Cave & Karst Symposium, 2017

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BCRA

YORKSHIRE GEOLOGICAL SOCIETY

LGA
Leeds Geological Association
Founded 1874

British Cave Research Association
28th Cave Science Symposium
hosted jointly with the Yorkshire Geological Society and Leeds Geological Association

Symposium - Saturday 21st October, 2017
Field-trip(s) - Sunday 22nd October, 2017
School of Earth and Environment, University of Leeds

Timetable and Abstracts

Welcome from the BCRA Chairman and President

For the second time in 6 years, on behalf of the Council of the British Cave Research Association (BCRA), we are pleased to welcome members of the Association and also members of the Yorkshire Geological Society (YGS) and the Leeds Geological Association (LGA) to Leeds University, this time on the occasion of the 28th BCRA Cave Science Symposium. The objective of the BCRA is "*to promote the study of caves and associated phenomena wherever they may be situated, for the benefit of the public*" and the Annual Symposium is one of the ways that this objective is fulfilled. The *associated phenomena* include karst landforms on the surface, and this aspect is reflected in the title of the Association's scientific journal, *Cave and Karst Science*. Caves can provide opportunities for geologists to view and study continuous or relatable parts of the rock succession that lack such high-visibility exposure on the surface. Though, sadly, only relatively few scientists seem to take advantage of such obvious opportunities, it is interesting to ponder that Tony Waltham's 1971 paper, published in the YGS Proceedings, describing "shale" bed distribution in the Carboniferous Limestone of the Yorkshire Dales, remains a guaranteed citation in recent detailed stratigraphical accounts and more general geological syntheses. The second volume of the BCRA's *Caves and Limestones of the Yorkshire Dales* is no exception, and it seems appropriate to wonder whether a pronouncement (handed down to one of us by a formerly eminent Yorkshire geologist) that "*Caves have nothing to do with geology"* was perhaps, to some extent, precipitous and misguided.

On a more serious note, the BCRA AGM is held during the Symposium. Administrative matters are kept to a minimum the primary objectives being to provide BCRA members with a succinct summary of Association activity during the past year and to seek views on what should be done in the coming year. Interested non-members are welcome to attend the AGM and to contribute to the discussion

Professor John Gunn, BCRA Chairman
Dr David Lowe, BCRA President

Time	Oral Presentations	Presenter
08.30	Doors open, registration, book sales, coffee	
09.15	Take seats	
09.20	Welcome and housekeeping	Phil Murphy
Session 1: Caves and Karst of the Yorkshire Dales		Chair: Gina Moseley
09.30	The Pleistocene Laminated Sediments of Victoria Cave, North Yorkshire, UK: Characteristics, Age and Significance	Peter Wilson
09.50	The 'Reefs' of Black Reef Cave and Other Strange Tales from Ribblehead	Phil Murphy
10.10	Rapid Climate Change Recorded in Speleothems from the Yorkshire Dales	Phil Hopley
10.30	Introduction to Posters	
10.40	Coffee, Posters and Book Sales	
Session 1 Continued: Caves and Karst of the Yorkshire Dales		Chair: John Gunn
11.10	New work on the Last Interglacial Bone Bed in Victoria Cave	Tom Lord
11.30	KEYNOTE - Caves and Karst of the Yorkshire Dales	Tony Waltham
12.00	Pause	
12.05	BCRA AGM	
13.00	Lunch	
Session 2: UK Cave and Karst Studies		Chair: Phil Murphy
14.00	Building a UK Speleothem Database	Dan Awcock
14.20	The Hydrogeology of Speedwell Cavern, Castleton, Derbyshire: Another layer of Complexity	John Gunn
14.40	Vandalism and Restoration at Joint Mitnor Cave, Devon	Andrew Chamberlain
15.00	Scratching the Subsurface: Understanding the Diversity of Microbial Communities in Ogof Ffynnon Ddu	Renee Lee
15.20	Coffee, Posters and Book Sales	
Session 3: Foreign Cave and Karst Studies		Chair: Dan Awcock
16.00	Speleothem Fluid Inclusions show Westerly and Easterly Moisture Advection across North East Libya during MIS 3 Humid Phases	Mike Rogerson
16.20	Analytical Study of Cave Passage Type Relation towards Radon Concentration for Effective Dose Estimation towards Cave Guides in Indonesia	Muhammad Rifqi
16.40	The White Rabbit Marble Cave, Monashee Mountains, BC, Canada: A Remarkable Cave System in Stripe Karst	Chas Yonge
17.00	Feelings from the Underground. A Cave Pursuit for an Archaeology of the Emotion	Konstantinos Trimmis
17.20	Summing up and details of Sunday fieldtrips	John Gunn
17.30	Close	

