The Ussher Society

Abstract Volume

Exeter

Volume 15, Part 1

The Ussher Society

Purpose

1. To promote research into the geology, geomorphology and other aspects of geoscience in South-West England and geologically related areas.

2. To hold an Annual Conference at various places within south-West England where those engaged or interested in this research can meet both formally, to hear original contributions and progress reports, and informally to effect personal contacts.

3. To publish the proceedings of the Annual Conference and other papers relating to geoscience in South-West England.

4. To organise field excursions.

5. To encourage other geoscience-related activities which the Management Committee may from time to time deem appropriate.

Constitution

Membership is open to anyone with an interest in geoscience in South-West England on written application to the Secretary and payment of the relevant subscription.

An ***Annual Business Meeting*** shall be held during each Annual Conference and shall elect a Management Committee and two auditors for the succeeding year.

Subscription shall be set by the Annual Business Meeting and shall be due on 1st January each year.

The affairs of the Society will be managed by a ***Management Committee*** consisting of a Chairman who shall hold office for not more than two consecutive years and who shall not be eligible for re-election to the office for a further two years; a Vice-Chairman who shall serve for the first year as Chairman-elect and, after two years as Chairman, for one further year as retiring Chairman; a Secretary, a Treasurer, an Editor and a Website Manager, any of whom may be eligible for re-election and who on leaving office shall normally retain Committee membership for one additional year and four others, any of whom might be eligible for re-election up to a maximum term of three years. The Committee shall have powers to co-opt.

Amendment of the Constitution may be effected by simple majority vote at the Annual Business Meeting.

Revised Constitution approved at the Annual Business Meeting St Ives January 2008.

The Ussher Society

Abstracts

The Scott Simpson Lecture

Basement, granites, basins and fluids — the regional geological evolution of SW England and its resource implications

Robin K. Shail

Camborne School of Mines, University of Exeter, Penryn Campus, Penryn, Cornwall TR10 9FE

The geological evolution of SW England is considered in ten scenes, arranged into three acts:

Act 1: Rheic Ocean margin
a) Pre-Devonian basement
b) Rhenohercynian marginal/successor basins (Devonian-Carboniferous rifting)
c) Variscan convergence and collision (Late Devonian – Carboniferous)

Act 2: Pangea intraplate
a) Early post-Variscan extension (Early Permian)
b) Intraplate shortening (Permian)
c) Basins and brines (Triassic)
d) Mind the gap (Late Jurassic-Early Cretaceous)

Act 3: Atlantic margin / European intraplate
a) Atlantic margin (latest Cretaceous-Paleocene)
b) In the vice (Oligocene-Miocene)
c) Hot and cold (Quaternary)

(1) Rheic Ocean margin: SW England includes the last segments of continental lithosphere accreted to form the British Isles, but its pre-Devonian basement is poorly constrained. The Rheic-Rhenohercynian suture runs immediately south of the peninsula and marks a subduction zone that was active until at least the end-Devonian. Variscan convergence and continental collision was punctuated by Early Carboniferous rift-related magmatism in the Tavy Basin. By the end-Carboniferous, all successions within the Devonian-Carboniferous sedimentary basins had undergone deformation and low-grade regional metamorphism and subsequently formed basement below the Permo-Triassic 'Variscan' unconformity. The resources within these successions reflect a combination of tectonic and climatic (palaeolatitudinal) controls; industrial rocks and minerals (limestones, igneous rocks and sandstones/slates) have dominated production but sedimentary exhalative (SEDEX) / volcanogenic massive sulphide (VMS) and orogenic gold styles of metalliferous mineralisation are developed.

(2) Pangea intraplate: The Early Permian post-Variscan extensional regime was marked by the development of 'red-bed' sedimentary basins and voluminous magmatic activity – the Cornubian and Haig Fras batholiths and contemporaneous mantle-derived lamprophyres and basalts. The associated, structurally-controlled, magmatic-hydrothermal W-Sn-Cu-As-Zn mineralisation has been of fundamental importance. Poorly constrained episodes of intraplate shortening post-date this mineralisation and may have contributed to substantial intra-Permian unconformities. Triassic ENE-WSW extension resulted in large-scale migration of basinal brines, predominantly through NNW-SSE fault systems, and 'cross-course' Pb-Zn-Cu ± minor Ag-As-Bi-Co-Ni-U mineralisation. Latest Jurassic-Early Cretaceous rifting was associated with substantial uplift and exhumation of SW England and at least localised magmatic activity (Wolf Rock-Epson Shoal) – a major unconformity developed at the base of the Upper Cretaceous successions across much of the region. The long-range migration of hydrocarbons into the western part of the Cornubian Batholith occurred during the renewed expulsion of basinal brines that may have contributed to kaolinisation and ± minor Ag-As-Bi-Co-Ni-U mineralisation.

