Home Counties North Regional Group Newsletter

Issue No. 20 - February 2023

HCNRG field meeting party at
Horniman Museum in Forest Hill, London, February 2023
© Rudy Domzalski FGS

CONTENTS

Abstract of Crystal Palace Dinosaur Park tour
John Wong FGS
Chair, Home Counties North Regional Group
P48

HOME COUNTIES NORTH REGIONA GROUP FORTHCOMING LECTURES 2023

Abstract of Home Counties North Reginal Group face-to-face lecture
'Mineralogy and Minerals of Chipping Sodbury, South Gloucestershire'
at RSK Hemel Hempstead offices on 23rd February 2023
Presented by Stuart Wagstaff FGS Director, Soil Consultants Limited
Past Chair of Home Counties North Regional Group
P48 – P49

Abstract of Home Counties North Reginal Group lecture on Zoom on 28th March 2023
'Some aspects of natural and anthropogenic halite (salt)
karst subsidence in north Cheshire'
Presented by Dr Colin J Serridge
Senior Lecturer in Earth Sciences, Edge Hill University, Ormskirk
P50 – P51

BIMONTHY NEWSLETTER ARTICLE CONTRIBUTORS

Home Counties North Regional Group bimonthly newsletter article contributors update from Newsletter issue 7, May 2020 (first bimonthly newsletter), to current issue 20, February 2023 (Newsletters prior to issue 7 were published annually).
John Wong FGS
Newsletter Editor, Home Counties North Regional Group
P52 – P53

HOME COUNTIES NORTH REGIONAL GROUP
CHAIR'S REPORT FEBRUARY 2023

John Wong FGS

Dear Home Counties North Regional Group members,

Belated Happy New Year to you and your families; I wish you all a healthy, successful and prosperous New Year.

As we start this new year, our committee will hope to build on the momentum from what we have achieved in 2022 and learn from the attendance records of the HCNRG lectures on Zoom and face-to-face, field meetings, the geology quiz social, and from members' positive feedback on the bimonthly newsletters.

In 2022, there were no HCNRG lectures in May, August, September, and November, due to speakers being indisposed and lectures being cancelled at short notice due to other priorities. This is something the committee had not envisaged before and we shall look into having back-up speakers, who can be contactable and step in at short notice.

As for the newsletters, there has been prolonged discussions during the extreme heatwave in the summer of 2022, with many debates on whether the newsletters should revert to publishing annually and be restricted to reporting past HCNRG events, as was the format originally and in all the newsletters published before Newsletter issue 8. The production of the bimonthly newsletter scheduled to issue in August 2022 was delayed. Later, with the complimentary feedback and many enquiries from the HCNRG members, the production of the bimonthly newsletter was resumed with the roll-out of Newsletter issue 19 in October 2022.

I am most grateful to every newsletter article contributor, a big thank you from me and a much bigger thank you from the readers of the newsletters; members sent in their compliments saying how much they have enjoyed reading the articles. My apologies to a small number of the contributors for having omitted their names from the list of contributors published in Newsletter issue 19, I will rectify this in this newsletter.

The momentum of the HCNRG events accelerated before the close of 2022 with two events delivered in December – A group visit to IBIS Limited in South Woodford organised by me and hosted by Barry J Hunt FGS, and an afternoon Christmas Geology Quiz social organised and hosted by our treasurer Mick McCullough FGS in High Wycombe.

To spearhead the Home Counties North Regional Group's activities in 2023, I have organised two events in February - The first event is on 13th February, a guided tour hosted by Dr Emma Nicholls FGS, who is the Senior Curator at the Horniman Museum in Forest Hill; I will give a talk on the local geology and the building stones of the museum and will facilitate an on-site building stone analysis practical. The second event is booked for 23rd February, at RSK's offices in Hemel Hempstead, a face-to-face lecture to be presented by our past Chair of Home Counties North Regional Group, Stuart Wagstaff FGS, Director of Soil Consultants; Stuart's talk is entitled 'Mineralogy and Minerals of Chipping Sodbury, South Gloucestershire'. The abstract of Stuart's talk is in this newsletter.

For March, Adrian Marsh FGS has booked a lecture on Zoom on 28th March, when Dr Colin J Serridge FGS, of Edge Hill University, Ormskirk, will talk on ‘Some aspects of natural and anthropogenic halite (salt) karst subsidence in north Cheshire’. The abstract of this talk is in this newsletter. The flyer will be sent to members shortly.

Gerald Lucy of Essex Rock and Mineral Society has accepted Adrian’s invitation to present a face-to-face talk entitled ‘Geology of Essex’ on 4th May at a venue in Bishops Stortford in East Hertfordshire District. We have not yet received the abstract of Gerald’s talk. Nevertheless, I have known Gerald for more than a decade and he is very knowledgeable on the geology of Essex.

Also in May 2023, Adrian has arranged a lecture on Zoom on 23rd May when Dr Margaret Stewart of the British Geological Survey, Edinburgh, will talk on ‘Tunnel valleys of the North Sea’. We have not yet received the abstract of Dr Margaret Stewart’s talk. I believe the talk is relating to the research on the glacial history of the North Sea,

I am in the process of putting together a few field meetings and workshops, all non-repeated and tailor-made. The locations of these field meetings will be spread around the region, as before the first lockdown in 2020, to offer more choices and to benefit as many HCNRG members as possible in different parts of the region. There will also be special field meetings in locations outside the region, such as visits to large industrial working quarries.

Many of our FGS members are not in the geotechnical profession and I think it would be beneficial to them to have a first-hand insight into the work of ground investigation and geotechnical engineering, so I asked Jon Bailey FGS, Director of RSK, whether it is possible to have a group visit to RSK’s Hemel Hempstead offices for an introduction on ground investigation and geotechnical engineering. Jon kindly said they can certainly investigate arranging such a visit but will need time to get arrangements in place as most of their geotechnical team are still working remotely most of the time. Jon, your help is gratefully appreciated.

HCNRG field meetings are organised for the benefit of HCNRG members with priority given to Fellows, Candidate Fellows and Juniors of the Geological Society who are members of the HCNRG; while other applicants may apply, their applications are to be put on the waiting list in the first instance with the decision to offer places to applicants on the waiting list only made after the application for places is closed and at the discretion of the field meeting leader.

Our career/job search liaison assistance programme is still open. I was amazed when I spoke to a HCNRG member at a recent field meeting; the member had been made redundant from a professional geoscience position and is currently doing a non-geoscience-related part-time job in the local area. The member was not aware of the HCNRG career/job search liaison assistance programme, so I advised the member to contact me (for oil and gas, education, general geology), Rudy Domzalski (for oil and gas) or Adrian Marsh (for geotechnics) for assistance in introducing prospective employers and arranging interviews for geoscience professional positions. I would like to thank past HCNRG committee members Suzie Lednarova FGS and Chloe Lam FGS for their extensive research and collation of valuable information on prospective employers in geotechnical engineering and the mining industry respectively.

Our committee members are not asking what you can do for the committee, on the contrary we are asking what we can do for you, and we will seek to be proactive, not with words but with action, to assist and serve you within the remit of Home Counties North Regional Group and Geological Society.

The long shadows beneath the low-in-the-sky mid-day sun are getting shorter and shorter by the day, as signs of a new spring are glowing everywhere. Let's welcome the year 2023 wholeheartedly and continue to promote geoscience, not only focusing on the traditional programme of events and pigeonhole-filling geoscience talks and field meetings, but, simultaneously, to engage in other rewarding activities such as outreach to local communities/schools and contributing to the protection and enhancement of RIGS.

The HCNRG Committee members and I are grateful for all your support and your valuable feedback and comments in 2022, we are aware that there is always room for improvement, and we look forward to continuing to serve you by delivering more geoscience events and activities, and one-to-one support, and, of course, more geoscience articles in bimonthly newsletters.

I hope every HCNRG member has a great year in 2023. Our elected committee members hope the same for all of you too.

Take care and best wishes,

John Wong FGS, Chair, Home Counties North Regional Group

HOME COUNTIES NORTH REGIONAL GROUP NEWSLETTER ARTICLE REVIEWS

John Wong FGS
HCNRG Newsletter Editor

Dr David Brook OBE FGS's article in this newsletter entitled '**Jurassic dolerites in the Theron Mountains, Antarctic. Part 2: Petrography**' is a follow-up of his article '**Jurassic dolerites in the Theron Mountains, Antarctica'** published in Newsletter issue 19.

In the first article Dr David Brook OBE described in detail the field relations and physiographical characteristics of the dolerites based on his unpublished draft scientific report written in the early 1970s

This (second) article extends that description to the petrography of the dolerite intrusions, which range from the extreme olivine-hypersthene-orthocumulates of the layered sills to the granophyric quartz-dolerites of the scarp-capping sill and the middle sill of Coalseam Cliffs. The description of the petrography of the dolerites is based on thin sections and a few specimens subject to x-ray diffraction analysis, with modal analyses of different intrusions.

The photomicrographs produced by Dr David Brook OBE with informative captions shown in the article, are invaluable references for igneous petrologists, mineralogists, microscopists, stratigraphers, and interested geologists for future research, and of course the information would enrich the geology knowledge of the Home Counties North Regional Group members.

Dr David Brook OBE FGS once said to me, I quote '**Throughout my professional life, I have always said that, if you give me a hand specimen, I will have a reasonable stab at identifying it but if you want to be sure I need to see a thin section**.' I am sure every geologist would agree. My grateful thank you to Dr David Brook OBE for writing such detailed and informative petrography and igneous petrology article, it is a knowledge treat that I appreciated very much.

******** ******** ********

Roy Dunn FGS, has contributed geology articles to the Home Counties North Regional Group bimonthly newsletter before, he is a specialist in tectonic and structural geology research. Roy's article this time is entitled '**Is New Zealand's South Island Alpine Fault equivalent to the Caledonides Great Glen Fault?**'

In the article, Roy compares the Great Glen Fault in Scotland with the Alpine Fault in the South Island of New Zealand in terms of plate tectonics, tectonic terranes, seismic activities, polarity, fault movements, and geomorphology. The sinistral transcurrent movement on the Great Glen Fault is well known, it is related to the final stages of the Caledonide Orogeny; recent research has shown a mapped structure near Loch Linnhe, southwest of the Great Glen Fault, to have a dextral movement; there were previous discussions about possible normal or reverse movement on the fault.

Thank you very much Roy for sharing your latest finding on the Great Glen Fault and highlighting how it compares and contrasts in its tectonic activities with the geologically younger Alpine Fault. A concise and entertaining article which showcases one of the most famous geological structures on the British Isles. I shall look forward to another structural geology article on British geology from Roy, to whet the appetite of the HCNRG member readers of the newsletters.

******** ******** ********

Barry J Hunt FGS is a consulting chartered geologist and surveyor specialising in the survey of stone-clad buildings and the investigation of construction issues where natural stone is involved. In December 2022, HCNRG members had a most welcoming group visit to IBIS Limited hosted by Barry; everyone on the visit appreciated Barry's unreserved enthusiasm in sharing his extensive academic and over 35 years of professional expertise in petrographic thin sections with us. I asked Barry whether he would write an article on Yorkstone for the HCNRG bimonthly newsletter, and I am so pleased that I have not been disappointed. Barry's article in this newsletter is entitled '**Yorkstone, so famous, yet so elusive**'.

The article is very professionally written with extensive information, yet the content is concise, educational, and entertaining to read; it is packed full of expert knowledge and thoroughly researched materials - the conundrum of the name of the stone, town of Elland in West Yorkshire, geological history of the Namurian and Westphalian stages of the Carboniferous Period, quarries, sedimentology, mineralogy, microscopy, wet and dry strength values, slip resistance test, weathered patina, masonry, ashlar, roofing and paving, are amongst so many subjects have mentioned relating to 'Yorkstone'.

Barry's concluding remarks are so well presented, quote '**I am convinced that Yorkstone is a figment of our collective imagination. This is the prime example of the problems with the naming of stone**

and how this can lead to imitation. We must stop using the term Yorkstone as it serves the natural stone industry no good and we should instead promote the many wonderful Carboniferous sandstones that there are, not just from Yorkshire but from around the UK. Don't ask for Yorkstone any more, ask for Carboniferous sandstone with a colour and texture, you'll be amazed at the variety that is available.' My review remark? The best building stone article I have ever read to date, exceptional. Thank you very much Barry for writing the article.

******** ******** ********

Adrian Marsh FGS, HCNRG committee member, is a retired engineering geologist. His article is entitled '**Landslide in the Oxwich Head Limestone Formation at Oxwich Bay, Gower, south Wales**'.

During Adrian's holiday in Wales in September 2022, he took the opportunity to observe the aftermath of historic large landslides and rockfalls in 2009 and 2019 affecting the Carboniferous Oxwich Head Limestone Formation in the coastal cliff southeast of Oxwich.

In the article, Adrian introduces the regional tectonic framework and local field relations setting of the Oxwich Head Limestone. Field evidence shows that the progressive failure mechanisms that have contributed to the coastal landslides are periodic winter rainstorms, winter rainwater infiltration on the headland plateau above the landslide, winter groundwater pressures, coastal erosion, increased stress relief resulting from historical quarrying, valley cambering formed during past periglacial conditions, reduction of shear strength in clay, and basal sliding on weathered palaeosols.

A good and concise account of coastal landslides and rockfalls; the location maps, aerial photograph together with pictures taken on site make good reference materials for future observation in the area. Thank you to Adrian for sharing his holiday geology observation knowledge with the HCNRG members, much appreciated.

******** ******** ********

Chris Vincett FGS, Associate Technical Director of Hydrock Consultants Limited, presented a lecture with Allan Bell FGS, also of Hydrock Consultants Limited, to the HCNRG audience at University of Northampton in October 2022, he has kindly taken up my invitation to write an article on their lecture entitled '**Ground investigation and beyond – the development of geotechnical design**'. Chris is the best person rather than a member of the attendee audience to write a report of the lecture on this occasion.

My profound thanks to Chris Vincett for writing such a detailed article revealing the full content of their informative lecture, reviewing current best practices on the geotechnical design processes, with many examples and case studies. Chris said that Ground Investigation is a process of exploration, making uncertainty less uncertain; as there will always be a degree of risk in the ground, the objective is to reduce risk as far as possible; Best Practice and Best Available Techniques should be used at all stages. Chris also commented that, quote' **Ground Investigation is a process of exploration of the unknown, whereby the initial conceptual ground model is drawn up from whatever evidence is available, be it from geological maps, geomorphology seen in walkover surveys, and from earlier exploratory work. Geologists are trained to think in three physical dimensions as well as the fourth dimension of time, to obtain an initial concept of what there might be under the ground**.'

The article is an excellent reference for ground investigation engineers as well as being an ideal introduction for geologists and geoscientists who are not geotechnical professionals.

******** ******** ********

Doris Southam FGS, HCNRG member, attended the group visit to IBIS Limited, she wrote an article entitled '**Visit to IBIS Limited on the 13th of December 2022**'.

Doris said the visit turned out to be fascinating, not only to learn and refresh our knowledge of petrographic thin section preparation, micromorphology, but also to learn about the application of these analyses in criminal and legal disputes; and said that Barry generously shared his knowhow and enthusiasm for the subject with us. Despite the difficulties that day with train strikes, this field trip was well attended; with so much enthusiasm for further information, Barry generously sent a list of "further reading" and reference works, pertaining to metamorphic, sedimentary, igneous and volcanic rock analysis.

Thank you very much to Doris for writing the report.

******** ******** ********

Richard Trounson FGS, HCNRG member, attended the group visit to IBIS Limited, he wrote an article entitled '**Report on the talk on Petrographic Thin Sections by Barry Hunt FGS of IBIS Limited, on 13th December 2022**'.

Richard said in the closing remarks of his report, he said, quote '**All in all, Barry not only gave us a basic, but valuable, refresher course on topics many of us had first learned about many years ago. He also gave us a fascinating insight into how an earth scientist can carve out a most interesting niche career in this country, in fields outside the conventional domains of academic geology, engineering geology and the petroleum and water industries**.'

Thank you very much to Richard for writing the report.