Poster Presentations (10.30-11.10 & 15.20-16.00)	
Myotis sp. nov. (Mammalia, Chiroptera), a Giant Representative of a Bat Genus from the late Pleistocene of Jamaica	Stephen Donovan
Yorkshire Dales Cave Climate Monitoring	Jo White
The Hydrogeology of the Banff Hot Springs, Banff National Park, Canada: A Karst Perspective	Chas Yonge

BUILDING A UK SPELEOTHEM DATABASE (ORAL)

Dan Awcock[1,2], Tim Atkinson[2], John Gunn[3], Ian Fairchild[3] David Richards[4], Peter Rowe[5], Phil Murphy[6]

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Data from a UK speleothem database is presented. A new(ish) part-time PhD student working on a UK interglacial palaeoclimate project looking for speleothem samples which had already been U-Th dated, collecting samples from caves could add years to the project, and by not removing samples we would be helping with and promoting UK cave conservation. Having met and spoken to cavers and academics at events in 2015 and 2016 it became apparent that there was no UK database for speleothem samples, but there is a huge wealth of literature and work being carried out in this field, so creating one would be useful. Travelling the UK searching through collections, cataloguing them and obtaining samples for the project it became apparent that there are a large number of speleothem samples in collections at UK Universities which can be made available for further research.

There are 432 UK speleothem samples in Bristol, 325 at UEA, 144 at Birmingham, Phil Murphy (Leeds), Gina Moseley (Innsbruck), Andy Farrant (BGS) Tom Lord (Lancaster) Phil Hopley and Dan Awcock (BBK) also have several samples.

947 samples have been catalogued, the samples do not belong to the institutions where they are being stored but by those who collected them, details of ownership are in the database. These samples do not amount to 900+ individual stalagmites; they are sections of stalagmites, stalactites and flowstones. Some of these samples are too small to use or have had destructive research methods carried out on them to the extent that they can no longer be used, but, a significant number are in good enough condition to be used in future research.

The samples come from cave systems in South Wales, The Sutherland/Assynt area of Scotland, the Mendips, the Cotswolds, the Peak District and the Yorkshire Dales & Moors.

The database will be handed over to and maintained by BGS or BCRA and hopefully result in samples not being taken from caves without first checking to see if there is a sample available/appropriate to work on.

VANDALISM AND RESTORATION AT JOINT MITNOR CAVE, DEVON (ORAL)

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Joint Mitnor Cave in Devon contains a rich deposit of fossil mammal remains, characteristic of the most temperate part of the Ipswichian Interglacial (Marine Isotope Stage 5e). The cave is the type site for the Joint Mitnor Cave Mammal Assemblage Zone, one of the principal biostratigraphic divisions of the British Pleistocene. The cave is located in a disused limestone quarry which is protected as a SSSI and as a Special Area of Conservation as well as being within the boundary of the Dartmoor National Park. The site is also in a local nature reserve, jointly managed by the Devon Wildlife Trust and the William Pengelly Cave Studies Trust.

The sediments in the cave were excavated in the early 1960s, when it was decided that a substantial portion of the deposits would be retained intact as a demonstration site and research resource. Since then the Pengelly Trust has provided guided visits for thousands of visitors of widely varying experience and knowledge of cave science. Thus the site is now at least as valuable as an educational facility as it is of scientific interest.

In September 2015 the cave was vandalised and some bones and teeth from the deposit were removed and the demonstration section damaged. It was decided that reinstatement of the section by placing replicas of the

missing material, with repair of the damage, was the only sensible course of action. We will outline the work that was done up to the re-opening of the cave in the summer of 2017 and will highlight a number of issues which deserve wider discussion.