(3) Atlantic margin / European intraplate
Rifting prior to Atlantic opening resulted in the Lundy Igneous Complex. Uplift and exhumation removed much of the Chalk across the region and thus exposed the previously described resources for subsequent exploitation. Intraplate shortening in the late Oligocene/early Miocene resulted in reactivation of the Sticklepath-Lustleigh Fault (and other NW-SE faults) and the localised development of small strike-slip basins infilled with sedimentary kaolins; it may also have contributed to kaolinisation elsewhere. Supergene enrichment and the accumulation of substantial Sn placer deposits during the Quaternary have contributed substantially to historical resources. Contemporary fluid flow and seismicity is influenced by a maximum horizontal stress orientated *c.* NW-SE.

Eileen Mary Lind Hendriks (1887-1978) who became the doyenne of Cornish Geology

Jennifer A. Bennett and John D. Mather

Crockernwell, Exeter, Devon

Lind Hendriks was born in Birmingham, the only child of a prosperous middle-class family. Following the early death of her father she studied geology at Aberystwyth before moving to Belfast, with her widowed mother, as senior demonstrator in the Geology Department. She resigned after a year and subsequently tried unsuccessfully to obtain a permanent post as a geologist, including attempting to join the Geological Survey. Mapping first in mid-Wales and then in south-west England she became an accomplished field geologist, gaining a PhD from Imperial College, London in 1932. Finding fragments of fossil wood in apparently barren sediments, she demonstrated their Devonian age and recognised the presence of thrusting which introduced Ordovician and Silurian rocks into the sequence. Moving permanently to Cornwall in 1938/9, and seeking help from specialists throughout the world, she devoted the rest of her long life to geology, without any institutional support. She received awards from the Geological Society of London and the

Royal Geological Society of Cornwall. Living in isolated cottages with her Alsatian dogs, she became respected by the young researchers who flocked to the south-west from 1955 onwards, as the energetic doyenne of Cornish geology.

Building stones of Wiveliscombe, West Somerset

Danny Clark-Lowes

Himalayan Geotours, 9 Silver Street, Wiveliscombe, Taunton, TA4 2PA

The red soil of the gently sloping fields of Taunton Vale stretching eastwards from Wiveliscombe bear witness to the iron rich calcareous red sandstones of the Permo Triassic succession filling the lower parts of the landscape. Within this succession are the pebbly sandstones of Castle Hill where lime kilns can be seen and weathered cliffs reveal the former existence of major building stone quarries. These calcareous sandstones were easy to cut but of poor quality and are in many cases in the town highly degraded. To the west of the town, in the Brendon Hills, Devonian sandstones are found associated with Morte Slate. The sandstone is purple in colour, somewhat metamorphosed, hard and irregular. It is widely used in rubble walls. The Morte slate was quarried at Okehampton Quarry, north of Wiveliscombe, which closed in the 1920s, better quality slate being then available from further afield. This Morte Slate was widely used for slate-cladding on west facing walls in the taller buildings of Wiveliscombe.

'Women are the largest reservoir of untapped talent': Introducing Women in Geothermal (WING) UK; striving to achieve gender equality in the geothermal energy industry

Madelaine Cherie Constance[1], Lucy Cotton & Clare Baxter

[1]GeoScience Limited, Falmouth, TR11 4SZ

In a currently male dominated industry, Women in Geothermal (WING), a not-for-profit organisation, aims to promote the education, professional development and advancement of women in the geothermal industry. The ultimate aim is to one day become redundant: where no group needs to advocate for gender equality.

The movement towards gender equality will see an increased number of women attracted to the geothermal industry and in leadership positions, women staying longer in the industry, and a more engaged workforce. This will encourage women, as the largest reservoir of untapped talent in the world, to drive the UK geothermal industry forward.