******** ******** ********

Thank you to **Dr Bryan Lovell OBE FGS** for sending in his **letter sent to The Hertfordshire Mercury weekly newspaper** on his thought on the **geology-climate exhibition at Hertford Museum**, it was published on 12th January 2023. The exhibition is highly recommended to see, until 16th April 2023. I shall arrange a HCNRG Hertford walk part II and visit Hertford Museum see the exhibition before the closing date of the geology-climate exhibition. I led the Hertford walk on 21st June 2014. Dr David Brook OBE wrote a five-page report of my Hertford walk field meeting and it is published in the HCNRG newsletter issue 2. Dr Bryan Lovell OBE met our field meeting party on the day at Hertford Castle and gave a talk on Puddingstone and Climate Change.

Jurassic dolerites in the Theron Mountains, Antarctic.
Part 2: Petrography

Dr David Brook OBE FGS

Introduction

In the last issue of the Newsletter (Brook, 2022), I gave an introduction to the Jurassic dolerites of the Theron Mountains and described their field relations based on the unpublished draft scientific report I had written in the early 1970s. This second article extends that description to the petrography of the dolerites based on thin sections and a few specimens subject to x-ray diffraction analysis. As with the previous article, I have not attempted to up-date this work from its original drafting.

The intrusions are petrographically variable, ranging from the extreme olivine-hypersthene-orthocumulates of the layered sills to the granophyric quartz-dolerites of the scarp-capping sill and the middle sill of Coalseam Cliffs. Some intrusions were sampled more extensively than others or are significant because of their petrography and these are considered separately below.

Plagioclase compositions have been determined by the extinction angles on combined Carlsbad-albite twins and are probably accurate to within 5% An content. Pigeonitic and augitic clinopyroxenes have been distinguished on the basis of optic axial angles estimated from interference figures. Orthopyroxene and olivine compositions have generally not been determined but fayalitic olivine has been distinguished from more magnesian olivine by its associated minerals and optic axial angle estimated from interference figures.

Modal percentages have been calculated from thin sections using a Swift Automatic Point Counter based on a minimum of 1,500 points. Including specimens reported by Stephenson from the TAE collection, 24 chilled marginal rocks and 28 more crystalline rocks from the interior of sills are reported. Olivine and pseudomorphs apparently after olivine have generally been counted together. Alteration products, which include hornblende, biotite, chlorite and unidentified green and brown material (?bowlingite and iddingsite) have not been differentiated.

The scarp-capping sill

This sill consists predominantly of medium-grained, granophyric quartz-dolerite with plagioclase, clinopyroxene and a micrographic intergrowth of quartz and alkali feldspar with iron ore present throughout, fayalitic olivine, apatite and zircon as common accessories and hornblende, biotite and chlorite as alteration products.

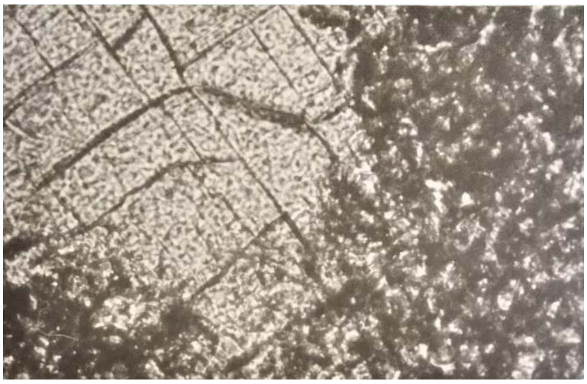
Table 1. Modal analyses of the scarp-capping sill

Specimen number	Micro-pegmatite	Plagioclase	Clino-pyroxene	Ortho-pyroxene	Olivine	Iron	Alteration	Matrix	Counts	Plagioclase composition
TAE 351/6	25	33	29	-	(P)	7	P	-		An_{56}
Z.455.1	33.2	29.4	24.0	-	(2,9)	6.2	4.4	-	3,000	An_{60}
Z.468.1	43.9	31.7	13.5	-	(2.7)	3.2	5.0	-	1,900	An_{60}
Z.484.1	41.0	27.1	20.4	-	(2,4)	4.2	4.8	-	1,500	An_{60}
Z.485.1	31.1	31.6	23.0	-	(1.0)	3.0	9.4	-	2,300	An_{56}
Z.486.1	30.5	31.3	22.4	-	(2.3)	7.3	6.2	-	3,000	An_{57}
Z.487.1	27.2	31.7	27.5	-	-	8.8	4.9	-	3,200	An_{40-50}
Z.508.1	29.8	34.6	21.7	-	(2.4)	4.4	7.2	-	3,600	An_{55}
Z.478.1	31.1	24.5	21.2	-	(1.1)	4.3	17.9	-	2,100	An_{55}
Z.483.5	34.3	25.2	20.2	-	-	5.3	15.0	-	3,000	An_{45-55}

Figures in parentheses refer to fayalitic olivine, others are magnesian olivine; P = present; Alteration products include hornblende, biotite, chlorite, etc.

TAE351/6 Granophyric quartz-dolerite near the centre of the thick wedging sill of Point 2600 (Stephenson, 1966, table 3, analysis 10).
Z.455.1 Granophyric quartz-dolerite about 40-50m below the upper contact on the eastern margin of Wornham Glacier.
Z,468.1 Granophyric quartz-dolerite near the centre of the sill on the south-western margin of Goldsmith Glacier.
Z.484.1 Granophyric quartz-dolerite upper third of the sill at Tailend Nunatak.
Z.485.1 Granophyric quartz-dolerite about 150m below the upper contact in the escarpment between Tailend Nunatak and Goldsmith Glacier
Z.486.1 Granophyric quartz-dolerite about 150m below the upper contact in the escarpment between Tailend Nunatak and Goldsmith Glacier.
Z.487.1 Granophyric quartz-dolerite about 150m below the upper contact in the long cliff immediately north-east of Goldsmith Glacier.

Z.508.1 Granophyric quartz-dolerite about 50m above the lower contact in the escarpment between Goldsmith Glacier and Lenton Bluff,
Z.478.1 Altered quartz-dolerite about 6-7m above the lower contact of the thick wedging sill of Point 2600.
Z.483.5 Altered quartz-dolerite about 6-7m above the lower contact in Marø Cliffs.



Clinopyroxene being replaced by minute granular fayalite.

Zircon needle penetrating hornblende with slight halo effect.

The lower contact is porphyritic with phenocrysts of plagioclase and pyroxene in a hemi-crystalline matrix.

Table 2. Modal analyses of chilled rocks from the scarp-capping sill

Specimen number	Plagioclase	Pyroxene	Olivine	Counts	Plagioclase composition
TAE.351/3	-	(1)	-		---
TAE.351/4	3	1	-		An_{60}
Z.478.4	1.9	0.9	-	6,600	An_{60-65}
Z.478.2	1.8	0.5	-	3,100	An_{60-65}
Z.497.2	2.0	0.6	-	3,100	An_{58}
Z.490.1	1.3	0.4	-	4,500	An_{55-60}
Z.490.2	1.5	1.1	-	1,600	An_{66}

Figures in parentheses refer to orthopyroxene, others are clinopyroxene

TAE351/3 Porphyritic chilled dolerite, upper contact of the thick wedging sill of Point 2600 (Stephenson, 1966, table 3, analysis 8).
TAE351/4 Fine-grained porphyritic dolerite, about 9m below the upper contact of the thick wedging sill of Point 2600 (Stephenson, 1966, table 3, analysis 9).
Z.478.4 Porphyritic chilled dolerite, lower contact of the thick wedging sill of Point 2600, in contact with a thin wedge of fine-grained dolerite.
Z.478.2 Porphyritic chilled dolerite, lower contact of the thick wedging sill of Point 2600, in contact with sediments.
Z.497.2 Porphyritic chilled dolerite, lower contact of the scarp-capping sill in the cliffs along the south-western margin of Jeffries Glacier.
Z.490.1 Porphyritic chilled dolerite, lower contact of the scarp-capping sill in the escarpment between Goldsmith Glacier and Lenton Bluff.
Z.490.2 Porphyritic chilled dolerite, lower contact of the scarp-capping sill in the escarpment between Goldsmith Glacier and Lenton Bluff.

Different intrusive phases

In Marø Cliffs, the first phase of intrusion is olivine-bearing with a cloudy quartzo-feldpathic mesostasis. The second phase, the apparent branch sill of the scarp-capping sill, is a medium-grained subophitic to intergranular dolerite with a poorly crystallised groundmass, which occasionally develops as micropegmatite. The lower contact rock has highly altered phenocrysts of plagioclase in a microlitic groundmass. The third phase is olivine-bearing throughout, vitrophyric in contact rocks to ophitic in the central parts of the sill. The contact rocks have phenocrysts of plagioclase and olivine with rare pigeonite, while the central parts of the sill have plagioclase laths enclosed by pink titan augite with small granular olivines also enclosed by clinopyroxene.

Table 3. Modal analyses of the different intrusive phases

Specimen number	Micro-pegmatite	Plagioclase	Clino-pyroxene	Ortho-pyroxene	Olivine	Iron	Alteration	Matrix	Counts	Plagioclase composition
Z.480.1b	-	45.6	23.6	-	-	1.5	15.9	13.4	2,400	An_{65}
Z.483.9	27.8	34.6	23.7	-	0.4	5.6	8.0	-	2,000	An_{45-50}
Z.481.11	-	41.3	18.5	-	7.0	5.5	16.7	11.0	1,600	An_{70}
Z.483.6	-	36.1	17.7	-	2.4	5.7	27.6	10.8	2,000	An_{75}
Z.471.15	-	44.0	30.6	-	6.6	1.8	17.0		1,500	
Z.498.3	-	41.7	23.3	-	-	n.d.	11.2	23.8	1,600	
Z.471.13c	-	44.9	32.9	-	3.8	1.8	16.6		1,800	An_{64}

Figures in parentheses refer to fayalitic olivine, others are magnesian olivine; P = present; n.d. = not determined; Alteration products include hornblende, biotite, chlorite, etc.

1st-phase sill of Marø Cliffs

Z.480.1b Altered dolerite, near the centre of the sill at its contact with the 3rd-phase sill in the cliffs beneath Point 3300.

Apparent branch sill of the scarp-capping sill (2nd-phase)

Z.483.9 Altered quartz-dolerite, near the centre of the sill in Marø Cliffs

3rd-phase sill of Marø Cliffs

Z.481.11 Ophitic olivine-dolerite, near the centre of the sill at the south-western end of Marø Cliffs.

Z.483.6 Altered ophitic olivine-dolerite, near the centre of the sill at the south-western end of Marø Cliffs.

Younger sills and dykes of Lenton Bluff

Z.471.15 Subophitic olivine-dolerite, about 1m below the upper contact of the sill which cuts the basal sill of Lenton Bluff.

Z.498.3 Intergranular dolerite, about 0.8m from the contact of a dyke in the sediments between the scarp-capping sill and the basal sill of Lenton Bluff.

Z.471.13a Intergranular to subophitic dolerite, centre of the dyke which cuts the sediments beneath the basal sill of Lenton Bluff.

Highly altered porphyritic hemicrystalline dolerite at lower contact of apparent branch sill of scarp-capping sill, the 2nd phase of intrusion in Marø Cliffs; alteration may be of hydrothermal origin.

Contact of the highly altered first- and vitrophyric third-phase sills; the latter has idiomorphic phenocrysts of plagioclase and olivine, while the former is highly altered.

Table 4. Modal analyses of chilled rocks from the different intrusive phases.

Specimen number	Plagioclase	Pyroxene	Olivine	Counts	Plagioclase composition
Z.483.1a	6.3	-	-	2,100	Saussuritised
Z,472.7	10.4	3.8	0.7	4,500	An$_{64}$
Z.472.8	12.9	3.5		1,500	Albitised
Z.472.9	9.4	3.7	0.6	7,900	An$_{60-70}$
Z.472.12a	10.9	4.4	1.1	2.600	An$_{66}$
Z.471.10	11.1	6.7	-	2,200	An$_{60}$
Z.471.14	3.0	-	1.2	3,700	An$_{60}$
Z.480.1a	10.9	0.3	8.5	2,900	An$_{67}$
Z.480.2	8.8	0.5	5.6	3,300	An62

Pseudomorphs of bowlingite and magnetite apparently after olivine have been counted with olivine.

Apparent branch sill of the scarp-capping sill

Z.483.1a Hydrothermally altered chilled dolerite, lower contact of the sill in Marø Cliffs.

Basal sill of Lenton Bluff

Z.472.7 Porphyritic chilled dolerite, contact with sedimentary xenolith in lower part of sill.

Z.472.8 Altered chilled dolerite, contact with sedimentary xenolith in lower part of sill.

Z.472.9 Porphyritic chilled dolerite, contact with sedimentary xenolith in lower part of sill.

Z.472.12a Porphyritic chilled dolerite, contact with sedimentary xenolith in lower part of sill.

Z.471.10 Porphyritic chilled dolerite, lower contact of the sill.

Younger transgressive sill of Lenton Bluff

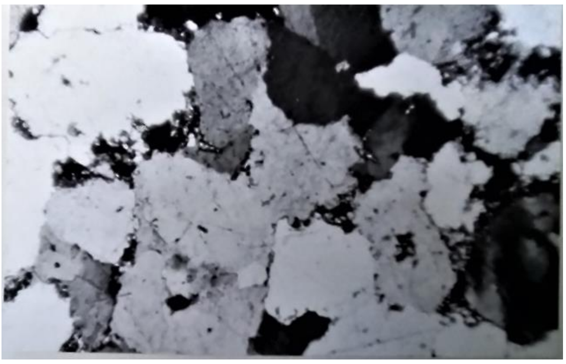
Z.471.14 Porphyritic chilled dolerite, upper contact of sill, in contact with the basal sill of Lenton Bluff.

3rd-phase sill of Marø Cliffs

Z.480.1a Porphyritic chilled dolerite, upper contact of the sill in the cliffs beneath Point 3300, in contact with the 1st-phase sill.

Z.480.2 Porphyritic chilled dolerite, lower contact of the sill in the cliffs beneath Point 3300, in contact with the 1st-phase sill.

In Lenton Bluff, the basal sill is pigeonite- and olivine-bearing throughout, distinctly chilled at the margins and at the xenoliths. This sill is unusual in the number of xenoliths enclosed by the dolerite. The largest xenolith has 3m of mudstone overlain by 5-6m of siltstones. The dolerite above has fibrous radiating veins of chlorite and tremolite (identified by x-ray diffraction) on joint planes. The dolerite has been brecciated and intruded by rheomorphic veinlets derived from the siltstones. The lower contact has a 15cm band of medium-grained sandstone which passes up into the mudstones. A few cm above the contact, sutured quartz grains with strongly undulose extinction are separated by interstitial areas of calcite, epidote, chlorite and prehnite (?) or by micropegmatite. Finer-grained areas have isolated corroded quartz grains in a matrix of fine-grained quartz, epidote and chlorite.




Photomicrographs of specimens from largest xenolith at Lenton Bluff (crossed nicols, x65)

Z.472.6 Sutured quartz grains in recrystallised matrix of calcite, Epidote and chlorite.

Z.472.5 corroded quartz grains separated by recrystallised matrix of quartz, feldspar, epidote, chlorite and calcite.

Just to the south-west, a smaller xenolith shows flow layering in the vitrophyric contact rock. A short distance from the contact, the dolerite is highly altered and green in colour and is cut by narrow veins of andradite garnet surrounded by boxwork calcite (both identified by x-ray diffraction). The dolerite has almost completely saussuritised plagioclase phenocrysts in a matrix of albitised plagioclase, lime-green epidote, chlorite, iron ore and sphene.


Upper contact of a small xenolith in the basal sill of Lenton Bluff; the vitrophyric dolerite shows flow layering.


Andradite garnets separated and enclosed by boxwork calcite in a hydrothermal vein at the contact of a small xenolith in the basal sill of Lenton Bluff.

A possible 4th phase of intrusion is present in Lenton Bluff and at the north-eastern end of Marø Cliffs. At the south-western end of Lenton Bluff, the basal sill is cut by a younger transgressive sill, which continues as a complex system of sills and dykes in the sediments above the basal sill. The younger transgressive sill has phenocrysts of plagioclase and bowlingite (after olivine) at the margin but 1m down it has fresh olivine with plagioclase laths separated by granular pigeonite laths in a hemicrystalline groundmass.