It is, of course, impossible to make any heritage site completely proof against unauthorised entry and damage – something which is a much greater problem in other parts of the world than in Britain. Whilst it is possible to achieve high levels of security, this can only be achieved through considerable investment of resources.

At Joint Mitnor Cave we benefited from having some good quality photographs as a record of what the site was like before the vandalism occurred, and we were fortunate that the Natural History Museum was willing to allow us to replicate similar fossils to replace those that were stolen. Such replicas can now be made to a very high standard although their placement in the cave does risk the introduction of contaminants and they may turn out to have a limited lifespan. Arguably the scientific value of the site is reduced by these introductions so that a precise and accurate record of what has been done need to be made and securely retained.

Site restoration would be easier and more accurate if three-dimensional digital models were available as insurance against the possibility of unauthorised disturbance. It is also recommended that organisations pool their cave conservation expertise and compile a list of specialists who can assist in instances of damage.

THE HYDROGEOLOGY OF SPEEDWELL CAVERN, CASTLETON, DERBYSHIRE: ANOTHER LAYER OF COMPLEXITY (ORAL)

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The basic pattern of water movement through Speedwell Cavern has been evident since the time of the first explorers. The majority of the water enters via two sumps, Main Rising (MR) and Whirlpool Rising (WR), flows along an open stream passage and enters the downstream sump (DS). Between MR, WR and DS there are a number of smaller inlets, most notably from Cliff Cavern Passage (CC), Bathing Pool Passage (BPP), the Assault Course, Pilkington's Cavern and the Longcliffe Vein (LV) inlet to the Near Canal. There have been many water tracing experiment and in every case where there was monitoring in Speedwell Cavern the tracer was detected at either MR or WR or at both sites. Tracer has never been conclusively detected from other inlets which are inferred to discharge relatively local percolation water. In the case of CC and BP this was supported by long-term water-temperature measurements which showed the temperature to be virtually constant in contrast to the MR and WR temperatures which vary markedly. In many experiments there was no in-cave monitoring and tracer was only detected at one or both of two springs on opposite sides of the Peakshole Water, Russet Well (RW) and Slop Moll (SM). It has always been assumed that all allogenic water from the Rushup Edge stream-sinks and autogenic recharge from caves south of the Winnats Pass flows through Speedwell en route to MR and WR although it is known that to the north of the Winnats Pass the water from Blue John Cavern and Treak Cliff Cavern flows directly to RW, that is not via MR and WR. The upstream source of the Peakshole Water is Peak Cavern Rising (PCR) which discharges autogenic water for most of the year but acts as a flood overflow for the Speedwell streamway.

To this well-established pattern must be added an additional 'sub-Speedwell' flow-path that was discovered during a water tracing experiment from Rowter Hole. During the experiment automatic water samplers were deployed at RW, SM and downstream in Peakshole Water and spot water samples were collected from MR and WR where granular activated charcoal fluocapteurs were deployed. By chance water samples were collected from MR before the dye arrived but after it had been detected at RW and SM, thereby demonstrating the existence of a previously unknown flow-path. Had the visit to MR been a few hours later the dye would have arrived and the existence of the 'sub-Speedwell' conduit would not have been discovered.

RAPID CLIMATE CHANGE RECORDED IN SPELEOTHEMS FROM THE YORKSHIRE DALES (ORAL)

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We present data from ongoing research into rapid climate change events in the Early Holocene, and their identification within U-Th dated speleothems from the Yorkshire Dales. Speleothems collected from Pippikin Pot and White Scar Cave show oxygen isotope excursions at 9.3 ka and 8.2 ka, similar in magnitude, age and duration to oxygen isotope excursions observed in Greenland ice-cores. We use a variety of methods, including fluid inclusion analysis and modern-day cave monitoring to inform our interpretation of the climate signal recorded in the Yorkshire Dales speleothems. Using these insights, we have begun to investigate older speleothems from previous inter-glacials (MIS 13 to MIS 3) from other caves within the Yorkshire Dales. We hope this work will further our understanding of the patterns and causes of rapid climate change events throughout the Quaternary.

