mudrocks and will create exposures larger than are usually available in these sequences. One such exposure was visited on the first day of the meeting by 10 participants at Cubbington, south of Coventry, which presented a fantastic cross-section through the West Midlands glacial sequence including the Baginton-Lillington sands and Thrussington and Oadby Tills amongst others (Figures 1 and 2). The field visit also allowed discussion of geotechnical approaches for reuse of Quaternary sediments in very tightly specified embankments and for ensuring long-term stability and climate change resilience of cuttings formed in these materials. We are grateful to **Steven Hassall** (BBV, Balfour Beatty Vinci) who facilitated the visit and site geologists **Sarah Onions** and **Michael Vance** (both of Mott MacDonald) who led the scientific discussion.



**Figure 1.** Group photo before entering the cutting, *Sarah Trinder*.

The day of talks on Friday was attended by c. 70 people (87% industry, 13% academia) and hosted in the Birmingham and Midland Institute in central Birmingham. We were treated to a packed programme of talks with a sandwich lunch. It was great to see many contributions from those who were earlier in their careers as part of their journey towards chartered status. The first session started with a keynote by **Sarah Trinder** (Lead Geotechnical Engineer, HS2) who set the scene by describing the carbon-reducing aims of HS2, the scale and phases of the project and the scale of the associated geoscience inputs needed





**Figure 2.** Participants in the Cubbington cutting, *Sarah Trinder*.

to deliver the project. The ground investigations supporting preliminary design of the scheme involved nine different companies that comprised a third of the UK's total ground investigation capability. The scale of HS2's ground investigation led to the new discovery of a Palaeocene pebble bed at Ruislip<sup>1</sup>. Following on, **Sam Hazell** (Arup) then outlined the findings of ground investigations from Phase 2a, which crosses the Trent and also multiple areas of glacial and glaciofluvial deposits. Safely recording exposures in trial pits is challenging and he showed how the use of 360-degree cameras both increases safety and avoids shadowing that is often present in photographs taken from the edge of the pit. The results of 360 degree cameras also allows field geologists to be trained in effective identification of different Quaternary sediments in the field. Next up **Joe Mazgajczyk** (Mott Macdonald) gave us more detail on two hitherto unknown deep (c. 28 m) bedrock channels filled with glaciofluvial gravels that were encountered in the Tame and proto-Tame valleys during ground investigations for the new Curzon Street station in Birmingham. This highlights the limitations of BGS mapping of Quaternary geology in many regions of the UK, particularly those not remapped in recent decades. Then heading into coffee time **Paul Fish** (Jacobs) outlined the work undertaken by HS2 (Moore *et al.*, 2022)<sup>2</sup> to predict the location and severity of

various geohazards along the Phase 1 and Phase 2a route based on detailed engineering geomorphological mapping of geospatial datasets. This work was used to support interpretation of ground investigation data and development of engineering ground models at the detailed design stage of the project.

After coffee the second keynote was delivered by **Julian Murton** (University of Sussex) who outlined the significant diversity of periglacial features that could be encountered during these works and how these might affect engineering properties of the ground, including deep weathering of mudstones, relict shear surfaces in clays and spatial variations in permeability arising from relict ice wedge casts and patterned ground. This talk was followed by a case study from **Guillermo Mondejar** (Jacobs) who outlined the challenging ground conditions encountered during design of the 3.4km long Colne Valley section due to past periglacial activity. Guillermo's talk highlighted the value of 3D geological models for understanding complex spatial relationships in the sub-surface. **Harry Saroglou** (EKFB, Eiffage, Kier, Ferrovial Construction and BAM Nuttall) then treated us to a beautifully illustrated talk on chalk dissolution features encountered during tunnelling in the Chilterns. As well as providing an excellent phone-photo opportunity for many in the audience (Figure 3), Harry also explained how microgravity surveys were used to identify the clay infills of these features that, untreated, pose significant challenges for the long-term stability of cut slopes and engineering

1 <https://www.gov.uk/government/news/hs2-workers-discover-ancient-coastline-in-west-london>