The WING UK committee have been working together to form new ideas to showcase the WING UK group, strengthen its community and start working towards our goals outlined in our 'Roadmap to Iceland 2020'. One initiative will see collaboration between WING UK and STEM with the purpose of coordinating a mentoring scheme. This scheme will look to support students and early career geoscientists with interest in geothermal energy, in the transition to industry.

With the recent growth of geothermal activity in the UK ranging from shallow to deep, WING UK now has an opportunity to ride this wave of momentum and drive the geothermal industry forward.

Project Overview of the United Downs Deep Geothermal Power Project, Cornwall, UK

Lucy Cotton[1], Peter Ledingham, Jon Gutmanis

[1]GeoScience Limited, Falmouth, TR11 4SZ

The United Downs Deep Geothermal Power (UDDGP) project is the first geothermal power project in the United Kingdom. Financial support has come from the European Regional Development Fund and the local authority (Cornwall Council) who, together, have provided £13m of the £18m project budget.

The project consists of two deviated wells drilled to intersect a target fault structure that is hoped will provide sufficient permeability to support circulation of between 20 and 60l/s and demonstrate electricity production from a 1-3MWe pilot power plant. To date both wells have been drilled to completion with the production well becoming the deepest onshore well in the UK with a measured depth of 5725m, the temperature here is expected to be 193°C. During the first quarter of 2020, production tests will help to establish the viability of commercial geothermal energy production from the Porthtowan Fault Zone with a view to constructing a power plant in 2021.

This talk places the project in the context of previous geothermal research carried out in Cornwall, summarises the UDDGP concept and reports drilling and testing results. It also outlines the microseismic monitoring programmes implemented to protect the local community and describes the associated public outreach, education and research initiatives.

Geological controls on upper crustal heat flow for deep geothermal energy in Cornwall

Christopher Dalby, Robin Shail, Tony Batchelor, Lucy Cotton, Jon Gutmanis, Gavyn Rollinson, Frances Wall, James Hickey

Camborne School of Mines, College of Engineering, Mathematics and Physical Science, University of Exeter, Pernryn Campus, Penryn, TR10 9FE (student)

The United Downs Deep Geothermal Project is the first geothermal power project to commence in the UK, situated near Redruth, Cornwall. Two geothermal wells have recently been completed to measured depths of 2393 m and 5275 m in June 2019. Previous investigations during the CSM Hot Dry Rock Project (1977–1991) indicated that challenges exist for modelling the high heat flow values of the granite (*c.* 120 mW/m2) due to uncertainties relating to the radioelement concentrations at depth and the volume and distribution of the granites.

This research aims to use data from the United Downs Deep Geothermal Project to investigate the current heat flow issues. Detailed mineralogical and geochemical analyses will be carried out to define different granite types and understand the host minerals of U and Th. These analyses in combination with wireline spectral gamma data will allow a detailed characterisation of the radioelements with depth to produce a high-resolution heat production profile. In addition to this, coupled thermal conductivity measurements will be carried out to examine the temperature dependence of thermal conductivity and characterise thermal conductivity with depth. The results of this will improve the thermal resource and sub-surface temperature evaluation of the region.

Late Pleistocene landscape in the Outer Bristol Channel: a preliminary report

Philip Gibbard[1], Philip Hughes, Chris Rolfe & Christine Batchelor

[1]*Scott Polar Research Institute, University of Cambridge*

Lower sea levels exposed the floor of the Bristol Channel during the Pleistocene glaciations and during these phases the River Severn extended its course over 110 km westwards. The palaeochannel of the Late Pleistocene River Severn is clearly preserved in the bathymetry of the central and inner Bristol Channel/Severn Estuary. However in the Outer Bristol Channel its former course is buried beneath Holocene marine sands. The former British-Irish ice sheet extended up the Outer Bristol Channel multiple times during the Pleistocene as indicated by till and glacially sculpted topography on the sea-floor, as well as on Lundy. The presence of ice would have inhibited westward drainage, forming an ice-dammed lake to form in the Bristol Channel valley. The drainage route of the palaeo-Severn catchment during glaciations remains unresolved. One hypothesis is that the palaeo-Severn system drained via an ice-free southerly route between Lundy and mainland Devon. Subsurface evidence revealed in geophysical surveys suggests that a series of palaeochannels and associated deposits occur in Barnstaple Bay. These are laterally-extensive, some including basal gravels underlying marine sands and spread over several kilometres, suggesting that an extensive braidplain could occur associated with a palaeo-fluvial system. However, these subsurface channels and spreads of gravels may be also associated with a palaeo-Torridge and Taw fluvial system draining from the southwest peninsula. Further research is required to establish the palaeodrainage of the Outer Bristol Channel.