SCRATCHING THE SUBSURFACE: UNDERSTANDING THE DIVERSITY OF MICROBIAL COMMUNITIES IN OGOF FFYNNON DDU (ORAL)

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Microbial life is ubiquitous and can be found in a variety of environment. Caves are no exception. Devoid of light and lacking in common nutrients, this harsh environment is known to harbor a variety of microbes that may play a significant role in geological processes that shape the biosphere and our climate. Despite that, little has been done to further understand the microbial diversity in British caves. In this study, DNA samples were obtained from a number of samples collected from Ogof Ffynnon Ddu (OFD), one of the largest caving systems in Britain. By using a metagenomic approach, we were able to determine the unique microbial community structure and its relative abundance in soil and biofilm samples. This analysis also provides an insight into the impact of human activity in caves as well as the efficacy of the conservation techniques that have been employed. The overall work will allow us to further understand the role of the microbial ecosystem in dictating the underground environment and vice versa.

NEW WORK ON THE LAST INTERGLACIAL BONE BED IN VICTORIA CAVE (ORAL)

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Victoria Cave is a key British site for Quaternary geochronology and biostratigraphy. The deep sequence of cave sediments exposed by nineteenth century excavations has been shown by TIMS speleothem dating to span at least 500,000 years with evidence of multiple Glacial – Interglacial cycles The Last Interglacial bone bed is especially important, because dated speleothems that directly overly it show that hyenas and mega-herbivores including hippopotamus, extinct elephant and rhinoceros lived in Britain during MIS 5e around 125,000 years ago. This is now an accepted cornerstone of Quaternary biostratigraphy in Britain. Yet our understanding of the processes that gave rise to the formation of the Last Interglacial bone bed still relies heavily on observations and interpretations made during the excavations at Victoria Cave in the 1870s. This presentation will briefly explain the history of investigations at Victoria Cave, before detailing preliminary results from the first modern analysis of the surviving collections and documentary

sources relating to the Last Interglacial bone bed. The research aims to identify the animals using the cave, and what were they doing there some 125,000 years ago.

THE 'REEFS' OF BLACK REEF CAVE AND OTHER STRANGE TALES FROM RIBBLEHEAD (ORAL)

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Black Reef Cave (NGR SD 774794) is a 550 m long cave system developed in the Lower Carboniferous Great Scar Limestone of the Ribblehead area, Yorkshire Dales. A restudy of the black materials encountered in Black Reef Cave as sheet like bodies cutting across the main passage has shown they have influenced the passage morphology. Upstream of the reefs the passage has a typical phreatic tube like cross section whereas downstream the passage cross section is that of a canyon suggesting the reefs have ponded water resulting the development of small perched phreatic loops. The reefs consist of a core of crystalline calcite surrounded by black manganese/iron material. It is proposed that calcite vein mineralisation along joints caused the ponding of water and the manganese/iron material is a secondary deposit preferentially deposited or preserved on the calcite vein.

The cave is characterised by the presence of extensive coloured bacterial colonies on the walls. Small patches of the gold bacteria in caves have been observed for several years however in 2012 a brilliant purple bacteria was first observed in one small area of the cave. This has been the subject of a study by the John Innes Institute at the University of Norwich. After many visits to the cave we still have not decided if the manganese deposits control the distribution of the bacterial colonies. There is only one very small area of purple but large areas of the walls and roof are covered in gold, rust coloured and grey/white bacteria, other bacteria with no colour must also be on the cave walls.