Layered sills

The sill alongside Jeffries Glacier has a mafic layer through the middle of the sill. The normal dolerite below this layer is a coarse-grained olivine-bearing 2-pyroxene dolerite with an altered felsic mesostasis. The mafic layer is slightly coarser-grained and the ratio of mafic to felsic minerals and the order of abundance of ferro-magnesian minerals are reversed. Both are orthocumulates with the cumulus minerals being olivine, plagioclase and orthopyroxene in the mafic layer and plagioclase, orthopyroxene and clinopyroxene in the lower pars of the sill.

At the south-west end of Marø Cliffs, the basal sill shows rhythmic layering in its lower 8m and dolerite-pegmatite near the upper margin. The layered section contains orthocumulates with varying proportions of olivine, orthopyroxene and clinopyroxene as cumulus minerals plus plagioclase in the leucocratic layer. The dolerite-pegmatite has long laths of plagioclase, clinopyroxene and rare orthopyroxene in a poorly crystallised mesostasis.

Table 5. Modal analyses of specimens from the layered sills

Specimen number	Micro-pegmatite	Plagioclase	Clino-pyroxene	Ortho-pyroxene	Olivine	Iron	Alteration	Matrix	Counts	Plagioclase composition
Z.481.2	-	29,5	17.7	17.0	24.8	3.9	7.1		2,500	An_{50-76}
Z.481.1	-	37.2	21.5	12.1	16.2	2.7	10.3		2,800	An_{45-70}
Z.497.10	-	29.0	9.2	18.0	30.4	2.8	10.6		4,600	An_{60}
Z.497.9	-	48.2	21.5	12.8	1.3	2.6	13.6		2,000	An_{70}

Pseudomorphs of bowlingite and magnetite apparently after olivine have been counted with olivine

Z.481.2 Pyroxene-olivine orthocumulate from a melanocratic layer in the lower part of the layered sill of Marø Cliffs.
Z.481.1 Plagioclase-pyroxene-olivine orthocumulate from a leucocratic layer in the lower part of the layered sill of Marø Cliffs.
Z.497.10 Olivine-hypersthene orthocumulate from the mafic layer approximately in the middle of the 50m layered sill on the south-western margin of Jeffries Glacier
Z.497.9 Normal dolerite from beneath the mafic layer approximately in the middle of the 50m layered sill on the south-western margin of Jeffries Glacier

The layered sill of Jeffries Glacier is similar in many ways to the Palisades sill in New Jersey and the presence of olivine distinguishes these sills from layered sills in the Ferrar dolerites elsewhere in Antarctica.

Table 6 Comparative modal analyses of layered rocks from the Theron Mountains, the Palisades sill in New Jersey and in the Basement. Upper Escalade and Mount Egerton sills of the Ferrar Dolerites of Antarctica

Specimen number	Micro-pegmatite	Plagioclase	Clino-pyroxene	Ortho-pyroxene	Olivine	Others	Locality
Z.497.10	-	29.9	9.2	18.0	30.4	13.4	Layered sill, Jeffries Glacier, Theron Mountains
Z.497.9	-	48.2	21.5	12.8	1.3	16.2	
PALIS.1	-	32.9	40.4		23.5	3.2	Palisades Sill, New Jersey
PALIS.2	0.2	50.0	44.9		1.0	3.0	
14910	0.7	38.2	31	29	-	0.4	Basement Sill, Kukri Hills
14908	0.4	48	51	-	-	0.6	
21870	5.2	47.9	32.5	13.1	-	1.3	Upper Escalade Sill, Skelton Glacier area
21874	15.0	41.7	37.2		-	6.1	
Z.481.2	=	29.5	17.7	17.0	24.8	11.0	Layered sill, Marø Cliffs, Theron Mountains
Z.481.1	=	37.2	21.5	12.1	16.2	13.0	
16795	2.3	27.3	20.0	50.0	=	0.4	Mount Egerton Sill, Byrd Glacier area
16797	1.2	84.5	13.5	-	=	0.8	
16794	6.4	48.8	41.9	1.5	=	1.4	

Others include hornblende, biotite, chlorite, etc

Z.497.10 Olivine-hypersthene orthocumulate from the mafic layer approximately in the middle of the 50m layered sill on the south-western margin of Jeffries Glacier
Z.497.9 Normal dolerite from beneath the mafic layer approximately in the middle of the 50m layered sill on the south-western margin of Jeffries Glacier
PALIS.1 Olivine-diabase from about 20m above the base of the Palisades Sill, Hoboken, New Jersey (Walker,1940, table 1).
PALIS.2 Normal diabase from about 1m above the base of the Palisades Sill, Hoboken, New Jersey (Walker, 1940, table 1).
14910 Hypersthene-cumulate from about 60m above the base of the Basement Sill, Kukri |Hills, Victoria land, Antarctica (Gunn, 1962, table 4).
14908 Normal dolerite from about 25m above the base of the Basement Sill, Kukri |Hills, Victoria land, Antarctica (Gunn, 1962, table 4).
21870 Hypersthene-cumulate from about 80m above the base of the Upper Escalade Sill, Skelton Glacier, Victoria land, Antarctica (Gunn, 1962, table 8).
21874 Normal dolerite from about 2m above the base of the Upper Escalade Sill, Skelton Glacier, Victoria land, Antarctica (Gunn, 1962, table 8).
Z.481.2 Pyroxene-olivine orthocumulate from a melanocratic layer in the lower part of the layered sill of Marø Cliffs.
Z.481.1 Plagioclase-pyroxene-olivine orthocumulate from a leucocratic layer in the lower part of the layered sill of Marø Cliffs.

16795 Hypersthene-cumulate from about 60m above the base of the Mount Egerton Sill, Byrd Glacier area, Victoria land, Antarctica (Gunn, 1963, table 2).
16797 Anorthosite lens from about 120m above the base of the Mount Egerton Sill, Byrd Glacier area, Victoria land, Antarctica (Gunn, 1963, table 2).
16794 Normal dolerite from about 30m above the base of the Mount Egerton Sill, Byrd Glacier area, Victoria land, Antarctica (Gunn, 1963, table 2).

Major sills of Coalseam Cliffs

The Middle sill of Coalseam Cliffs, which extends about 50km to Parry Point, varies from porphyritic olivine-bearing contact rocks through sub-ophitic 2-pyroxene quartz-dolerite to granophyric quartz-dolerite in the upper central parts of the sill.

Table 7. Modal analyses of the major sills of Coalseam Cliffs.

Specimen number	Micro-pegmatite	Plagioclase	Clino-pyroxene	Ortho-pyroxene	Olivine	Iron	Alteration	Matrix	Counts	Plagioclase composition
Z.479.2	22.5	42.9	25.1	6.6	-	1.3	1.6	-	2,700	An$_{72}$
Z.473.1	53.1	21.1	10.2	-	(4.1)	2.7	8.8	-	3,600	An$_{35-47}$
Z.476.1	27.5	30.4	29.3	-	(0.5)	5.1	7.2	-	3,600	An$_{40-50}$
Z.479.3	24.7	45.2	16.1	8.3	-	1.0	4.6	-	2,700	An$_{66}$
Z.475.1	18.3	42.4	21.1	11.0	P	1.2	6.0	-	1,800	An$_{65-70}$
Z.474.1	-	47.9	n.d.	-	14.0	n.d.	38.1		3,400	An$_{65-70}$
Z.478.11	-	47.6	17.0	-	3.3	4.6	27.5		2,300	An$_{70}$
Z.500.1	-	43.9	18.0	-	14.7	4.7	18.7		2,800	An$_{68}$
Z.477.4	-	52.4	20.9	-	11.8	6.4	8.5		1.900	An$_{64}$

Figures in parentheses refer to fayalitic olivine, others are magnesian olivine; P = present; n.d. = not determined; Alteration products include hornblende, biotite, chlorite, etc.

Middle sill of Coalseam Cliffs
Z.479.2 Subophitic 2-pyroxene-dolerite, about 3m below the upper contact beneath Stewart Buttress.
Z.473.1 Granophyric dolerite, upper part of sill in a dolerite window in the ice cliffs between Coalseam Cliffs and Parry Point.
Z.476.1 Granophyric dolerite, upper part of sill in a dolerite window in the ice cliffs between Coalseam Cliffs and Parry Point.
Z.479.3 Subophitic 2-pyroxene-dolerite, about 310m above the lower contact beneath Stewart Buttress.
Z.475.1 Subophitic 2-pyroxene-dolerite, about 2m above the lower contact at the south-western end of Coalseam Cliffs.
Basal sill of CoalseamCliffs
Z.474.1 Porphyritic olivine-dolerite approaching a troctolitic composition, just above the contact of a sedimentary xenolith about 6m below the upper contact at the south-western end of Coalseam Cliffs.
Z.478.11 Altered ophitic olivine-dolerite, near the centre of the sill beneath Point 2600.
Z.500.1 Ophitic olivine-dolerite, lower part of sill beneath Stewart Buttress.
Z.477.4 Ophitic olivine-dolerite, about 3m above the lower contact beneath Point 2600.

The basal sill of Coalseam Cliffs is olivine-bearing throughout and shows limited compositional variation, the main variations being in texture as the contact is approached. It varies from vitrophyric olivine basalt to medium-grained ophitic dolerite. At the south-west end of the cliffs, just above a small xenolith, is a porphyritic orthocumulate of near-troctolite composition, with idiomorphic phenocrysts of plagioclase and olivine in a groundmass of small skeletal plagioclase laths and small granular olivine crystals, probably due to localised setting and chilling in the sill immediately above the xenolith.

Photomicrographs of specimen Z.474.1

Large glomeroporph with plagioclase and olivine phenocrysts with chilled groundmass with slight flow structures

Away from glomeroporph, idiomorphic plagioclase and olivine phenocrysts in fine-grained groundmass with seriate texture

Other minor intrusions

Minor intrusions include porphyritic dolerite with a hemicrystalline groundmass, variolitic and intergranular examples and sub-ophitic to ophitic textures in the central parts of the thicker sills. Compositions range from olivine-dolerite to olivine-free dolerite with a granophyric matrix.

Table 8. Modal analyses of other minor intrusions.

Specimen number	Micro-pegmatite	Plagioclase	Clino-pyroxene	Ortho-pyroxene	Olivine	Iron	Alteration	Matrix	Counts	Plagioclase composition
Z.464.2	9.0	44.3	35.1	-	9.6	2.1	1.8	-	2,300	An_{70}
Z.464.3	14.6	48.5	31.1		-	4.0	1.6	-	2,500	
Z.461.1	14.8	41.5	26.7	-	-	2.6	14,4	-	2,900	
Z.461.2	-	48.3	36.9	-	5.4	2.0	4.7	2.7	1,600	
Z.509.1	-	38.0	27.8	-	-	3.5	12.5	18.1	1,700	
Z.453.3	-	38.0	30.2	-	0.4	n.d.	1.2	30.3	2,000	An_{68}
Z.453.1	-	52.9	35.3	-	9.6	1.8	0.4	-	3,500	An_{60-65}
Z.477.11	-	39.2	26.2	-	-	n.d.	3.6	31.0	3,200	

n.d. + not determined

Z.464.2 Subophitic olivine-dolerite, near the top of the sill immediately above the scarp-capping sill on the south-western margin of Goldsmith Glacier.
Z.464.3 Subophitic 2- pyroxene-dolerite, near the centre of the sill immediately above the scarp-capping sill on the south-western margin of Goldsmith Glacier.
Z.461.1 Subophitic olivine-dolerite, lower part of the first sill above the scarp-capping sill on the north-eastern margin of Jeffries Glacier.
Z.461.2 Olivine-dolerite, near the upper contact of the first sill above the scarp-capping sill on the north-eastern margin of Jeffries Glacier.
Z.509.1 Intergranular dolerite, near the centre of the 6m wide dyke on the north-eastern margin of Goldsmith Glacier.
Z.453.3 Intersertal dolerite, centre of a 1-2m wide dyke along a faut plane in the ridge leading eastwards from Point 3300.
Z.453.1 Olivine-dolerite, near the centre of the 15m sill which is offset by a fault in the ridge leading eastwards from Point 3300.
Z.477.11 Intersertal dolerite, centre of the thin sill which is the lowest sill beneath the basal sill of Coalseam Cliffs.

Table 9. Modal analyses of chilled rocks from other minor intrusions.

Specimen number	Plagioclase	Pyroxene		Olivine	Counts	Plagioclase composition
TAE350/6	-	-		1		
TASE351/7	1	-		1		An_{80-85}
Z.464.1	6.4	-		2.7	1,900	An_{66}
Z.487.3	7.1	1.0		2.8	3,600	Albitised

TAE350/6 Porphyritic chilled dolerite, contact of the thin sill immediately below the basal sill of Coalseam Cliffs (Stephenson, 1966, table 3).
TAE350/6 Chilled dolerite, top contact of the thin sill which is the lowest sill beneath the basal sill of Coalseam Cliffs (Stephenson, 1966, table 3).
Z.464.1 Porphyritic chilled dolerite, upper contact of the sill immediatelyabove the scarp-capping sill on the south-western margin of Goldsmith Glacier.
Z.487.3 Porphyritic chilled dolerite, upper contact of the 30m sill above the scarp-capping sill in the long cliff immediatelynorth-east of the mouth of Goldsmith Glacier.

Summary and conclusions

In chilled margins, aphyric rocks are rare and hiatal and seriate textures are present. Cooling-contraction and flow structures sometimes occur. Plagioclase is almost ubiquitous, often, with olivine, being the first mineral to form. Olivine (or pseudomorphs after olivine, most commonly of bowlingite, magnetite and ?talc) is present in most sills except for the scarp-capping sill but orthopyroxene is not seen as phenocrysts. Clinopyroxene is the dominant ferro-magnesian phenocryst in the scarp-capping sill and the basal sill of Lenton Bluff but is rare elsewhere. It crystallises later than plagioclase and olivine when it occurs with them. Altered phenocrysts (notably saussuritised and albitised plagioclase and epidotised and chloritized groundmass) indicate hydrothermal activity. The main minerals in hydrothermal veins are quartz, calcite, chlorite, epidote, prehnite, tremolite, andradite, apophyllite and chalcopyrite.

Holocrystalline rocks are fine- to medium-grained with intergranular to sub-ophitic and ophitic textures and granophyric in the scarp-capping sill. Plagioclase is variable in composition and it is often of two generations, an earlier well twinned and weakly zoned and a later, less idiomorphic, strongly zoned and poorly twinned generation. A micropegmatitic or cloudy felsic mesostasis is almost ubiquitous. Magnesian olivine occurs in many sills, often pseudomorphed by bowlingite and magnetite and mantled by orthopyroxene and clinopyroxene. Fayalitic olivine occurs in the granophyric quartz-dolerites of the scarp-capping sill and the middle sill of Coalseam Cliffs. Orthopyroxene is rare but clinopyroxene is ubiquitous and pigeonite and augite, often titaniferous, are present. Hornblende and biotite may be primary in some of the granophyric quartz-dolerites. Accessory minerals include ilmenite, magnetite, titanomagnetite with possibly some pyrite and haematite, apatite and zircon. Alteration products include hornblende, chlorophaeite (?), talc (?), sericite, quartz, calcite, albite, epidote and sphene.

References

BROOK, D., 2022. Jurassic dolerites in the Theron Mountains, Antarctica. *Geological Society Home Counties North Regional Group Newsletter*, No. 19, October 2022, 13-25.

GUNN, B.M., 1962. Differentiation in Ferrar Dolerites, Antarctica. *New Zealand Journal of Geology and Geophysics*, ***5***, No. 5, 820-23.

GUNN, B.M., 1963. Layered intrusions in the Ferrar Dolerites, Antarctica. *Mineralogical Society of America Special Paper*, **1**, 124-33.

STEPHENSON, P.J. 1966. Geology. 1. Theron Mountains, Shackleton Range and Whichaway Nunataks (with a section on palaeomagnetism of the dolerite intrusions, by D.J. Blundell). *Scientific Reports Transantarctic Expedition.* No. 8, 79pp.