Coastal instability in South West England – Triggers, Controls and Mechanisms

John Grimes[1], Steve Atkins, Sarah Turner & Rod Smith

[1]*John Grimes Partnership Ltd., The Barns, Leonards Rd, Ivybridge, PL21 0RU*

The winters of 2012 to 2014 were some of the wettest winters on record with the winter of 2012 being the longest sustained period of wet weather for 254 years of recorded weather records. Gales generated large and ferocious storm waves that impacted the cliffs of Cornwall. Both the hydrostatic pressures generated largely by the exceptional rainfall and pneumatic pressures induced into the fissured/fractured rock mass by the impacting waves triggered large scale and numerous cliff failures around the coast of Cornwall and Devon. The purpose of this paper is to present the geology and coastal processes which have contributed in the main to these observed failures.

Structural analysis of the Devonian rocks which are extensively exposed around the South West coast in a variety of structural styles related to the late Variscan final stages of the construction of Pangea. This has led to structural zones with different jointing styles which are either overlapping and/or in close juxtaposition. Joint, fracture and fault zones often comprise many open discontinuities which lead to parts of the rock mass being particularly susceptibility to marine erosion. Sections of both the South West Cornwall and Devon coastal platforms have been structurally analysed and correlated with areas of highly active marine erosion. Previously, one of the Authors (JG) carried out similar studies on the Glamorgan Heritage Coastal Platform in respect of fracturing, jointing, lithology and erosion rate.

Extensive thicknesses of Frost Shattered Head deposits are present around the coast, these may be up to 40m thick. It is proposed that these are related to basal ice segregation which developed beneath former permafrost layers causing dilation and fracturing of previously undisturbed rock strata. These zones where now exposed within the sea cliff are particularly vulnerable to storm wave induced pneumatic action instability and erosion.

Analysis of the altitude and topography of exposed shore platforms suggest that accumulation of Head may have affected the positioning of ice segregation which in turn may have effected platform development. Such accumulations may have been episodic and related to climatic events throughout late Pleistocene cold stages.

In conclusion, storm wave impact and induced massive associated pneumatic pressures and their significance in relationship to sea level rise, cliff instability and coastal erosion are discussed.

The MIREU Project: Overview and work in Cornwall

Rowan Halkes

Camborne School of Mines, College of Engineering, Mathematics and Physical Science, University of Exeter, Pernryn Campus, Penryn, TR10 9FE

The MIREU project aims to establish a network of mining and metallurgy regions, and identify ways to ensure the continued & sustainable supply of mineral raw materials across Europe. Both the Camborne School of Mines – University of Exeter and Cornwall Council are members of the project consortium which comprises 30 partners from 17 mining regions across the EU. Our work involves a twinning project with Saxony (Germany), which like Cornwall hosts a UNESCO World Heritage Site based on its mining history and is also experiencing a rejuvenation of the mining sector. We're also aiding development of Social License to Operate (SLO) guidelines and accompanying Toolkit which, in addition to a new SLO model, will be used by projects across Europe. Furthermore, we're conducting the first specific study of SLO in Cornwall, an area of growing importance due to the increasing interest in the South West's geo-resources and assessment of projects with a view to environmental & social impacts.

This project is funded by the European Union's Horizon 2020 research and innovation programme under Grant Agreement No.776811, Topic: H2020-SC5-2017.

Life and death in the Jurassic seas of Dorset, Southern England

Malcolm B. Hart[1], Gloria Arratia[2], Chris Moore[3] and Benjamin Ciotti[4]

[1]*School of Geography, Earth & Environmental Sciences, Plymouth University, Drake Circus, Plymouth PL4 8AA, UK*
[2]*Biodiversity Institute and Natural History Museum, The University of Kansas, 1345 Jayhawk Blvd, Lawrence, KS 66045, USA*
[3]*The Forge Fossils, The Street, Charmouth, Dorset DT6 6NX, UK*
[4]*School of Biological & Marine Sciences, Plymouth University, Drake Circus, Plymouth PL4 8AA, UK*

The Jurassic succession of the Wessex Basin, especially that cropping out along the Dorset Coast, contains important lagerstätten for squid-like coleoid cephalopods. The Blue Lias and Charmouth Mudstone formations have, since the nineteenth century, provided large numbers of important body fossils that inform our knowledge of coleoid palaeontology. In many of these mudstones specimens of palaeobiological

significance have been found, especially those with the arms and hooks with which the living animals caught their prey. This is particularly true in the case of a specimen of *Clarkeiteuthis* sp. cf. *C. montefiorei* (Buckman, 1879) found in the nineteenth century with a fish in its jaws and which appears to have caused the death – and subsequent preservation – of both animals.