ANALYTICAL STUDY OF CAVE PASSAGE TYPE RELATION TOWARDS RADON CONCENTRATION FOR EFFECTIVE DOSE ESTIMATION TOWARDS CAVE GUIDES IN KALISUCI CAVE, GLATIK CAVE AND JOMBLAND CAVE, PACAREJO VILLAGE, SEMANU DISTRICT, GUNUNGKIDUL REGENCY, SPECIAL REGION OF YOGYAKARTA, INDONESIA (ORAL)

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Cave is one of earth's landscape that formed from the process of rocks dissolution. Cave that located underground contains radioactive substances from Uranium, Thorium, and Actinium series that become one of the elements that formed rocks in earth. The Radiation from radionuclide 222Rn, one of the daughter from Uranium series that in gaseous phase is contains in cave air. The Radiation from Radon needs to be measured and determined the dosed in order to mitigate radiation hazards from cave workers, especially cave guides. The impact of Radon radiation towards health can be calculated and analysed by measuring the radiation exposure from Radon and converts it to effective dose unit. For the measurement, Radon radioactivity measured inside karst cave in Pacarejo Village, Semanu District, Gunungkidul Regency, Special Region of Yogyakarta, Indonesia at Kalisuci Cave, Glatik Cave, and Jomblang Cave. The Measurement for Radon radioactivity is done using Durridge RAD7 Solid State Alpha Detector. The result from the radon concentration measurement in kalisuci cave are 9,4 Bq/m3 at cave entrance, 7,3 Bq/m3 at cave passage , and 8,4 Bq/m3 at cave exit. In Glatik cave radon concentration values are 46,6 Bq/m3 at cave entrance, 25,7 Bq/m3 atcave passage, and 30,0 Bq/m3 at cave exit. Meanwhile in Jomblang Cave, Radon concentration values are 59,4 Bq/m3at cave entrance, 130,5 Bq/m3 at cave passage, and 187,2 Bq/m3 at cave exit. The difference of radon concentrations caused by the variance of cave passage volume, cave passage type, and cave's floor sediment. Radiation effective dose that received by cave guides in Kalisuci and Glatik Cave is

ranged within 0,045 – 0,090 mSv/year and for Jomblang Cave guide the effective dose value is 0,539 mSv/year. From these values, there is no need for special treatment for cave guides because the amount of effective dose receive by the cave guides are still below the limit based on ICRP no. 126.

Keywords: Radon Concentration, 222Rn, Effective Dose, Cave Guide, Detector RAD7.

SPELEOTHEM FLUID INCLUSIONS SHOW WESTERLY AND EASTERLY MOISTURE ADVECTION ACROSS NORTH EAST LIBYA DURING MIS 3 HUMID PHASES (ORAL)

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Atmospheric latent heat is a major component of global and regional climate energy budgets and changes in its amount and distribution are key aspects of the climate system to constrain. Equally, in mid- and low latitude regions, the aspect of past climate change that has had the most impact on landscapes and ecosystems is changes in the water cycle. Rainfall in semi-arid regions is also amongst the climate parameters human society is most sensitive to. Constraining past water cycle changes within the arid mid-latitudes is therefore a globally significant research priority. Here, we present speleothem-based fluid inclusion, strontium isotope and stable isotope data for a record in northeastern Libya spanning MIS 3 and demonstrating 15 newly identified humid periods during this time-period. Comparison to modern rainfall isotope data shows that fluid inclusion water is likely unmodified rainfall water, but that waters of significantly different composition are preserved in at least two families of inclusions. The whole population of measurements indicates that more than one rainfall system is represented in the fluid inclusion dataset, with moisture advection from both the west (Atlantic) and the east (Levant). We discuss different scenarios which can explain this geochemical behaviour, including changes to sources, rainfall seasonality and impact from the amount effect. Demonstration of humid periods during MIS 3 in Cyrenaica are of great significance to understanding human populations and migration through central North Africa, and we discuss the implications of the changes in the annual cycle we observe to regional human prehistory.

FEELINGS FROM THE UNDERGROUND. A CAVE PURSUIT FOR AN ARCHAEOLOGY OF THE EMOTION (ORAL)

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Which is the final frontier in Archaeology? And where this can be explored? In the second decade of the 21st century the theoretical discussion in Archaeology has a significant sift towards the study of the sensorial spectrum of the past, and the way that this spectrum affected the human activities. This paper aims to stretch this discussion from the senses to the emotions and feelings and to connect those with tangible human actions. In other words, can we understand how the people feeling in the past if we de-code their sensorial stimuli?