WALKER, F., 1940. Differentiation of the Palisades diabase, New Jersey. *Bulletin Geological Society of America*, **51**, No. 7, 1059-1106.

******** ******** ********

Is New Zealand's South Island Alpine Fault equivalent to the Caledonides Great Glen Fault?

Roy P Dunn FGS, post graduate structural geologist

As my daughter is presenting a volcanology paper at the International Association of Volcanology and Chemistry of Earth's Interior (IAVCEI) conference in Rotorua, New Zealand, in February 2023 the Dunn family decided to follow her down there for this year's family holiday. I research the Moine Thrust and related structures, so the contrast between the Caledonian terrane bounding faults and the structures currently mapped in New Zealand was tempting to examine. (Not easy in the context of a non-geological family holiday!)

The Alpine Fault of New Zealand's South Island is adjacent to active subduction zones off the east coast of the North Island. Active volcanology throughout the North Island and surrounding area supports the fact that consumption of oceanic crust under the north island is ongoing. Bell et.al 2014 postulates that the roughness of the subducting Pacific plate controls the amount of aseismic vs. seismic movement down the Kermadec Trench. Fig.1. Smooth oceanic crust subducts seismically, while rough oceanic crust with topographic features such as sea mounts has a rougher passage, causes hanging wall flexure until the stress is released with a potentially major seismic event.

The junction between the Kermadec trench in the north and the Macquarie Trench in the south is the Alpine fault zone which crosses the South Island diagonally. Typically, when subduction polarity changes the transform boundary faults accommodate the different movement directions. In the textbooks these faults are shown at 90° to the subduction zones, but this is not the case in New Zealand.

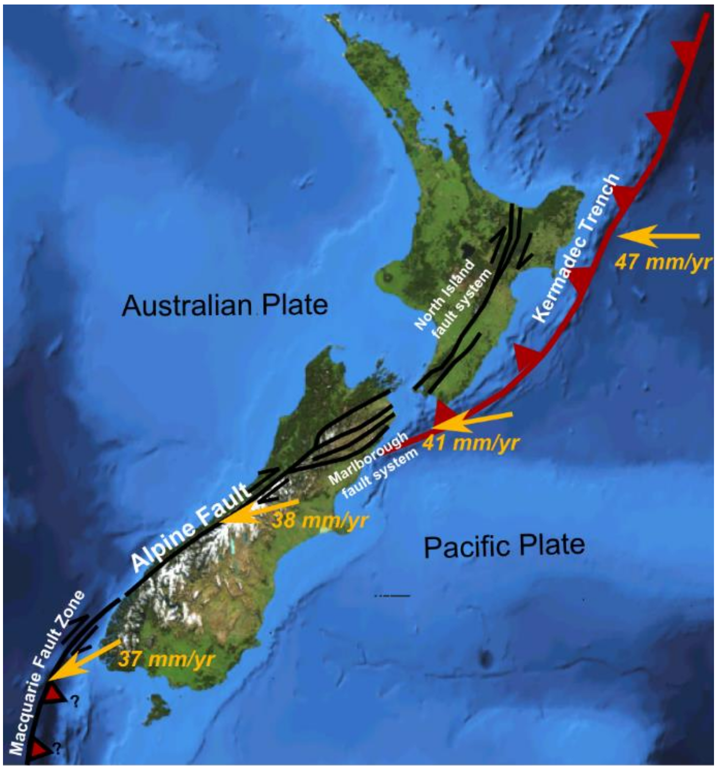


Fig.1 New Zealand Fault systems (Wikipedia). Note the switch in subduction polarity at the ends of the Alpine fault. (Creative Commons)

The Great Glen Fault in Scotland is recognised as a dextral and sinistral transcurrent fault, related to the final stages of the Caledonide Orogeny, separating the Grampian deformed Dalradian metasediments in the SE, from the Moine in the NW. The sinistral movement on the GGF is well known, although estimates vary from 60 to 2000km. My PhD. tutor has mapped structure near Loch Linnhe, SW GGF that has dextral movement. And of course, way back there was discussion about possible normal or reverse movement on it also. Personally, I think it has mostly moved sinistrally, with a bit of jiggling about in the late Caledonian during a softish docking.

Check in link below for a satellite view from the Geological Society website. Then compare to the New Zealand image of Fig.1.

[Geological Society - Strike-slip fault, Scotland (geolsoc.org.uk)]

The GGF passes laterally into potentially a merged series of terrane bounding faults that are expressed as the Walls Boundary fault in the present north at the Shetland Islands. Strachan et.al 2020. The SW end of the Moine Thrust and Great Glen Fault are more difficult to constrain.

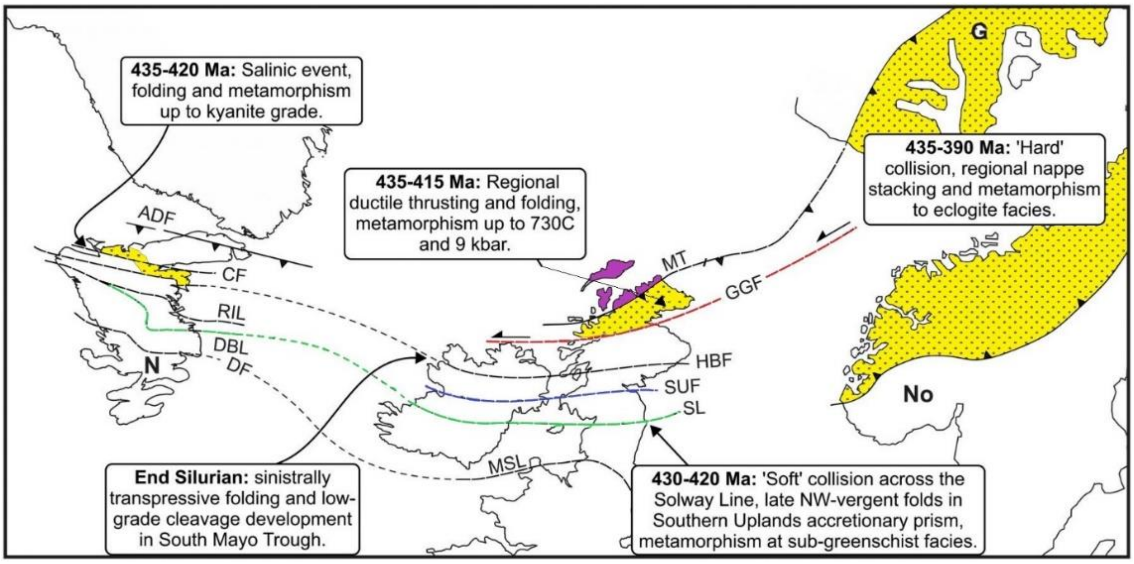


Fig.2 Strachan et.al. map of the Appalachians and Caledonides with major faults marked. MT=Moine Thrust, GGF = Great Glen Fault, HBF = Highland Boundary Fault, SUF = Southern Uplands Faults, SL = Solway Line (Iapetus Suture).

Geomorphologically the GGF is a steep sided valley, with a river and canal system running the length from Fort William in the SW to Inverness in the NE. The fault has been deeply excavated by glaciation. In the North Sea the GGF, Highland Boundary Fault and Southern Uplands faults potentially merge with the Iapetus Suture and track north to the Walls Boundary Fault. This is a complex zone of merged terranes that potentially flags the junction between the Laurentian continent and the Baltican continent. A subduction zone is suggested to have existed here also, allowing the continental masses to converge.

Part of the Alpine fault system runs along the Wairau Marlborough Wine region in a wide currently flat bottomed valley filled with glacial infill. This is obviously much younger fault system and continental segments were mostly believed to be Cenozoic rather than Proterozoic and Lower Palaeozoic involved in the Caledonides. However recent work by Woodward 2021 suggests the faults are part of a mostly submerged Zealandia microcontinent. The Marlborough Fault system, four parallel strike slip faults accommodate dextral movement across the Zealandia submerged continent.

© Roy P Dunn 2022

© Roy P Dunn 2022

The Alpine fault in the Marlborough region is less defined than the Great Glen in Scotland. The images above taken from the State Highway 63 leading into Blenheim through the wine region. Two mountain ranges, different geology (apparently) leading to different wines. The region is seismically active, generally not impacting human activity, but they are preparing for "the big one" which they know must arrive at some stage in the not too distant future.

So to summarize, two glacially eroded valleys, one produces a variety of very drinkable wines, one not yet. Both are or have accommodated lateral movement. Both are adjacent to flipped polarity (potentially) subduction zones or acted as the accommodation of that opposite polarity. Both currently seismically active, the GGF must less frequently active than the Alpine Fault.

So given another few tens of millions of years, the Alpine Fault may be similar to the GGF. Not that we are likely to be around to see it.

References

Bell, R. Holden, C. Power, Wang, X. [b]Downes, G.
Hikurangi margin tsunami earthquake generated by slow seismic rupture over a subducted seamount. *Earth and Planetary Science Letters***.** Volume 397, 1 July 2014, pp. 1-9

BIRD, A. F. M. F. THIRLWALL,M.F. R. A. STRACHAN, R.A. & MANNING, C.J.
Lu–Hf and Sm–Nd dating of metamorphic garnet: evidence for multiple accretion events during the Caledonian orogeny in Scotland. *Journal of the Geological Society, London,* Vol. **170**, 2013, pp. 301 –317. doi: 10.1144/jgs2012-083.

Woodward, A. (14 August 2021)
"A fragment of a mysterious 8th continent is hiding under New Zealand – and it's twice as old as scientists thought". *Business Insider.*

Seismicity in New Zealand » *Seismic Resilience*

Is Yorkstone, so famous, yet so elusive

Barry J Hunt FGS, Director of IBIS Limited

Introduction

The reputedly eccentric English cleric, writer and collector Charles Caleb Colton had probably had no experience with the natural stone industry when he coined the phrase: *imitation is the sincerest form of flattery*. For those whose stones are left on the shelf due to another stone with a substituted name being used, imitation seems anything but sincere. And of all the stones available in the UK, possibly the one most imitated has been Yorkstone, as there is no actual definition of what Yorkstone is. Furthermore, there is no one to defend the name as no one has laid claim to it.

We have a conundrum: a seemingly very famous British stone that only exists in the minds of those who use the term! This is no illusion or subtext to Rene Descartes musings on existence; Yorkstone is firmly embedded in the British psyche as the prime paving stone. It can be argued that of all the British stones, it is the most recognisable and widely known, despite this drawback of not actually existing. The plot thickens due to the ambiguities surrounding Yorkstone and there are references to Yorkshire stone, Yorkshire gritstone, York flagstone and other similar variations on this theme. The origins of these names is not clear but they have gained popularity for describing any buff, grey or blue coloured sandstone from Northern England prepared as slabs for external paving.

Yorkstone is clearly a name that should be left to describe stone that actually comes from York, but there are no actual working quarries in York. If the reference to York really is a contraction of Yorkshire, then there are many stones of great variety and not necessarily sandstone that would fall under such a term, making it unworkable. Is there such a thing as Yorkstone? If we believe there is then we need to define it, or drop the term completely and start recognising the truly great stones whose names have remained shielded from the populace by use of such a generalist term.

What is Yorkstone?

The present belief is that the first stones classed as Yorkstone were from Elland Edge, a geographical feature above the town of Elland in West Yorkshire. Local records show that Elland Edge was quarried from at least the early 17th Century for masonry, roofing Fig.1, and paving purposes Fig. 2. Elland is sandwiched between Halifax and Huddersfield, and then Bradford and Leeds are in the way before we even get close to York. However, there are local structures that prove that use of stone from the region certainly occurred in medieval times.

If we actually head across to York, we find that the land is mostly obscured by recent glacial deposits and the rocks below are found to be pink and red sandstones and mudstones of Triassic age, providing materials that would not be recognised as Yorkstone. The inference from all this is that York is a contraction of Yorkshire, which is almost expected, and that this term is too generic for use in today's enlightened times of CE marking and British Standard requirements.

So what is it that everyone has been so readily recognising as Yorkstone? Quite simply it is buff stone used for paving. There are also flashes of colour sometimes with red, pink, blue and grey hues.

© Barry J Hunt. Fig 1

© Barry J Hunt. Fig 2

Fig.1 - Contrast between a true geological slate and Carboniferous sandstone 'roofing slates' (lowest seven courses). Carboniferous sandstone has been used for roofing purposes.
Fig. 2 - Some of the wild colour variation when the surface cuts across the bedding as well as weathering pattern

Sometimes the colours are more dominant than the background buff colour, and often there is the presence of silvery flashes, which are crystal flakes of mica (usually a variety called muscovite), which gave rise to the term 'flaggy'. Often thin horizons with higher proportions of micas are found to be the natural splitting planes of the stone. Otherwise, many sandstones occur in combination with related stones such as siltstone, mudstone and claystone, which are less competent than the sandstone layers, and thus used as planes of extraction.

It is also apparent that material being described as Yorkstone may actually be derived not just from Yorkshire but from Derbyshire, Northumberland, Lancashire and County Durham. Similar rocks are also found in different parts of Wales and Scotland and there are lesser occurrences in several other English counties. What many people are actually recognising without realising it are the persistent features of the underlying geological formations that provide these stones, which are unrelated to our arbitrary land divisions. We actually find all stones that fit the perceived Yorkstone description are from two very distinct geological sequences, the Millstone Grit and the Coal Measures, which were both laid down during the Carboniferous Period.

Now for some brief geological history and what happened between 326 and 304 million years ago, or more specifically the Namurian and Westphalian stages of the Carboniferous Period. At this time there was a series of uplands that were being eroded and major river systems flowed into what has been termed the Pennine Basin that covered much of what today is north-eastern England. Here thick alluvial deposits collected that were subjected to occasional inundation by the sea and which later became marshes. This is highly simplified, but the upshot was that a huge amount of sand and grit collected in thick but also variable sequences of beds. Sand, being the weathered product of other existing stones, comprises predominantly those minerals that are found to be more resistant to the weathering processes, notably quartz, and to a lesser degree feldspar and mica. The stones formed at this time also included amounts of iron minerals that were able to concentrate, and which are now responsible for the colour variations we see now.

Because of the large area of original deposition, variations in the parent rocks, local variations in the environment, different geographical features and other factors, there is a considerable variety in the stone formed, though often this is not actually readily apparent without a microscope. The depth of burial and later geological factors has also dictated how the constituent grains are stuck together, particularly the formation of silica that can alter porosity, strength and other factors that will affect how the stone performs. This is what makes every stone unique, despite appearances.

It is clear that Yorkstone is not an appropriate descriptor for any stone material and should not be used, but this may be easier said than done. There are almost 60 sandstones currently quarried in the UK from the Millstone Grit and Coal Measures sequences, and those actually from the Yorkshire region include the following: Appleton, Bank Top, Bolton Woods, Brackenhill, Branshaw, Cromwell, Crosland Hill, Crossley, Flappit, Gledhills, Greenmoor, Hillhouse Edge, Hunters Hill, Naylor Hill, Ringby, Scoutmoor, Silex, Sunnybank and Woodkirk. There really is no need to market any of these stones as Yorkstone, though the temptation could remain very strong.

Properties of Yorkshire Carboniferous Sandstone

It really is extremely hard not to keep describing all these materials together as Yorkstone, because it avoids the mouthful of geological terms and description that otherwise should be applied. But we are dealing with historical subtleties and the pride of Yorkshire, and this is where the great bugbear of imitation really starts to bite. But it seems Yorkshire would have no right to take umbrage with someone describing a material from outside Yorkshire as Yorkstone if it fits with the imagined description. If there is to be demarcation then the simplest description we might apply is given in the title of this section; this simplified description must encompass gritstone, which essentially is extremely coarse-grained sandstone.

A beautiful glow from the stone masonry of Nostell Priory: Yorkshire Carboniferous sandstone at its absolute best.

Table 1 lists the typical test results for some of the Yorkshire Carboniferous sandstones listed in the previous section. Please note that wet and dry strength values have not been differentiated and are for materials tested with the loading direction perpendicular to the natural bedding planes. It is also apparent that the presence of water does not significantly affect the slip resistance test results, so this too has not been differentiated.