2 <https://www.lyellcollection.org/doi/pdf/10.1144/qjegh2021-122>

performance of high-speed railway tracks. **James Ogden** (Jacobs) followed this with an excellently clear explanation of the construction of tunnel shafts in the Chiltern Hills, illustrating the importance of detailed ground investigation and logging to enable shafts to be sited away from dissolution features and to take account of periglacial weathering of the chalk. The meeting then moved to an excellent buffet lunch which fuelled many animated conversations and the creation of new links and networks. The third keynote from **Seb Gibson** (Cambridge) outlined the findings of new research into the glacial sequence in the West Midlands and along the route of HS2 (Gibson *et al.*, 2022)<sup>3</sup>. He noted that his research brought the controversial Wolstonian ice limit much further south than previously thought, reinterpreting some sequences previously assigned to the Anglian, and dated them using OSL to two different phases of ice advance at c. 200 ka and c. 150 ka. He also brought our attention to a new Hoxnian sequence at Gilson, immediately south of HS2 near Coleshill (Gibson *et al.*, 2023)<sup>4</sup>. A nice touch, given the post-lunch timing of the talk, was the use of significant railway terminology in the talk. After this, **Vincent D'Oriano** (Mott MacDonald) discussed how to deal with compressible glaciofluvial deposits in geotechnical design of earthworks for high-speed rail. Difficulties with applying cone penetration testing in locations with large cobbles led to the development of an instrumented trial embankment which yielded better data enabling them to cut costs by decreasing the conservatism in designs. This was followed by two talks on halite karst, which is a characteristic of much of the Phase 2a route that crosses the Cheshire Basin between Birmingham and Crewe. The first of these, by **Colin Serridge**, (Edge Hill University) explained the concept and processes involved in mere formation and introduced the audience to various Cheshire meres formed naturally and in one case (Melchett Mere – Serridge and Cooper, 2023)<sup>5</sup> induced by salt pumping during the industrial revolution, particularly from the late 1920s onwards. This was followed by **Peter Sharp** (Mott MacDonald) who shared with us his experience of working in these landscapes, stressing the importance of monitoring gradual change rather than assuming stability. Our final talk of the session was from **Nicole Metje** (University

of Birmingham) who introduced us to their National Buried Infrastructure Facility, the research facilities they have and some of the projects they are currently undertaking in collaboration with industry.

After a break, the fourth keynote was delivered by **Kevin Briggs** (University of Bath) who brought some results from his ongoing Senior Research Fellowship (Bath University/Royal Academy of Engineering/HS2 co-funded) on the periglacial weathering of clays in mudstones such as the Charmouth Mudstone Formation of the Lias Group, an under explored area compared to the many studies on the London Clay. Detailed laboratory testing, in situ heave trials and investigation of boreholes over an 18 km transect identified a group of deposits that look like mudstone but have the strength of a clay due to weathering. These can only be identified on visual inspection, stressing the need to train loggers well (Briggs *et al.*, 2022)<sup>6</sup>. This periglacial theme was continued by **Giles Hemmings** (EKFB) who explained how LiDAR had been used to identify historical landslides and relict periglacial shear surfaces, with nearly half the route inspected (47 km) affected, even when slopes were of very low angle. By further analysis of these slopes, using a classification into four risk categories, it was possible to determine the most hazardous shears (covering c. 2 km) and focus remedial action in these areas. In our final talk of the day, **David McCandless** (Mott MacDonald) outlined work on rapid assessment and characterisation of Quaternary sediments removed during cutting formation to maximise reuse of the material within earthworks on site. Material reuse, with a mandated earthworks balance between excavations and embankments, is a critical part of the project's requirement to reduce carbon by 50%. Use of 2D models fail to capture sufficient detail, but by using 3D models and a detailed classification of material properties, a greater percentage of sediments were seen to be suitable, without the need for carbon-intensive lime treatment to improve its engineering performance.

A short discussion was then held between all the participants about how to maximise the learning legacy from this project. **Sarah Trinder** (HS2) noted that all HS2 data will eventually be publicly available, with all AGS data passed to BGS. Sarah stressed that HS2 are able to accommodate requests to access data directly in the meantime and that site visits to

3 <https://royalsocietypublishing.org/doi/pdf/10.1098/rsos.220312>

4 <https://onlinelibrary.wiley.com/doi/pdf/10.1002/jqs.3537>

5 <https://www.lyellcollection.org/doi/pdf/10.1144/qjegh2022-081>

6 <https://pubs.geoscienceworld.org/qjegh/article/612135/The-influence-of-weathering-on-index-properties>



collect samples or to view core were possible, with appropriate planning and scientific justification. **Dave Giles** (Card Geotechnics Ltd) stressed that while data is useful in general, for specific academic research, such as improving the understanding of Quaternary stratigraphy, samples collected from site exposures are crucial (especially in the case of dating). It was noted that the project offers a perfect opportunity to sample the entire Mid to Late Pleistocene of England over a 100km long cutting while work is ongoing. A lively debate then ensued about how such ‘rescue geology’ might be undertaken and possible sources of funding. This debate is to be continued offline.