Cognitive psychology and neuroscience had already made a link between senses – emotions – feelings and human behavior. The key to unlock this link is the senses. But archaeologically is very difficult to re-construct the paleosensorial spectrum of the past. There is only one archaeological context where the sensorial spectrum is still – thousand years later – intact; Caves.

Our project – partly funded from BCRA – aimed to record the sensorial spectrum of Neolithic caves in the western and southern Balkans. Then to plot these spectrums against the activities that took place inside the caves in order to explore how these activities have been generated. The outcomes showcasing social groups that structured their decision-making strategy along with emotions that generated from the different subterranean environments.

Myotis SP. NOV. (MAMMALIA, CHIROPTERA), A GIANT REPRESENTATIVE OF A BAT GENUS FROM THE LATE PLEISTOCENE OF JAMAICA (POSTER)

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The extant bat fauna of Jamaica is comprised of over 20 species, only some of which have also been found in the fossil record. Moreover, a number of fossil finds show species that either no longer live on the island or have become extinct altogether. Herein, we document one of these, a well-preserved mandible that appears to belong to a hitherto unknown species of the mouse-eared bats, *Myotis*.

Myotis includes around one hundred species and has a worldwide distribution. The oldest *Myotis* described comes from the early Oligocene of Belgium. The genus appears to have migrated into the New World around the end of the middle Miocene. There, the genus diversified into the American clade, which is comprised of almost 40 species.

The number of *Myotis* species inhabiting the Antillean islands is five. Three of these are endemics, whereas the others are also known from South American. All of these species inhabit the Lesser Antilles and presumably colonized these islands from northern South America.

Myotis sp. nov. is only known from the Red Hills Road Cave, Jamaica, as part of the most diverse terrestrial fauna from the Neogene of the island. The site is Late Pleistocene, about 40,000-25,000 years old.

The new species is known from a dentary which preserves the p4 and all of the molars. It is broken behind the m3. In front of the p4, four alveoles are preserved. The foremost of these is tiny and evidently belongs to an incisor. It contains part of the root. The alveole behind this is very large. It has a sub-elliptical shape with the length axis in the direction of the mandible. This is considered to be the alveole of the canine. The last two alveoles are smaller, with the front one being larger than the other, but still clearly smaller than the canine alveole. The alveoles stand in line and are interpreted as the alveoles of the p2 and a relatively small p3.

Merely by its size, it is clear that the new Jamaican bat cannot be assigned to any known species. The largest New World *Myotis* is M. vivesi (Blood & Clark); the largest length of the mandibular tooth row of M. vivesi makes it clear that the Jamaican species was larger still. *Myotis* is not otherwise known from the Greater Antilles, and it is hardly surprising that it represent a new and endemic species. The large size of *Myotis* sp. nov. is probably related to the ancestral *Myotis* finding its niche in the varied bat fauna of Jamaica.

Myotis is considered to have only limited dispersal ability, but long distance dispersal is a matter of chance. Chances for bats to reach remote islands such as Hawai'i are infinitely small, yet these islands were colonized on two separate occasions. The ancestor of *Myotis* sp. nov. presumably reached Jamaica during such a chance event. As Jamaica became subaerial during the Miocene, the available time window is quite large.

CAVES AND KARST OF THE YORKSHIRE DALES (KEYNOTE)

Tony Waltham
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Stretching over the last seven years, compilation of the two volumes of the BCRA's new book has given the editors an unusually broad and deep overview of the caves and karst of the Yorkshire Dales. The necessary joined-up thinking has improved our understanding of the Dales, but has also revealed how much we still don't know.

Some very large chunks of passage await exploration, notably behind Black Keld. Beneath Gragareth, Duke Street and Eastern Front are just fragments of an ancient trunk route that carried the drainage from entire dales, but we don't know where from or to or even in which direction for much of Quaternary time. Major inlets and outlets are unknown at Gaping Gill, and include questions about deep phreatic lifts. We still cannot explain the evolution, and even the locations, of the great phreatic ramps in Sleets Gill Cave and elsewhere.