Global Climate Events and Time in the Early Jurassic; multiproxy records from the Central Somerset Basin, Somerset, UK

Alexander J. L. Hudson[1] James B. Riding, Clemens V. Ullmann, Dominika Szucs, and Stephen P. Hesselbo

[1]Camborne School of Mines, College of Engineering, Mathematics and Physical Science, University of Exeter, Pernryn Campus, Penryn, TR10 9FE

The Lower Jurassic archives some of the most severe palaeoclimatic events known in the geological record. Prominent hyperthermals are recorded at the Triassic-Jurassic boundary and the Toarcian stage that give us insights into the biogeochemical responses to global warming. However, current records of the Early Jurassic are patchy with little known about the climate of the intervening 17 million years between these events. Here we present a high-resolution record through the Lower Jurassic (Sinemurian-Pliensbachian stages) from the Burton Row Borehole, Somerset UK. An integrated multi-proxy approach using stable isotope geochemistry, source-rock analysis, and portable X-ray fluorescence geochemistry reveals significant and regular perturbations to the climate. Negative carbon isotope excursions with ~4 ‰ amplitude in $\delta^{13}C$ are expressed in bulk organic and wood associated at the *obtusum* – *oxnotum* zones and in the *jamesoni* zone. Productivity-driven marine euxinia and anoxia developed cyclically during the early Sinemurian (and Hettangian) and then abruptly with the *obtusum* and *oxynotum* zone CIEs. The causes and context of such Early Jurassic perturbations are discussed in the context of volcanism, tectonics and astronomical forcing. The time series data is used to estimate the duration of the Sinemurian stage; hereby addressing the duration of the identified climatic perturbations.

Granite pluton emplacement mechanisms in a post-orogenic extensional tectonic regime – an example from the Land's End Granite, Cornwall

Sam P. Hughes and Robin K. Shail

Camborne School of Mines, College of Engineering, Mathematics and Physical Science, University of Exeter, Pernryn Campus, Penryn, TR10 9FE

The timing and kinematics of regional deformation play a key role in granite pluton construction, as well as controlling the distribution of evolved melts as precursors to magmatic-hydrothermal mineralisation. The Land's End Granite pluton in the Permian Cornubian Batholith of South West England is an excellent area to assess the role of regional tectonics on pluton construction and magmatic-hydrothermal evolution. The timing and association of regional tectonics and the batholith are well established, but the link between regional tectonics and the construction and evolution of individual plutons is poorly constrained. A comprehensive investigation in to the roof zone of the Land's End Granite and associated aureole has been completed. Field-based collection of structural data and mapping was complemented by geometric and kinematic analysis, and petrographic, mineral-chemical, and geochronological studies. This study provides a clear case for the incremental emplacement of a laccolith-type pluton in a post-orogenic extensional tectonic setting, constructed by the amalgamation of discrete intrusive episodes over a complex and protracted (c. 3 Ma) magmatic history. The Land's End Granite formed as a result of the amalgamation of three smaller plutons. The older Zennor Lobe is composed of a coarse-grained biotite granite carapace and is cross-cut by later medium- and fine-grained muscovite, Li-mica and tourmaline granites. The St Just Wedge intruded approximately 1.5 Ma after the Zennor Lobe, with the emplacement of Li-mica and tourmaline granites. ENE-WSW-striking faults controlled magma ascent, and a major sub-horizontal fault zone acted as a magma trap and controlled lateral migration. Granite emplacement was accommodated by roof uplift, and both tectonically- and magmatically-induced reactivation of ENE-WSW and NW-SE faults.