Table 1: Some Standard Tests and Result Ranges for Yorkshire Carboniferous Sandstone

Test	Method	Result
Density (Bulk Specific Gravity), Mg/m^3	BS EN 1936	2.31 – 2.46
Water Absorption, %	BS EN 13755	2.3 – 4.5
Porosity, %	BS EN 1936	8 – 15
Compressive Strength, MPa	BS EN 1926	85 – 186
Flexural Strength, MPa	BS EN 12372	9 – 26
Slip Resistance – Sawn Surface	BS EN 14231	67 – 83
Slip Resistance – Riven Surface	BS EN 14231	75 – 100
Abrasion Resistance	BS EN 14157	16 – 25
Salt Crystallisation, % loss	BS EN 12370	Typically minimal weight loss

There are some quite wide ranges in the properties of Yorkshire Carboniferous sandstone, notably the strength, but this must be expected. What the table is unable to show is that the strength is not necessarily related to either the slip resistance or abrasion resistance. How a stone maintains it slip resistance is often related to grain shape and interlock, cementing media and other subtle factors such as clay particles that weather out rapidly to help keep a surface rough as it abrades at an uneven rate. There is a point at which sandstone grades into quartzite, when the cement is mostly siliceous, the porosity and water absorption reduce, density and strength increase, but such apparently higher quality material may not be quite so good for paving, which seems to go against instinct.

A good paving stone needs to refresh its surface and not suffer polishing that can affect slip resistance, which must be considered the most important feature of any paving material. And it is this that makes the sandstones of the Millstone Grit and Coal Measures, and particularly those from in and around the Yorkshire area, so good. The imitators may promote such things as higher strength or better abrasion resistance, but to the unknowing this is missing the point of what makes a good paving material. Stronger stones tend not to refresh their surfaces so quickly and eventually may polish up and reduce their slip resistance.

We have naturally focused on paving as the classic use of Yorkshire Carboniferous sandstone, but it is also used successfully for many different masonry elements and for roofing purposes.

Use of Yorkshire Carboniferous Sandstone

The natural splitting properties of the stone have been exploited for paving purposes but they are also a potential downfall of exploiting it for others. For ashlar the different elements of a façade typically require a stone to have a substantial bed height that does not include potential splitting planes, which immediately starts to limit the use of some of the supplies. For some long elements that stand vertically such as with mullions, architraving and columns, the stone can be prepared with the bed and rotated, but this can leave the stone prone to vertical splitting. For sills, lintols, transoms, strings and other horizontal elements the lamination is a considerable benefit and even if splitting managed to occur this often does not present an issue.

Some laminated stone does present a potential issue when there are delicate carved features detaching along weaker laminations, resulting in the loss of isolated items such as cornice dentils and more decorative column capitals of the Corinthian and Composite Orders, for example. There is also a longer term issue as weathering may affect different laminations and there can be highly uneven weathering of faces. Thus, the selection of any laminated stone needs to minimise the lamination variation and again the Yorkshire Carboniferous sandstones are particularly good in this respect, having some very large and consistent beds. Fig. 3 and Fig. 4.

© Barry J Hunt. Fig. 3

© Barry J Hunt. Fig. 4

Fig. 3 - Close view of variation in weathering of Carboniferous sandstone due to subtle differences in the competency of the different beds and laminations. To the lower right one stone is unaffected with the original tooling marks visible after 500 years of exposure.
Fig. 4 - Different competencies of bedding are being picked out by weathering processes, whilst the mortar is also found to be too strong and likely exacerbating the weathering processes.

In those parts of the geological sequences where lamination is much thinner and grades more rapidly into very fine materials, it is these products that are actually more suited to preparation as roofing slates, which requires thinner materials to reduce roof loadings. Do not confuse the term 'roofing slate', which is any stone material that can be split and dressed for roofing purposes, with the term 'slate' that is used to define metamorphosed mudrocks and similar materials of extremely fine grain size. The Yorkshire Carboniferous sandstone slates work fine if they are ventilated from below to allow moisture to escape if they are saturated by rain that is then followed by freezing at the outer surface.

Sandstone is typically harder to carve than limestone and the Yorkshire Carboniferous sandstones are no exception. The coarser and more angular the grains the more difficult it is to form sharp edges, whilst detailed work is more likely to suffer granular disintegration over time. So the stone is more suited to brutal architectural details, and whilst gravestones are easy to form, any fine detail is unlikely to last. Fig. 5.

© Barry J Hunt. Fig. 5 © Barry J Hunt. Fig. 6 © Barry J Hunt. Fig. 7

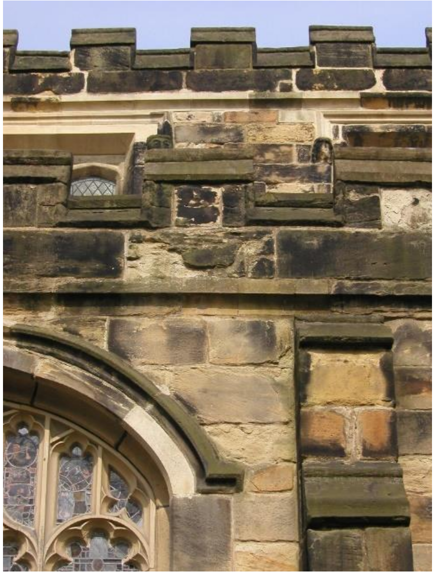
Fig. 5 Weathering occurring only in the middle of this memorial where salts gathering and aeolian effects are complicating. A good example of a tipping point for weathering to occur.

Fig. 6 Coping suffering from salt weathering related to adjacent chimney and long-term fossil fuel burning.

Fig. 7 In order to be able to make long column sections, the stone has been cut and set with the bedding vertical. It is normally considered wrong to set a bedded stone against its bed due to the potential for splitting, which is beginning to occur here.

Over time sandstone tends to suffer onion peeling effects from prolonged weathering. The porous structure allows moisture into a certain depth, it hangs around a bit, and then travels back to the surface as it dries out. However, whilst hanging around the universal solvent that is water takes a bit of the stone with it and often the outer surface is gradually depleted of cementing minerals. Now add pollution and all manner of things can start to happen, then add heating and cooling cycles and the outer skin tries to detach itself. Fig. 7. This is a serious problem with many historic structures built using Carboniferous sandstone and detail can be rapidly destroyed by misguided conservation efforts or even basic maintenance such as repointing. The black crust that may commonly develop is often protecting the stone and should not be removed without careful consideration of the potential consequences.

Although the Yorkshire Carboniferous sandstones appear to be the perfect materials for paving, as is the norm with all natural stone, there are a number of things that will try to upset this view that you need to take into account. Sandstone is porous and will soak up staining media and there is little you can do to combat this. It is actually better to let all the stone stain over time and develop the weathered patina you see in heavily trafficked areas that is more pleasing. Never seal this stone as this can court potential disaster because how moisture behaves externally cannot be predicted. Make sure there is positive drainage at the surface if you are not using porous jointing and bedding.



© Barry J Hunt. Fig. 8   © Barry J Hunt. Fig. 9

Fig. 8 Poorly restored church masonry with wide joints and curved edge profiles created by removal of weathered stone that had suffered contour scaling.

Fig. 9 One of the more common decay results affecting Carboniferous sandstone is contour scaling, with pieces of the surface splitting away that are unrelated to the bedding and other natural structures.

One issue that may be a cause of contention is that sawn or similar flat surfaces should never be used for paving, despite what the slip test results may tell you: only ever use riven or more heavily textures surfaces. The problem here is that areas of low pedestrian trafficking will not have constant abrasion, dirt will remain on surfaces, and eventually the stone is a wonderful seed bed for algae and other green things that can reduce the slip resistance to next to nothing. Without a textured surface feet will slip from underneath you. Patios may need to be jet-washed every six months or so, but not too harshly as the pressure can pluck the grains of the sandstone, and always remove leaf litter as the nitrogen can feed the stone. Yorkshire Carboniferous sandstones may be wonderful for paving but even they cannot combat these issues without a bit of regular care.

Concluding Remarks

To paraphrase Descartes, I've thought about it and therefore I am convinced that Yorkstone is a figment of our collective imagination. This is the prime example of the problems with the naming of stone and how this can lead to imitation. We must stop using the term Yorkstone as it serves the natural stone industry no good and we should instead promote the many wonderful Carboniferous sandstones that there are, not just from Yorkshire but from around the UK. Don't ask for Yorkstone anymore, ask for Carboniferous sandstone with a colour and texture, you'll be amazed at the variety that is available. Look out for Scoutmoor, Naylor Hill, Cromwell, Woodkirk and many more wonderful stones.

******** ******** ********

Landslide in the Oxwich Head Limestone Formation at Oxwich Bay, Gower, south Wales

Adrian Marsh FGS

Holidaying in Wales is always a pleasure for me and this September there was the added bonus of being able to observe the aftermath of a series of relatively large landslides / rockfalls affecting the Oxwich Head Limestone Formation. Subsequent research indicates that a series of events over many years has occurred at this locality. A major event occurred over the period 19th and 20th December 2009 (Jenkins, 2010) followed ten years later by renewed movements on 9th January 2019 (Anon, 2019) and subsequent rockfalls that winter. However, big limestone blocks, locally known as 'the Dices'. resting on the foreshore prior to 2009 indicate older rockfalls have occurred. The location of the landslide is shown in Figure 1.

Fig 1: Location plan (Contains OS data © Crown copyright)

The feature, visible across Oxwich Bay from several km away, is situated on a heavily wooded, c. 80m high steep coastal slope with its toe at high water level and backscarp rising some 30+m upslope as shown in Figure 2. Large, generally rectilinear blocks of intact rock up to 6m across rest at the toe, with a well-defined near-vertical backslope and rock, soil and fallen vegetation mantling much of the base on the slide, as shown in Figure 3.

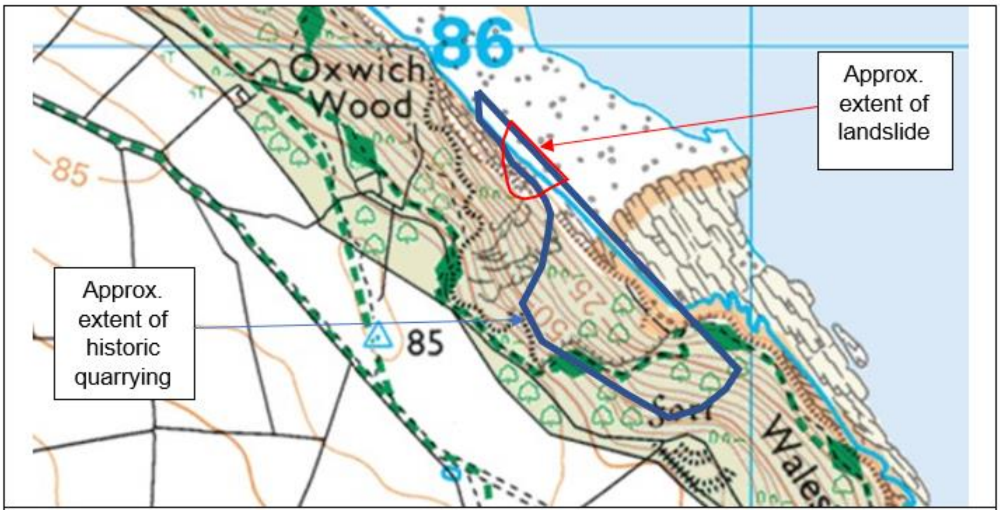


Fig 2: Site plan (Contains OS data © Crown copyright)

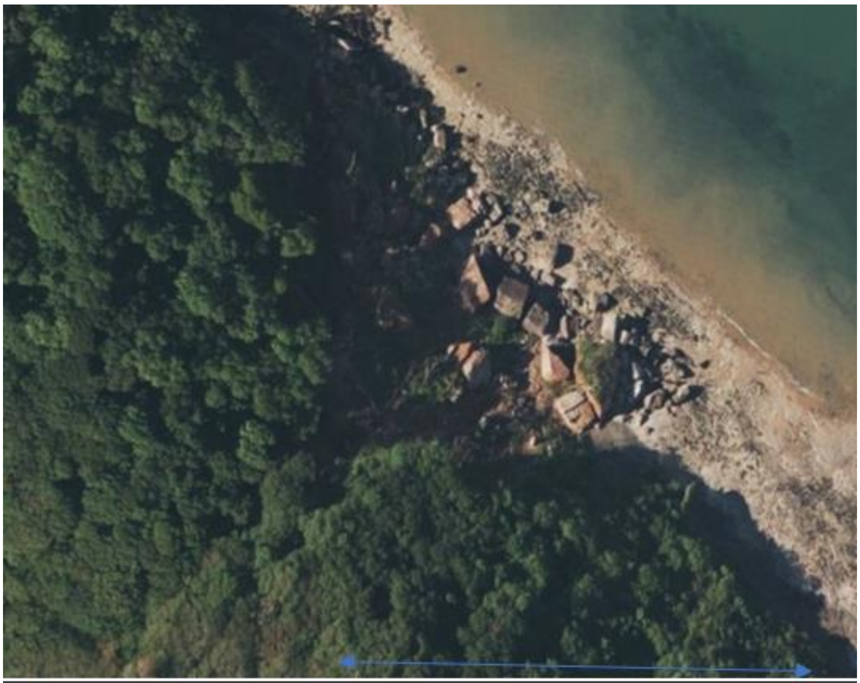


Fig 3: Aerial photo – scale bar approx. 100m

This section of the coastline was subject to an history of quarrying up until the end of the 19th century and probably dating back to much earlier times. Limestone was used locally with the remains of a limekiln still present in the village and exported to Devon from the old port of Oxwich, located a little further out towards Oxwich Point. An ancient church, St Illtyd's, which lies just to the north of the landslide complex on the wooded hillside, is thought to date back to the 6th century. In its history of the church, Gower Ministry Area (2022) speculate that it is possible that the original Medieval village of Oxwich was near the shore below the church but was forced to move inland as the sea encroached further into the bay. A similar pattern of coastal sediment erosion and marine inundation is known to have occurred in Swansea Bay.

Geology

The geology of the slope comprises Carboniferous Oxwich Head Limestone Formation (337-329Ma) of thick bedded fine- to coarse-grained, recrystalised, bioturbated, skeletal packstones with distinctive pale to dark grey mottling and pseudobrecciation and ooidal limestones. Units of dark grey, irregularly bedded skeletal packstones with shaly partings are developed at intervals, see Figure 4. This cliff and foreshore section on the eastern and southern sides of Oxwich Head is the partial type section where most of the Formation is present apart from the uppermost part. It mainly comprises thick bedded pseudobrecciated skeletal packstones with prominent scattered palaeosols (BGS Lexicon of Named Rock Units).

Fig. 4: Exposed limestone-shaly palaeosol sequence just above the foreshore immediately to the north of the landslide

The geological structure of the south Wales coast framework is controlled by Variscan structures that formed at the end of the Carboniferous Period (c. 290Ma) with the Variscan Thrust front shown in Figure 5. In the Oxwich bay area there is a synclinal structure running parallel to the Thrust front, with the younger Carboniferous Millstone Grit Group (329-319Ma) bedrock sub-cropping along part of the central axis of the syncline beneath the beach a few hundred metres to the north of the landslide.