Debate continues over the earliest stages of cave development. Shale beds, bedding planes and inception horizons are all variations on a theme, but it will take a lot of detailed underground mapping to resolve which are the most important of the guiding geological features. And then there is the role of hypogene cave development, which is conspicuous in the great maze caves within the Yoredale limestones. But we don't know its extent within the Great Scar Limestone before the allogenic streams invaded from the shale cover. Trunk passages exist now beneath the shale and grit cover in Nidderdale, and did exist beneath the same cover in Gragareth, but we have to question how far they reached beneath the flanks of ancestral Ingleborough.

Understanding the chronology of the Dales caves and karst took a leap forward with uranium-thorium dating of stalagmites, but many caves evolved before a time that is the limit of this technique. We await the opportunity and budget to determine earlier ages by aluminium-beryllium dating. And then we can look further into the state of the caves during the Quaternary glaciations. Sub-glacial drainage, ice plugs and pro-glacial lakes are still open to debate, and we don't even know exactly how Malham Cove was formed.

These are just some of the questions that remain, and answers are not easy, but these are the challenges for the next generation of cavers.

YORKSHIRE DALES CAVE CLIMATE MONITORING (POSTER)

Jo White
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Birkbeck University and University College London are currently undertaking research into rapid climate events in the early Holocene using speleotherm samples from Yorkshire Dales caves.

This study aims to provide and analyse current cave climate data as a background to this work. A variety of methods have been used including temperature and drip rate loggers situated in the caves along with hand held temperature, CO2 and relative humidity readings. In addition to this cave and surface water samples have been collected for isotope analysis. This study will be one of the longest running cave climate monitoring studies to date, and we hope that this will provide an interesting insight into both current cave climates and palaeoclimate.

The project began in August 2016, and this poster provides the findings one year in along with future progressions and objectives for the project.

THE PLEISTOCENE LAMINATED SEDIMENTS OF VICTORIA CAVE, NORTH YORKSHIRE, UK: CHARACTERISTICS, AGE AND SIGNIFICANCE (ORAL)

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Victoria Cave (National Grid Reference SD 838650) is part of a relict phreatic cave system that opens to the surface at 440 m above sea level in the face of Langcliffe Scar on the eastern side of the Ribble valley, ~2 km northeast of Settle, North Yorkshire. The cave has developed in massive, gently-dipping beds of the Gordale Limestone Member of the Lower Carboniferous (Asbian) Malham Formation. The cave, ~50 m in length, is probably a glacially-truncated remnant of a formerly more extensive passage.

The cave contains several calcite flowstones between which laminated silts and clays are present. Thermal Ionization Mass Spectrometer U/Th (TIMS) dating indicates that flowstone formation occurred in each of the interglacial stages MIS 13, 11, 9, 7, 5 and 1. The four laminated units have been assigned to cold stages MIS 12, MIS 10, MIS 6 and MIS 2 (note there is no laminated unit equivalent to MIS 8), but they have not been directly dated and there is limited information concerning their sedimentary characteristics.

These units are present in the deep sections left open at the cessation of the large-scale excavations by the Settle Cave Exploration Committee in the 1870s. They are inherently fragile, and where exposed susceptible to damage from visitor egress and rabbit burrowing.

As part of a conservation initiative by the Yorkshire Dales National Park Authority we focussed our investigations on the deep mid-cave section where the exposures are most at risk. This part of the cave contains a stack of three discrete laminated units formerly assigned to MIS12, MIS 10 and MIS 2. The uppermost unit is overlain by an AMS radiocarbon dated Late Glacial Interstadial bone bed. We sampled the laminated units for mineralogical evaluation using X-ray diffraction, micromorphology using thin sections, pollen investigation, and optically stimulated luminescence (OSL) dating.

The laminated units have remarkably consistent mineralogy with samples consisting principally of quartz and calcite with minor amounts of kaolinite, chlorite and muscovite. These results suggest the sediments consist of grains derived from the local Carboniferous limestones, sandstones of the Yoredale Series and/or the Millstone Grit. The presence of chlorite in all samples suggests that the Lower Palaeozoic rocks which crop out as an inlier in the Ribble Valley north of Victoria Cave were exposed prior to MIS12 when the Light Brown Sandy Laminated Clay was deposited. This supports previous geomorphological reconstructions of the area that indicate the Lower Palaeozoic inlier up-ice from Victoria Cave was exposed by ~500 ka BP.