Ammonite time in the Toarcian: New insights from the 'Junction Bed' of Ilminster, Somerset – and their global significance

Kevin N. Page

Geodiversity & Heritage, Thornedges, Longbarn, Sandford, Crediton, Devon, EX17 4BR

The Early Toarcian (Early Jurassic) is famous for a major phase of oceanic anoxia and global warming, the TOAE (Toarcian Oceanic Anoxic Event). The TOAE is widely claimed to be globally synchronous, although some have argued that it may be diachronous, or even that there may be several events. Only the application of a reliable high-resolution timescale can help resolve such questions, and this should be available using ammonites. Nevertheless, correlations between northern (*e.g.*, 'Subboreal' Yorkshire) and southern (e.g. 'Sub-Mediterranean' France and 'Mediterranean' Italy) remain poor, with most studies tending to emphasise differences rather than similarities. Two new sections in the Beacon Limestone Formation ('Junction Bed'), near Ilminster in Somerset, however, have now yielded rich faunas dominated by Submediterranean and Mediterranean Hildoceratidae associated with typical Subboreal Dactylioceratidae – plus a number of rare genera which provide tantalising possibilities for correlations with Arctic and even Ethiopian areas. Crucially, the sites have also been sampled for microfossils and geochemistry, and the results can now be integrated with cyclostratigraphical calibrations from the famous Mochras Borehole in west Wales. With this new chronology in place, it will finally be possible to make statements about the relative, even the absolute, chronology of Early Toarcian events.

The lithium potential of South West England and implications for a broader UK scoping study (Li4UK)

Rebecca Paisley

Cornish Lithium, Tremough Innovation Centre, Penyrn, TR10 9TA

As the world transitions to a decarbonised future, low-carbon technologies are driving increasing the demand for lithium compounds that are used in batteries in electric vehicles, portable technologies and grid storage of renewable energy. Currently a vast proportion of the Lithium supply chain is situated outside of Europe and, as demand in the region increases, there is a desire to secure a supply chain within the UK. Li4UK is a consortium of partners (Cornish Lithium, Natural

History Museum and Wardell Armstrong) tasked with identifying potential UK sources of Lithium, to ensure this domestic supply.

For UK sources, target minerals include spodumene, Li-rich micas (Zinnwaldite and Lepidolite) and lithophorite, in addition to lithium-bearing fluids. Li4UK are conducting sampling across the UK focusing on springs, geothermal waters and hard rock – building on our focus and research on the prospectivity of Cornish geology. This broad sampling approach is the foundation of a pre-feasibility assessment into the production of a Lithium compound from a UK source, its economic viability, and the potential benefits to the South West. Funding for the project was obtained from the UK Government's Faraday Battery Challenge programme that seeks to bring the UK to the forefront of the battery industry.

Integrated Remote Sensing Study of the North Cornwall Coast

Alistair Salisbury

Cornish Lithium, Tremough Innovation Centre, Penyrn, TR10 9TA

By combining different remote sensing techniques Cornish Lithium have been able to map alteration mineralogies across permeable structures exposed on the cliffs of the north coast and undertake a structural mapping project. These data can provide information on local and regional scale fracture networks and stochastic fracture pathways can be generated in 3D – information important for modelling movement of lithium-enriched geothermal waters.

An airborne hyperspectral survey was flown over the north coast between Godrevy and Newquay targeting cliff exposures where known permeable structures outcrop. This led to mapping key alteration minerals such as kaolinite and haematite as evidence of fluid flow through highly fractured zones.

Photogrammetric drone surveys were undertaken on seven north coast cliff exposures where known permeable structures outcrop. These surveys captured images of the cliffs in cross section which were used to build 3D digital models. Structures and joint networks were then digitised to begin to build up local and regional stress and strain regimes.

Using these two innovative mapping techniques the requirement of geologists to spend lengthy periods of time in the field can be alleviated and areas that are usually inaccessible can be successfully mapped.

Building Stone: making the right choice

Peter W. Scott[1] and Kathy J. Hicks[2]

[1]*Camborne School of Mines, College of Engineering, Mathematics and Physical Science, University of Exeter, Pernryn Campus, Penryn, TR10 9FE*
[2]*Carrak Consulting Ltd, Redruth, Cornwall*

The Palace of Westminster burnt down in 1834 and in 1839, a team of four led by the well-known architect, Sir Charles Barry, reported on their recommended choice of building stone for the reconstruction. They visited a large number of sandstone and limestone quarries throughout Britain, including many in SW England. They described the appearance of each stone and had some physical and chemical properties measured. They also assessed the quality of the stone in use by visiting many churches, cathedrals, castles, stately homes and others. They strongly recommended that the Lower Magnesian Limestone (Cadeby Formation) of Bolsover Moor, on the Derbyshire – Nottinghamshire border, was the most suitable stone. This recommendation was taken up by Parliament. Portland Stone, Bath Stone, Ham Hill Stone and others in SW England were rejected as were rocks such as SW Granites, the latter on the basis that they could not be worked easily.