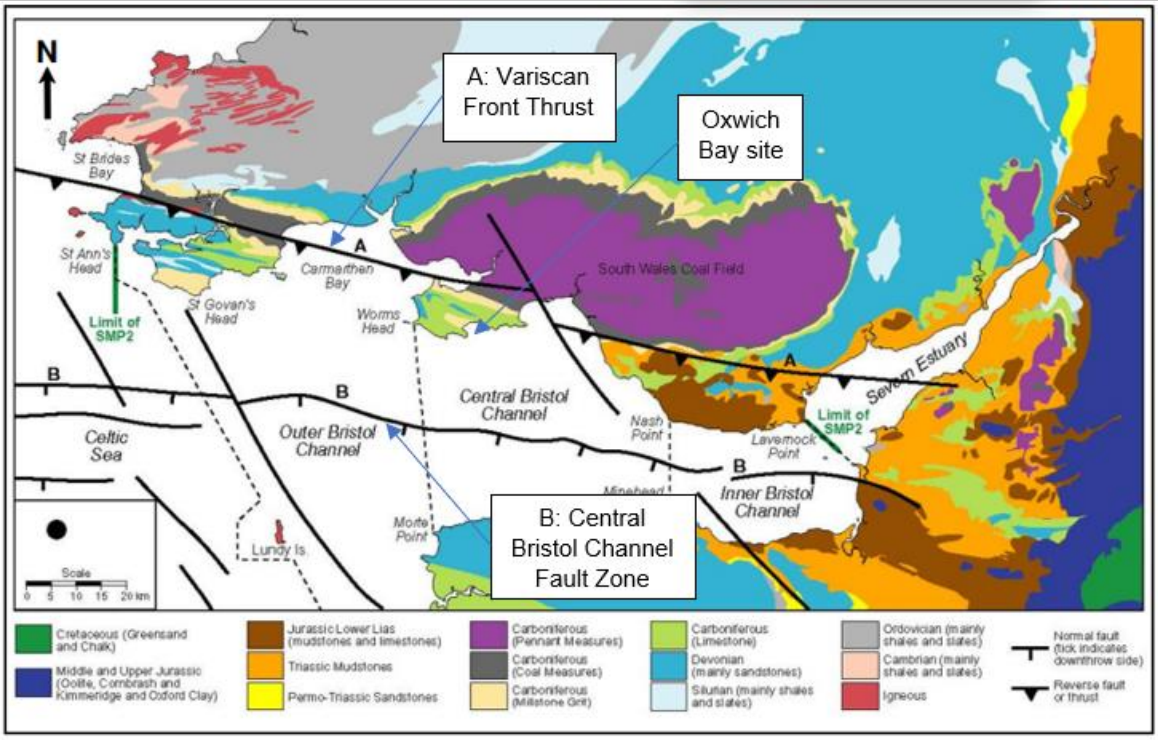


Fig. 5: Regional geological setting. Reproduced from Halcrow (2012)

During the Quaternary, this coastline was subject to significant fluctuations in sea levels through the successive cold and warm climate cycles, with evidence from peat deposits in the region of sea levels having been at least 20m lower in the past at the start of the Holocene (10Ka). Then rising sea levels in the early Holocene were associated with extensive new deposition including beach, tidal flat and estuarine deposits, aeolian sand dunes and submerged peats. Modern beach and intertidal deposits including storm beach deposits veneer these earlier sediments around Oxwich Bay (Barclay, 2011).

Landslide

The 2009 event was investigated by BGS (Jenkins, 2010) who concluded that *"the cause of the slope failure was probably due to water penetrating fractures in the limestone cliff. During periods of cold weather, this water has frozen and then thawed and expanded, increasing the in situ stress acting in the fracture and causing the rock to fail"*. Jenkins also reported that *"It appears that the (2009) failed section probably formed in a feature that was proud of the surrounding cliff face as the newly exposed face is now concordant with the older surrounding faces (i.e., the failure has not cut back into the cliff face)"*. However, the more recent 2019 event has clearly extended the rockfalls back behind the line of the surrounding quarry face, as shown in my 2022 photograph in Figure 6.

Fig. 6: Backscarp on south western flank in September 2022

How might the 2019 events allow us to update our understanding of the landslide complex?

There is evidently a progressive failure mechanism in action with at least three major periods of movements (pre-2009, 2009 and 2019) separated by many years. The winters of 2009/10 and 2018/19 were not exceptionally wet or cold and this coastal location does not suffer prolonged periods of freezing weather, although winter rainstorms are likely to have been a factor in the timing of the rockfalls.

On 1st January 2010, a large volume of water was observed by Jenkins (2010) flowing from the middle to lower sections of the landslide during the BGS walk over survey. This would be consistent with winter rainwater infiltration on the headland plateau above the landslide seeping north-eastwards down the dipping bedding towards the foreshore. However, the progressive nature of the landslide suggests that other factors are also pertinent.

Prior to the commencement of quarrying the approximately 20^0 north-easterly dip of the strata into the bay would have given rise to the potential for both valley cambering during past periglacial conditions and coastal erosion at the toe of the slope. Cambering would have opened pre-existing joints and fractures, and movement of the competent limestone blocks on the shaly palaeosol layers, together with weathering processes, reduced the clay's shear strength towards its residual strength value, probably at or less than around 20^0. The presence of significant red clayey joint infill on the exposed backscarp, as shown in Figures 6 and 7, indicates that joints in the limestone are likely to have been already open prior to quarrying. (Indeed, open-jointed limestone blocks may have added to the attractions, and risks, of quarrying at this location.) Weathering along the palaeosol layers is indicated in Figure 7.

Fig. 7: Backscarp on northern flank

Once quarrying started, the removal of material from the quarry face would have added to stress relief behind the face, potentially leading to further opening of existing joints and possibly triggering the propagation of new open discontinuities. This process will have continued after the cessation of quarrying with each new rockfall event.

In conclusion, it is believed that this was a landslide scenario waiting to happen as soon as quarrying commenced, with individual rockfall events probably resulting from a mix of basal sliding on weathered palaeosols and joint-bound blocks over-tipping, with winter groundwater pressures playing their part in the timing.

References

Barclay, W J. 2011. **Geology of the Swansea district — a brief explanation of the geological map**. *Sheet Explanation of the British Geological Survey. 1:50 000 Sheet 247 Swansea (England and Wales)*

Gower Ministry Area. A History of St Illtyd's Church, Oxwich. Downloaded from www.gowerma.org November 2022

Halcrow Group Limited. 2012. **Swansea and Carmarthen Bay Coastal Engineering Group - Shoreline Management Plan** *(SMP2) Final Report and Appendices*.

Jenkins, G. O. 2010. **A walkover survey of the Oxwich Bay landslide**. *Open Report OR/10/001. British Geological Survey.*

******** ******** ********

Ground investigation and beyond – the development of geotechnical design

Home Counties North Regional Group lecture

at University of Northampton on 18th October 2022,

presented by Chris Vincett FGS and Allan Bell FGS

of Hydrock Consultants Limited

Chris Vincett FGS

On 18th October, 2022, a talk was presented to the Home Counties North Regional Group of the Geological Society at the University of Northampton, by Chris Vincett and Allan Bell of Hydrock Consultants Ltd. Allan stood in for Ian Gardner, also of Hydrock, who prepared the second half of the talk but was unable to present it due to illness.

Chris Vincett, Associate Technical Director of Hydrock, is a Chartered engineering geologist with over 40 years' experience of working in construction and land quality. His experience is mostly in ground investigation but also in areas such as piling and landfill design, in a wide range of ground conditions in the UK and overseas.

Ian Gardner is a Technical Fellow at Hydrock, with responsibility for geotechnical design, and has over 30 years of experience. He particularly specialises in the design, specification and verification of earthworks, and has detailed experience of geotechnical laboratory testing and soil testing in the field.

Allan Bell is a Chartered Geologist with over 30 years' experience in the fields of mining, site investigation and geotechnical design. He is RoGEP and SiLc qualified.

The talk was entitled "Ground investigation and beyond – the development of geotechnical design" and it was conceived to bring together the various stages of ground investigation through to geotechnical design. The importance was emphasised of considering the continuity between the initial concept of a construction project, development of the Ground Model through the ground investigation, into the design phase, and subsequently into the verification of construction. It has to be recognised that the ground is not made to a specification; it has been created by a combination of many natural processes, over huge periods of time.

Therefore, whatever there is underlying a site has to be first of all anticipated based on knowledge of geological processes, historical data and a deal of guesswork inspired by experience and precedent. Ground Investigation is a process of exploration of the unknown, whereby the initial conceptual ground model is drawn up from whatever evidence is available, be it from geological maps, geomorphology seen in walkover surveys, and from earlier exploratory work. Geologists are trained to think in three physical dimensions as well as the fourth dimension of time, to obtain an initial concept of what there might be under the ground.

The most sensitive and potentially most expensive risks on any construction project are most likely to relate to the ground in some way. In addition, any problem encountered in the ground is commonly related in some way to water – be it groundwater, or surface water. Difficulties in construction related to the ground conditions are often quoted as a major cause of cost over-runs and delays. As a recent example, in answer to questions in the House of Commons regarding why the costs of HS2 construction had increased from the 2009 figure of £37.5 bn to nearly £80bn by 2019, the reason was given that the ground conditions along the route were "significantly more challenging" than had been predicted.

The lay person is generally unaware of the scale of ground related problems and how the related risks can be mitigated. This lack of exposure has resulted in engineering geology becoming a niche profession, with the number of young people having aspirations of becoming engineering geologists becoming fewer in recent years.

In exploring the ground, the evidence obtained on the ground conditions is based on small samples taken from a relatively small number of sampling points. The overall ground model relies on a huge amount of interpolation, and extrapolation of available evidence. We can never know exactly what there is in the ground. This leads to the need to recognize that there will always be uncertainties and associated risks in the ground, but that the quality and appropriateness of the ground investigation will dictate how much the information can be relied upon and how much the risks can be reduced. The risks can never be removed entirely – there will a degree of uncertainty in any ground-related project.

The process of ground investigation therefore has to follow a route based on Best Practice, so that the information obtained is from a set of standardised repeatable processes, detailed in the various applicable British and European standards. This is an iterative process, constantly expanding and improving on the accuracy and precision of the existing information. The information must be communicated to the design team in a clear way, using defined terms, so that the properties of the materials in the ground which will impact on the structures are best understood. This involves work being done by competent people who are appropriately qualified and experienced. It also increasingly involves the use of extremely powerful computer-based tools to help in data analysis and conceptualising models in a three-dimensional way. However, the application of the knowledge of real people is still essential in the process of interpretation.

To a large extent, the uncertainty of the ground is covered by a series of assumptions. The adage here is "you pay for a ground investigation whether you do one or not". However, given that the cost of a ground investigation is usually much less than the cost of putting right a problem arising from lack of knowledge of the ground conditions, there is a very good case for arguing for more, not less, ground investigation. Ground investigation should be measured by its value, not by its cost.

The lecture built on these points by describing a number of case studies. One involved an appreciation of the complexity of glacial superficial materials, in which contrasting granular and cohesive materials are laid down in a way that leads to highly variable and unpredictable ground conditions. Until these are seen in their entirety, such as is exposed in sea cliffs or large excavations, it is difficult to conceive how complex these materials actually are.

The examples described included a site for a proposed large scale rail freight terminal in the Midlands with an area of over 170Ha. It includes multiple large warehouses, linked to existing infrastructure by new rail lines and roads, with associated tunnels, bridges, cuttings, and embankments. Other infrastructure involves water and sewer mains, energy and communications. The objective is to enable logistics and manufacturing companies to reduce reliance on road transport by transferring to rail. Construction levels are controlled by these factors, resulting in the need for cut-to-fill earthworks involving millions of cubic metres of material. In addition, the schemes necessitate the improvement of road and rail transport connections, including new motorway junctions, bypasses, and junction improvements. All of these require varying types of information on the ground conditions to allow successful construction and long-term performance.

In the design and construction of these projects, the ground model is put to the test in the areas of excavation, where the ground conditions can be seen in detail and compared with the predicted model in the ground investigation. Correct prediction of ground conditions allows most efficient re-use of materials which require different specifications of compaction for different uses and materials.

Many contractors rely on claims for 'unexpected ground conditions' to be a source of profits in the otherwise low profit-margin earthworks. However, the aim of a good ground investigation should be to ensure that the ground conditions are not 'unexpected', even though they may still be highly variable. Hopefully the ground model will reflect reasonably well what is actually found during the cutting excavation works, showing that the ground conditions are predicted as accurately as possible to reflect the actual ground conditions.

The key to a good ground model is appropriate cross sections, contour plans and other images illustrating the relationship between different main types of materials. These may or may not correlate with their geological classifications, but the geology is usually the best starting point. Fine-tuning into different materials through their grades of weathering or other factors are often required depending on the engineering behaviour of the different material types.

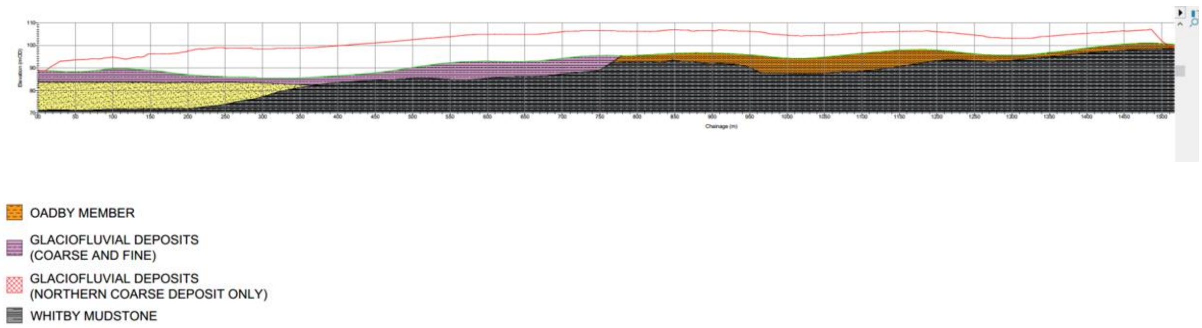


Figure 1 – example of a cross section to illustrate the ground model.

A case history was outlined of the investigation for a road bridge to carry a new by-pass over a deep existing railway cutting was described. The bypass was required as part of the off-site works related to the rail freight terminal discussed above. The cutting is steep sided, through a sequence of limestones and mudstones and was constructed in the 19th century to carry a main line railway and a local link line parallel to each other. The geological sequence was well defined prior to the ground investigation through being defined as a geological SSSI, in which the strata had been logged in detail and made available publicly. The objectives of the ground investigation were to confirm the geological sequence, and determine the geotechnical characteristics of the strata, to enable the stability of the slope to be assessed under the loads applied by the bridge foundations. They were also required to enable the design of temporary works, including cuttings to form the bank seats and the foundations of a working platform to carry heavy cranes, used to move the deck of the bridge into position over the railway lines. The geological profiles were also tied into information from separate investigations undertaken for the road embankment for the by-pass either side of the railway bridge.

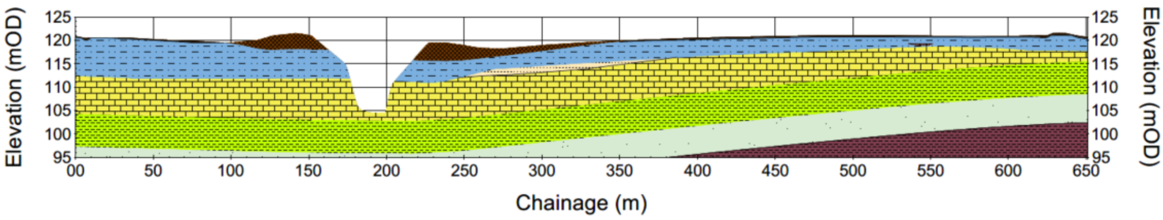


Figure 2 – Cross section for by-pass bridge over main line railway

The geotechnical parameters determined included the uniaxial compressive strength of the materials under the bridge abutment footings.

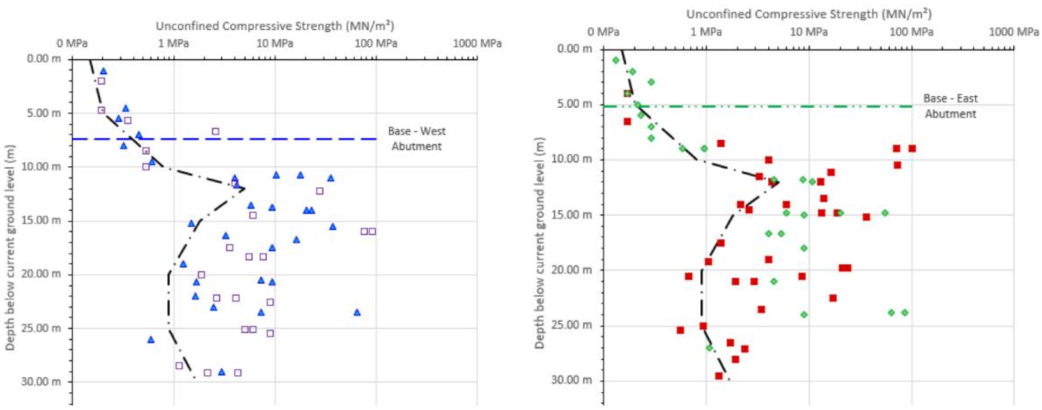


Figure 3 – Uniaxial compressive strength profile for the western and eastern abutment foundations

From the results of the ground investigations, geotechnical parameters could be selected and discussed in detail in the Geotechnical Design Report (GDR), prepared separately from the Ground Investigation Report (GIR). The GDR is prepared to contain the analyses required to assess the construction and long term performance of the bridge and associated structures.