The micromorphology demonstrates a broadly consistent evolution of the laminated units during the different cold stages. All the evidence indicates sediment deposition into standing water, and it is tempting to regard the silt-clay couplets as varves associated with glaciolacustrine environments. In this case a cave lake seems to have developed, perhaps because of an ice/sediment dam across the entrance.

Slides prepared for pollen investigation revealed only a mineral component, and this was true of those samples drawn from the lowermost and uppermost levels within the laminated units. These levels might have been expected to yield pollen representing the decline and initiation, respectively, of regional plant assemblages associated with transitional environmental conditions. (non-glacial – glacial, glacial – non-glacial). The total absence of pollen is regarded as negative evidence for the laminated units having accumulated under full glacial conditions.

A preliminary OSL date of ~65 ka was obtained from the upper part of the youngest laminated unit previously assigned to MIS 2. If this age is correct it indicates an MIS 4 rather than MIS 2 age for the unit. Two issues arise from this date: (1) where are the MIS 2 sediments? (2) did northern Britain have extensive glacial ice cover during MIS 4? This latter point is supported by offshore sediments in the North Sea Basin and in the North Atlantic to the west of Scotland/Ireland. The upper laminated unit of Victoria Cave may represent terrestrial evidence for this glaciation.

THE HYDROGEOLOGY OF THE BANFF HOT SPRINGS, BANFF NATIONAL PARK, CANADA: A KARST PERSPECTIVE (POSTER)

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The Banff Hot Springs at the Cave and Basin in Banff is the historical focal point of Banff National Park. These carbonate springs lie within a 10-km section of the 300 km-long Sulphur Mountain Thrust (SMT) where it meets the topographically low-lying Bow Valley. The maximum depth of flow for the thermal water has been calculated to be around 3.2 km with discharge temperatures up to 67^{o}C. Hot spring discharge, via the SMT, appears to have targeted the low-lying antecedent Bow Valley, the latter having commenced its incision with the Rocky Mountain Uplift some 85 Ma ago. More recently, in the Holocene, tufa deposits have formed. The cessation of growth of these tufa deposits from 5.3-3.3 ka has been explained in terms of climate change, but we suggest that Holocene post-glacial karstification of the system has allowed shallow groundwater to dilute the supersaturated underflowing thermal water thereby preventing external calcite precipitation. (We also discuss the speleogenesis of caves within the tufa.) Further, we calculate that the hottest spring temperatures are associated with recharge locations much more distant than thought previously. We apply a quasi-Darcian flow model, usually applied to epigenetic cave systems, to those in thermal hypogene carbonates, finding that distal recharge may be ~95 km away. In support of our

assumptions, we compare the Banff Hot Spring karstification to a local relict cave system also developed along a thrust fault.

THE WHITE RABBIT MARBLE CAVE, MONASHEE MOUNTAINS, BC, CANADA: A REMARKABLE CAVE SYSTEM IN STRIPE KARST (ORAL)

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The White Rabbit System is an extensive marble cave found in the Shuswap Metamorphic Complex lying within in the Monashee Mountains, west of the Main Ranges in Canada. Other significant marble caves in this belt are Nakimu, the Tupper-Raspberry System and Cody.

While the oldest rocks at White Rabbit are within the Precambrian, between 2.5 and 1.8 billion years, metamorphism occurred later - possibly in the Cambrian to early Palaeozoic around 500 million years ago - which generated an overfolded cave-bearing marble. The cave is a classic example of marble stripe karst, sandwiched between schists and quartzites of relatively low dip. This geological structure has favoured the development of a relatively long cave system – currently around 5 km with considerable hydrological depth potential (>1,000 m). This presentation explores the stripe karst speleogenesis of the cave system especially in respect of its glacial karst in an alpine setting.

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Next Cave and Karst Science Symposium, Saturday 13th October, 2018 hosted by Dr. David Richards, University of Bristol

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