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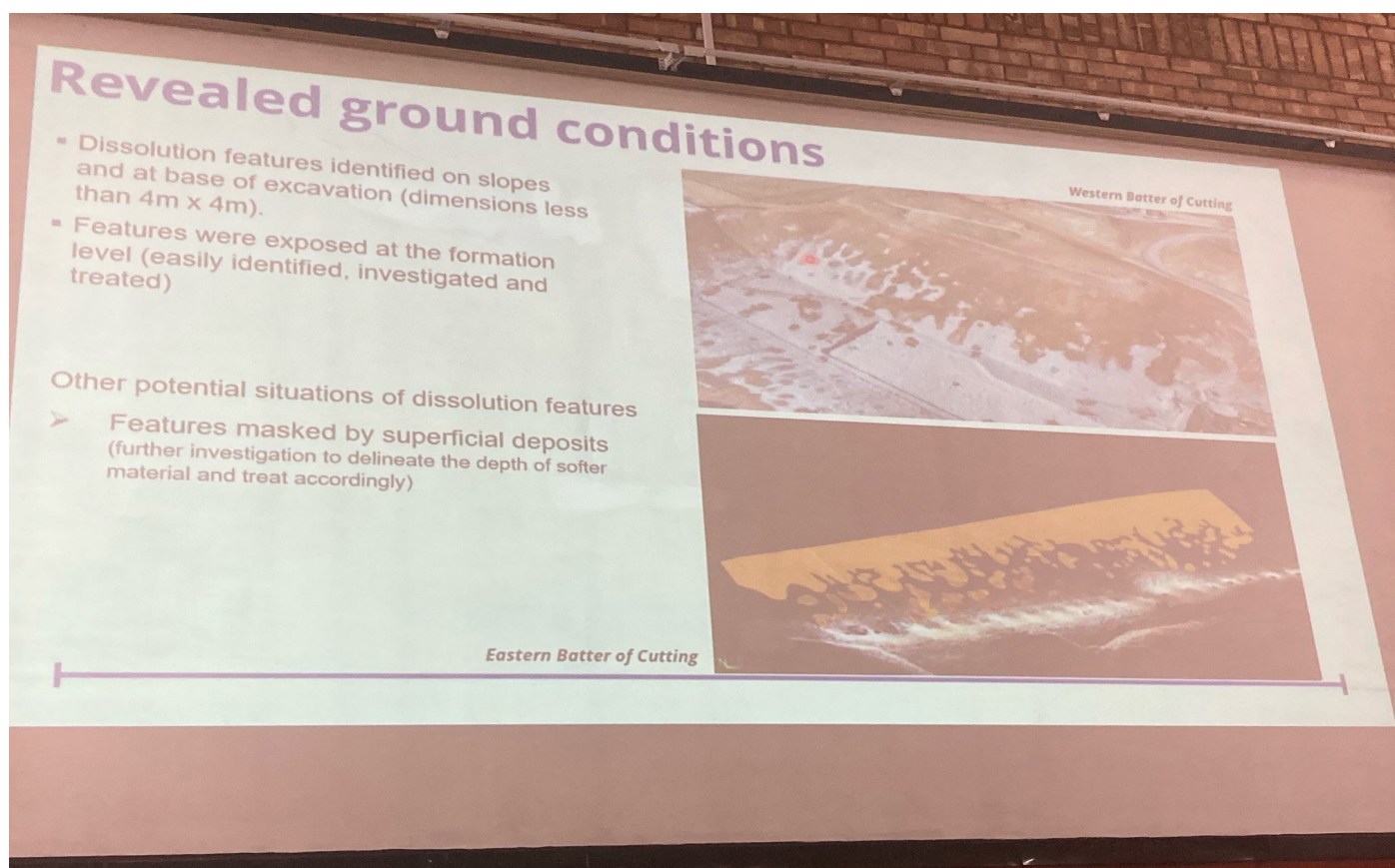
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**Figure 3.** Chalk dissolution features encountered during tunnelling in the Chilterns (Harry Saroglou, EKFB, Eiffage, Kier, Ferrovial Construction and BAM Nuttall), *Paul Fish*