Another important document which is prepared in parallel with the GIR and GDR is the Geotechnical Risk Register (GRR), highlighting the key risks to various structures and parts of structures, at different stages of their construction and long term performance. The GRR identifies hazards, assesses the probabilities and consequences of their outcome, and gives them each a 0-10 risk rating. This can be used as the basis of a structured methodology for designing suitable mitigation to reduce risks to acceptable levels and for communication of these risks to all parties involved in the construction and operation of the various elements covered.

The talk then covered how the Designs and Specifications for the different parts of the project are developed from the information contained in the GIR. These are required to ensure the construction is undertaken correctly, compliance with the Specification can be verified and to enable the Contract to be set up. The importance of understanding the objectives of the structures and their performance was described.

The Specification outlines the performance objectives, design principles and defines the correct construction sequence to ensure the outcomes are met. These are often produced as detailed annotated drawings, for display in site offices to ensure operators understand how works should be undertaken.

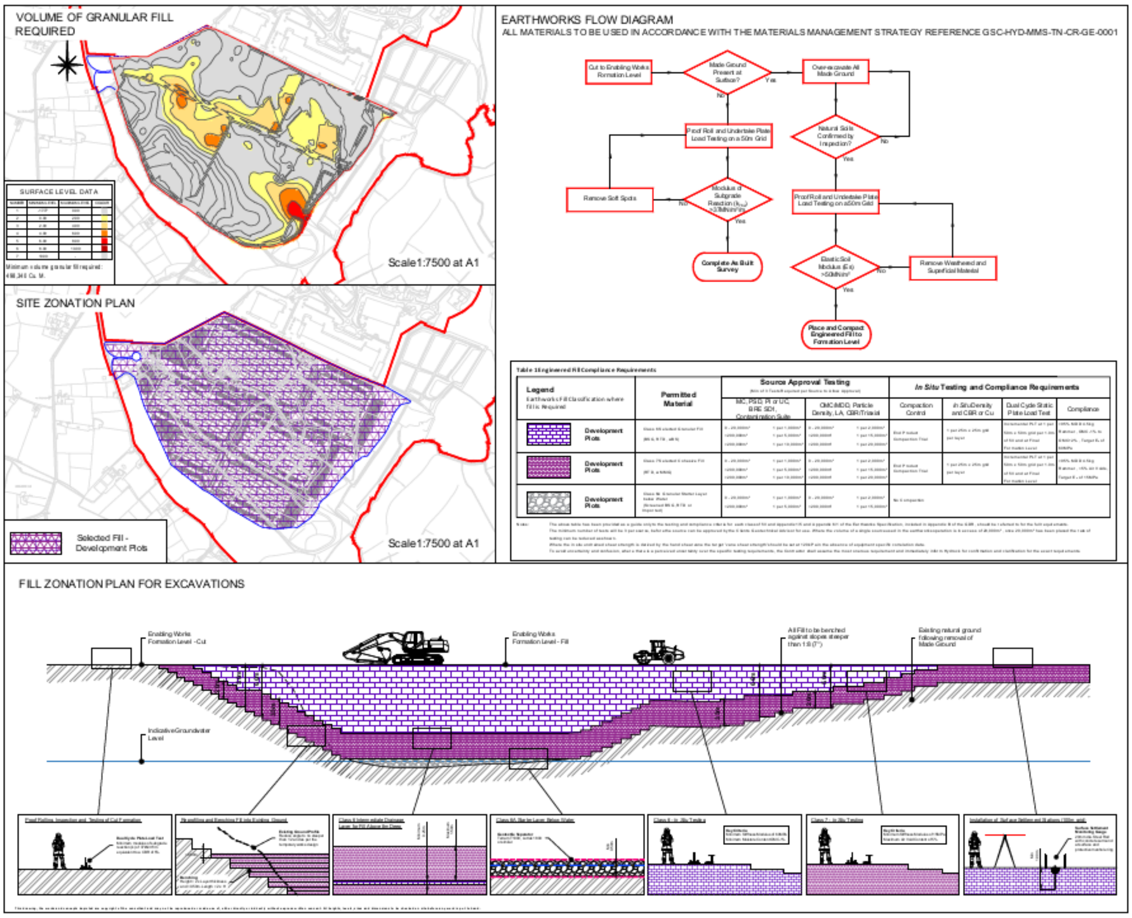
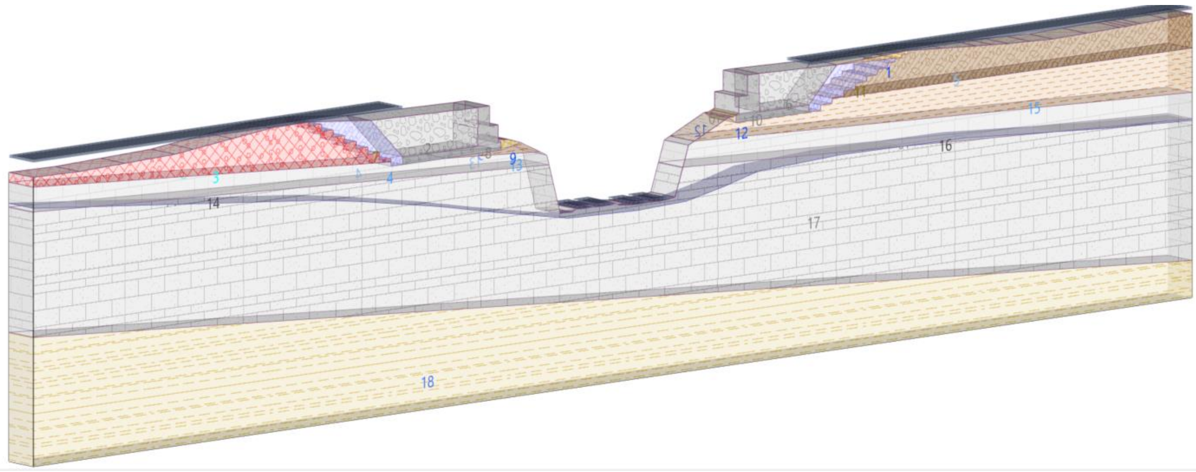


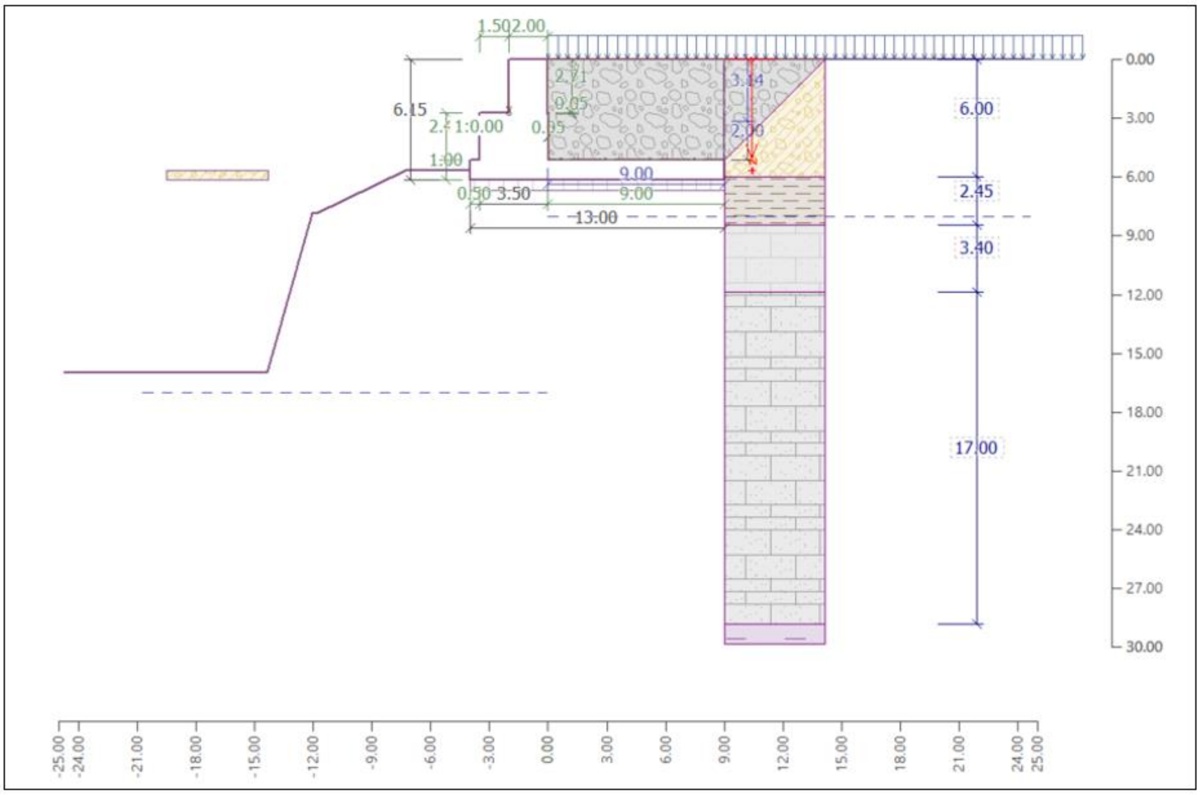
Figure 4 - Example of illustrated version of an earthworks specification

Examples of methods of geotechnical analyses were then briefly described, involving the Limit State approach (Ultimate and Serviceability Limit States – ULS and SLS). These are necessary to comply with the Eurocode 7 design approach, and are specific to the individual structures, the ground conditions, groundwater conditions and how they will operate under changing environmental conditions.

The selection of appropriate geotechnical parameters is crucial at this stage, including what parameters are needed, how to select them, taking into account test results alongside published values and experience, and the quantum of stresses and acceptable strains. This is where the factors outlined by Professors Peter Vaughan and John Burland of Imperial College are so pertinent – the influence of well-winnowed experience being applied as a sense-check to the input of computer analysis. The principle of 'Garbage in / garbage out' also comes into play here.

The advantages of different types of software – Finite Element modelling and Limit State analysis – were briefly discussed and illustrated in relation to the construction sequence for the bridge.





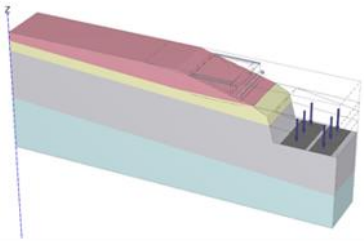
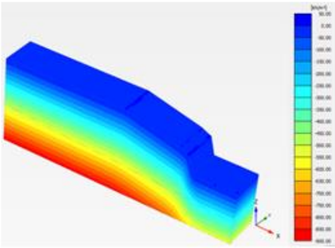
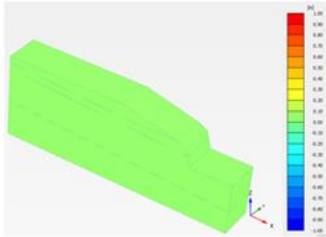
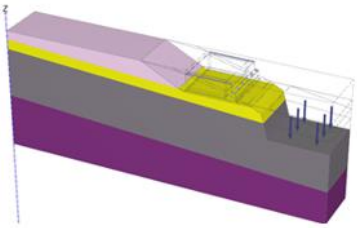
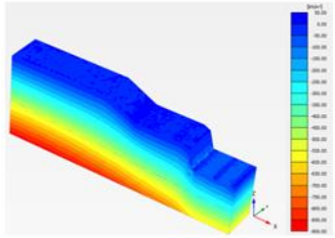
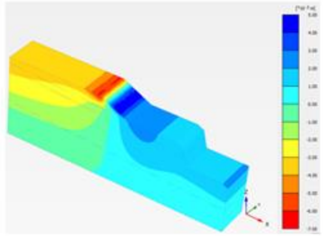
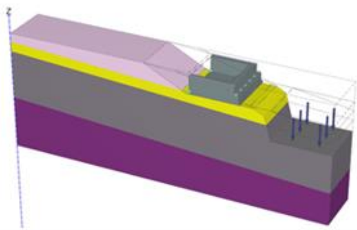
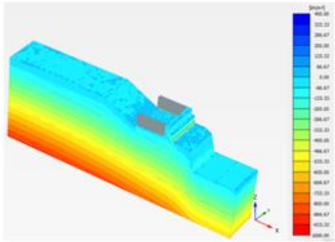
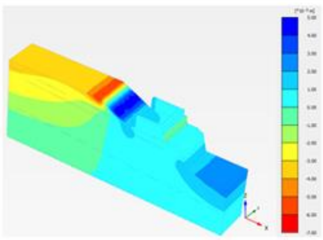
Stage	Construction Stage	Stress	Displacement
1			
2			
3			

Figure 5 – Conceptual bridge design and construction sequence

The talk concluded by stating that:

- The ground is inherently complex, and naturally variable, not made to a specification.
- Allowance for appropriate Groundwater pressure and water flow are crucial in geotechnical design.
- Ground Investigation is a process of exploration – making uncertainty less uncertain.
- There will always be a degree of risk in the ground – the objective is to reduce risk as far as possible.
- Designing for the ground is difficult.
- Best Practice and Best Available Techniques should be used at all stages.
- Detailed as-built records must always be kept to verify that construction was in accordance with the design.
- Communication is essential.
- Training and experience are both necessary to make for competence.

The talk was attended by 13 members of the Home Counties North Regional Group, from a variety of backgrounds, some in construction but others in unrelated areas of Geology including hydrocarbons, minerals, and non-professional geological enthusiasts, and also 4 staff members from Hydrock Consultants Limited.

Questions from the floor were invited and a lively discussion was held.

******** ******** ********

Visit to IBIS Limited on the 13th of December 2022

Doris Southam FGS

Our Visit to IBIS Limited on the 13th of December 2022 turned out to be fascinating, not only to learn and refresh our knowledge of petrographic thin section preparation, micromorphology (thin section analysis) under cross polarized light, but also to learn about the use of micromorphology as research evidence in criminal and legal disputes.

Barry Hunt, FGS, Director of IBIS Limited, with 35 years of professional expert knowledge in petrographic thin sections analysis, generously shared his knowhow and enthusiasm for the subject with us.

We learned about the delicate preparation of slides, (an art in itself), about the power of the cross polarized microscope, (of the importance to have the most up-to-date and most powerful tool possible, for accuracy and magnification power).

As under the cross polarized microscope every mineral has its own characteristics (colour, angle of extinction, etc.) Barry explained to us that thin section analysis can be used not only for field samples but also in legal disputes where not only stones, but also cement samples, for instance, can be analysed for their properties and qualities, such as permeability, strength, and potential premature decay. (For example, material mixes containing too many water absorbing minerals and therefore not suitable for certain construction purposes).

Despite the particular difficulties that day with travel, (train strikes) this field trip was well attended, and with so much enthusiasm for further information, Barry generously sent a list of "further reading" and reference works, pertaining to metamorphic, sedimentary, igneous and volcanic rock analysis. John shared these with us.

There might be a possibility to organize a follow up visit to IBIS Limited, to enlarge on this taster of a fundamental skill for every Geologist.

******** ******** ********

Report on the talk on Petrographic Thin Sections by Barry Hunt FGS of IBIS Limited, on 13th December 2022

Richard Trounson FGS

A number of us experienced difficulties in arriving at Barry's laboratory and offices, situated in the basement of a house adjoining his residence in South Woodford, due to the inclement weather, train alterations, car problems etc., but Barry kindly gave out refreshments and waited until we had presence all those who would be arriving, before starting his talk.

He summarised his background and career. This had led him from studying geology at Sheffield, where the Department had placed a significant emphasis on the study of thin sections, to his present work. This, it appeared, involved partly working as a surveyor, sometimes with an adventurous role abseiling down high buildings to identify problems with facades, partly as a geological consultant, identifying problems in building stones through examining samples in thin section, and partly as an expert witness. In that connection it emerged that he has a particular expertise in disputes involving defective concrete.

He mentioned some of the issues with building stones in which he had been involved, such as marble hysteresis, a bowing effect in that stone found particularly in panels of 20-40mm thickness, and issues with the Wicklow Granite, at Leinster House, the seat of Oireachtas Éireann, the Irish Parliament, in Dublin.

He introduced the very sophisticated microscopy and display equipment which he used in his practice, outlined the history of thin section techniques, originally developed by the Sheffield geologist and metallurgist (and President of the Geological Society) H.C. Sorby, and explained how thin sections were made.

He then told us how thin sections could be used to identify rocks, and problems in building materials. In that connection he emphasised, that although he worked with a very large reference library, apparent from the many shelves lining the walls of his basement laboratory complex, most practical work rested on the knowledge of some 8 to 9 key minerals.

He then took us through the optical properties of minerals in plane polarised light and under crossed polars.

He illustrated his talk with slides of Portland Stone, travertine from Pamukkale ("Cotton Castle") in Turkey, Rubislaw Granite, Burlington Slate and of course concrete.

Finally, he spoke about how he conducted his business, his work as an expert witness in civil litigation, particularly in a case in which he had compelled a prominent research institute to climb down in the face of incontrovertible evidence, the importance of being candid and straight with clients, and of paying suppliers' invoices promptly.

All in all, Barry gave us, not only a basic refresher course on topics many of us had first learned about many years ago, but also a fascinating insight into how an earth scientist can carve out a most interesting niche career in this country, in fields outside the conventional domains of academic geology, engineering geology and the petroleum and water industries.

******** ******** ********

Letter to The Hertfordshire Mercury weekly newspaper from Dr Bryan Lovell OBE FGS Past Chair, Home Counties North Regional Group Past President of Geological Society

Reported by John Wong FGS
HCNRG Chair/Newsletter Editor

Dr Bryan Lovell OBE FGS

© Dr David Brook OBE FGS 2014

Dr Bryan Lovell OBE FGS sent a letter to The Hertfordshire Mercury weekly newspaper on his thought on the Geology-Climate Exhibition at Hertford Museum, it was published on 12th January 2023.

'On Christmas Day the Mercury published a topical piece on Hertfordshire Puddingstone. This remarkable rock is now famous well beyond the boundaries of the county. Recent research shows that Hertfordshire Puddingstone formed 55 million years ago, during an exceptionally warm episode in the history of Earth's climate. That warm episode has important lessons for us today, as we strive to cope with the consequences of present-day climate change caused by us. Hertford Museum is currently staging (until 16 April) an authoritative exhibition on these vital matters: The Proof of the Puddingstone - Geology and Climate Change. Don't miss it!'

Dr Bryan Lovell, CGeol

Dr Bryan Lovell OBE FGS said 'Congratulations to those involved in getting this display in place, with such good specimens and explanations.'

The exhibition is highly recommended to see, until 16th April 2023. I shall arrange a HCNRG Hertford walk part II and visit Hertford Museum see the exhibition before the closing date of the Geology-Climate Exhibition.

I (John Wong) led the HCNRG Hertford walk on 21st June 2014, Dr Bryan Lovell OBE came to meet our field meeting party on the day at Hertford Castle and gave a talk on Puddingstone and Climate Change.

2 

HCNRG Hertford Walk Part One, 21st June 2014.

© Dr David Brook OBE FGS 2014

Dr David Brook OBE FGS wrote a six-page report of my Hertford walk field meeting and it is published in the HCNRG newsletter issue 2, pp.14-19.

FORTHCOMING FIELD MEETING TO HORNIMAN MUSEUM AND CRYSTAL PALACE DINOSAUR PARK 13TH FERUARY 2023

Abstract of the talk on the history of Horniman Museum

John Wong FGS
Chair, Home Counties North Regional Group

Brief History of Horniman Museum

The Horniman Museum and Gardens is a museum in Forest Hill, south London. The museum has displays of anthropology, natural history, and musical instruments, and it is known for the large collection of taxidermized animals.

Horniman Museum is named after its founder Frederick John Horniman, an elected MP for the Liberal Party in 1895; he inherited and ran his father's business Horniman's Tea. Frederick John Horniman was a tea trader and a dedicated traveller who spent wisely on his travelling to minimize the variable costs, so that he could do more travelling; he has a strong instinct to collect souvenirs during his travelling and exploring, the items collected were mainly related to natural history, cultural artefacts, and musical instruments.

The original Horniman family house was demolished in 1898, architect Charles Harrison Townsend was invited to design Horniman house (Known as Horniman Museum from 1901 to the present day) in arts and crafts style that stands in its place today. Frederick John Horniman later realised his collections were taking up so much space within the family home, so he moved his family out of Horniman house, and in July 1901 and gave Horniman house and gardens and six other houses to London County Council as a gift to the people of London.

Horniman house changed its name to the Horniman Museum in 1901, when it opened to the public in the new purpose-built museum building.

The museum has three main galleries – The World Gallery and the Music Gallery are on the lower ground floor, and the Natural History Gallery is on the ground floor. There is no charge to visit the galleries, your donations to support the work of the Museum are welcome. There is a charge to visit the Aquarium and the Butterfly House.

In 2019, before the first lockdown, 952,954 visitors have visited the Horniman Museum.

Notes on talk and onsite group practical sedimentology analysis on the building stones at Horniman Museum

John Wong FGS
Chair, Home Counties North Regional Group

1. Identify the type of building stone
2. Name of the building stone
3. Quarries
4. Geological age of the building stone
5. Stratigraphy
6. Palaeoenvironment
7. Burial history
8. petrology
9. Sedimentary structures
10. Palaeontology
11. Rock texture classification
12. Classification of carbonates
13. Porosity and permeability
14. Hydrocarbon reservoir rock analogue
15. Durability to weathering

Abstract of the guided tour of Horniman Museum's Natural History Gallery

Dr Emma Nicholls FGS
Senior Curator of Natural Sciences of Horniman Museum

© Dr Emma Nicholls

© Anglian Water

You are invited to join us for a guided tour of the Horniman's Natural History Gallery, led by Senior Curator of Natural Sciences, Dr Emma Nicholls FGS. Emma focuses on the curation, documentation, and research of the Palaeontology, Geology and Osteology collections.

Emma was one of the palaeontologists that excavated the "Rutland Sea Dragon", the largest near-complete ichthyosaur skeleton ever found in Britain. The specimen is in a conservation lab in Shropshire, under the care of specialist conservator Nigel Larkin. However, Emma would be delighted to tell us about the excavation and answer questions, after which she will give us a tour of the Horniman's Natural History Gallery. The Horniman Museum is on the verge of a major redisplay project, and this is a rare opportunity to hear about the exciting redevelopment plans for the space.

Abstract of Crystal Palace Dinosaur Park tour on 13th February 2023

John Wong FGS
Chair, Home Counties North Regional Group

After the museum guided tour, weather and daylight hour permitting, we travel with John on the London overground train from Forest Hill to Crystal Palace at around 3.30 p.m. (9 minutes travel time). In the Crystal Palace Dinosaur Park, there are more than 30 sculptures constructed in the 1850s, representing 15 genera of extinct prehistoric animals of the Palaeozoic Era, the Mesozoic Era, and the Cenozoic Era; only four of which are dinosaurs - one each of Megalosaurus and Hylaeosaurus, and two Iguanodons. The animal models were designed and sculpted by Benjamin Waterhouse Hawkins under the scientific direction of Sir Richard Owen, the animal sculptures representing the latest scientific knowledge at the time. There are two model rock exposures representing the Carboniferous Period and the Permian Period, the Jurassic Period and the Cretaceous Period.

HOME COUNTIES NORTH REGIONA GROUP
FORTHCOMING LECTURES 2023

Abstract of Home Counties North Reginal Group face-to-face lecture 'Mineralogy and Minerals of Chipping Sodbury, South Gloucestershire' at RSK Hemel Hempstead offices on 23rd February 2023

Presented by Stuart Wagstaff FGS, Director, Soil Consultants Limited
Past Chair of Home Counties North Regional Group

Picture supplied by Stuart Wagstaff FGS

Stuart Wagstaff
FGS CGeol
Director, Soil Consultants Limited
Holmer Green

Abstract of lecture

South Gloucestershire has a unique mineralogy and was once the world's largest producer of Celestine; the ore of Strontium. This mining industry has long since disappeared (under a shopping centre) but the legacy of the mineralogy is still present in Chipping Sodbury.

Stuart's talk will be centred around Hampstead Farm Quarry which will look at the geology, how the minerals occur, how they were formed and will be showing samples of what can be found (including sample give aways!). The quarry has produced many fine mineral specimens over the years some of which are housed, and on display, at the natural History Museum.

Lecture speaker

Stuart started his career as a mineral exploration geologist after graduating from Portsmouth University. This, career path took him to various parts of the globe in search of metalliferous deposits before settling back in the UK where he worked for various UK mining companies. Closure of much of the UK mining industry forced a career path into geotechnics and currently Stuart is a Director at Soil Consultants Limited who undertake investigation and geotechnical design work for the construction industry.

Stuart has kept an interest in the mining industry through the Russell Society and regularly visits mines and quarries throughout the UK including Chipping Sodbury in South Gloucestershire which was one of the quarries Stuart worked on in his early career.

Stuart started his career as a mineral exploration geologist after graduating from Portsmouth University. This, career path took him to various parts of the globe in search of metalliferous deposits before settling back in the UK where he worked for various UK mining companies. Closure of much of the UK mining industry forced a career path into geotechnics and currently Stuart is a Director at Soil Consultants Limited who undertake investigation and geotechnical design work for the construction industry.

Stuart has kept an interest in the mining industry through the Russell Society and regularly visits mines and quarries throughout the UK including Chipping Sodbury in South Gloucestershire which was one of the quarries Stuart worked on in his early career.

******** ******** ********

Abstract of Home Counties North Reginal Group lecture on Zoom on 28th March 2023
'Some aspects of natural and anthropogenic halite (salt) karst subsidence in north Cheshire'

Presented by Dr Colin J Serridge
Senior Lecturer in Earth Sciences, Edge Hill University, Ormskirk

Dr Colin J Serridge
FGS CGeol EurGeol

Senior Lecturer in Earth Sciences
Edge Hill University, Ormskirk

Abstract of lecture

Most of the north Cheshire (Knutsford Group) meres (lakes) in the UK formed naturally by dissolution of Triassic halite (salt) after the Devensian glaciation. Natural halite dissolution induced by the retreating Devensian ice sheet, followed by the establishment of the natural pre-anthropogenic hydrogeological regime caused brine movement towards low areas where brine springs, locally referred to as 'wiches', developed, with the term captured in local place names coinciding with these locations such as Nantwich, Northwich and Middlewich (Cooper 2020). These natural brine springs have been exploited since pre-Roman times; later becoming the main salt producing areas in Cheshire, particularly in the late 19th to early 20th centuries, when a flourishing salt and associated chemicals industry developed.

Anthropogenic industrial brine extraction in the 19th and 20th centuries, contributed to further subsidence, enlarging some of the meres and formed the new mere of Melchett Mere. The characteristic features of three meres, Rostherne, Melchett and Tatton are compared by reference to historical surveys, maps, photographs and light detection and ranging (LiDAR) Interpretations. Similarities between the natural and anthropogenic subsidence features are presented and which can be separated only by temporal evidence of their formation. All three meres will be shown to be surrounded by landslip scars related to the subsidence, as illustrated in the photograph.

Former brine pumping at Northwich, Plumley and possibly Agden is implicated in the formation of Melchett Mere and reactivation of natural subsidence at Rostherne and other Knutsford Group meres.

Brine run linkages between these abstraction areas and the subsidence cross the route of the proposed Phase 2b of the HS2 railway between Crewe and Manchester.

The lecture will cover the geological setting and natural dissolution processes affecting the halite deposits and related surface subsidence features. Results will be presented on the detailed investigation of the three meres, including their morphology, bathymetry and changes with time derived from historical surveys and maps, together with more recent evidence from LiDAR imagery. Interpretation of these data reveals characteristic surface extension and compression ground movements with associated slip scars and ridges respectively. These naturally generated features are compared with those produced by brine pumping over many decades. The likelihood and impact of possible future brine-related subsidence on the HS2 route is considered.

Colin is a Chartered Engineering Geologist with over 30 years industrial experience in the design and project management of specialist ground improvement techniques both within the UK and overseas. Over the last 10 years Colin has increasingly engaged with postgraduate MSc Engineering Geology and Geotechnical Engineering courses, as a visiting lecturer, delivering lectures and workshops on ground improvement techniques and sharing experiences as an Engineering Geologist working in the ground engineering industry with the next generation of geoscientists.

More recently this has been extended to Earth Science undergraduate teaching as a Teacher-Practitioner, where modules are delivered on the BSc Geology and Physical Geography course at Edge Hill University. Colin's research interests include halite (salt) karst in Cheshire, recycled aggregates and various aspects of Ground Improvement.

Colin's time is currently spent around 60% in industry with the remaining 40% in academia.

Lecture speaker

Colin is a Chartered Engineering Geologist with over 30 years industrial experience in the design and project management of specialist ground improvement techniques both within the UK and overseas. Over the last 10 years Colin has increasingly engaged with postgraduate MSc Engineering Geology and Geotechnical Engineering courses, as a visiting lecturer, delivering lectures and workshops on ground improvement techniques and sharing experiences as an Engineering Geologist working in the ground engineering industry with the next generation of geoscientists.

More recently this has been extended to Earth Science undergraduate teaching as a Teacher-Practitioner, where modules are delivered on the BSc Geology and Physical Geography course at Edge Hill University. Colin's research interests include halite (salt) karst in Cheshire, recycled aggregates and various aspects of Ground Improvement.

Colin's time is currently spent around 60% in industry with the remaining 40% in academia.

Remembering and thank you to all newsletter article contributors

John Wong FGS
HCNRG Newsletter Editor

Since the launch of the Home Counties North Regional Group bimonthly newsletter in May 2020 during the Covid pandemic first lockdown, to date many HCNRG members have sent in tens of articles to support the production of the new format newsletters, with some members having submitted two or more articles.

Every newsletter article is a good read whether it is long or short; with contents initially aimed to share personal and work experiences during the lockdowns and post-lockdowns; later articles report on the learning from geology excursions and holidays in Britain and abroad, reports on general and specific geoscience research locally and outside Britain, local earthquakes, local geoarchaeology, local water resources, tectonic and structural geology, ground investigations, palaeontology, book and published geology paper reviews, history of geology activities of local geology societies, debates on climate change, personal hobbies such as mineral and fossil collecting, and sadly obituaries to remember the Home Counties North Regional Group members who have passed away not long ago.

Let me assure every newsletter article contributor that their support will never be forgotten, therefore I have compiled an up-to-date list of all the bimonthly newsletter article contributors; my grateful thank you always glowing brightly to all of you, and you are all forever shining stars of the Home Counties North Regional Group bimonthly newsletters.

Dr Haydon Bailey
Dr David Brook OBE
Nick Cameron
Jacqueline Clayton
Jessica Crane
Adam Dawson
Rudy Domzalski
Roy P Dunn
Glenda Easterbrook
Bev Fowlston
Dr Liam Gallagher
Kerril Grun
Wojtek Grun
Dr Tom Hose
Barry J Hunt
Dr Ilias Karapanos
Zuzana Lednarova
Dr Bryan Lovell OBE
Adrian Marsh
Mick McCullough
Kwame Ofori
Karoly Pesztranszki
Nicholas Pierpoint
Nigel Rothwell

Doris Southam
Femi Tanimola
Richard Trounson
Derek Turner
Chris Vincett
Stuart Wagstaff
John Wong