The supply of the Bolsover Moor stone was inadequate, such that other sources had to be sought. The quality of the stone supplied was very variable. Deterioration occurred shortly after construction. An enquiry was held and in 1861 a 'Decay Report' published, resulting in an abundance of adverse publicity in the press. Several SW building stones, such as Portland Stone or granite, would have been more suitable. They were used extensively before, during and after the mid-19th Century in London and elsewhere. Whilst not overtly stating that the choice of magnesian limestone was wrong, the 'Decay Report' emphasises the merits of Portland Stone. The Lower Magnesian Limestone has been used principally as a local building stone. If Charles Barry and his colleagues had been aware of the detailed stratigraphy of the Lower Magnesian Limestone it is likely that they would never have chosen it as the source of stone for the Palace.

The Meldon Aplite – Revisited and Demystified

Janviere Uwanyirigira, Charlie Moon, Gavyn Rollinson

Camborne School of Mines, College of Engineering, Mathematics and Physical Science, University of Exeter, Pernryn Campus, Penryn, TR10 9FE

The Meldon Aplite has long been described as unique feature of SW England in terms of its mineralogy and exceptional enrichment in lithium, caesium, fluorine, phosphorous and niobium-tantalum. However although there have been a number of detailed mineralogical studies in particular by Nawaz (Chaudhry) these are not well spatially or geochemically constrained. An added complication is that many first mineral descriptions are by Kingsbury, who is known to have fraudulently mislocated minerals. To avoid compounding errors we have undertaken studies on freshly collected loose material.

The Meldon Aplite is of particular interest for lithium minerals. This study has identified using SEM and QEMSCAN, as well as optical work, a range including lepidolite, elbaite, petalite, amblygonite-montebrasite, and eucryptite. We have not been able to confirm the occurrence of spodumene. Other distinctive minerals in the Aplite are mangano columbite-tantalite (tungsten-rich in places). topaz, zircon, xenotime, monazite, coffinite and grayite.

The detailed geochemistry of the Aplite will be discussed.

The setting of the Aplite will be debated as it appears geochemically of the topaz-granite (G5) type and unrelated to the majority of the Dartmoor Granite(s).

What might a fault-hosted geothermal reservoir look like?

Christopher M. Yeomans, Robin K. Shail, Matthew Eyre

Camborne School of Mines, College of Engineering, Mathematics and Physical Science, University of Exeter, Pernryn Campus, Penryn, TR10 9FE

The high heat flow associated with elevated U, Th and K contents of the Early Permian Cornubian Batholith mean SW England is one of the most prospective areas in the UK for deep geothermal energy exploration. Current projects at United Downs and the Eden Project target fault-hosted geothermal reservoirs that transect high-heat producing granites in a region of high crustal heat flow.

Steeply-dipping NW-SE fault zones are well-known

throughout SW England and commonly have trace lengths exceeding >10 km. They are being targeted as deep geothermal reservoirs due to a perceived higher permeability than the surrounding granite and a favourable parallelism, or slight obliquity, with the maximum horizontal stress (σ_H). The onshore expression of these fault zones is reasonably well-known from a combination of classical field mapping and metal mining, but the latter data are typically restricted to within 300 m of surface (two mines to 1000 m). The post-Carboniferous structural evolution of these faults is less well-constrained. Reactivation in the Permian, Triassic and late Jurassic-Cretaceous has been documented and the Sticklepath-Lustleigh Fault Zone in Devon has developed mid-Cenozoic strike-slip basins.

The purpose of this work is to combine remote-sensed and historical data, including that from offshore sedimentary basins, with new field data to generate improved model(s) for the tectonic and structural evolution of these fault zones that addresses their: (1) distribution, (2) geometry, kinematics and relative chronology.

The Land's End Granite provides significant exposures of granite and there is cut by an abundance of NW-SE lineaments. The Land's End-Porthgwarra Fault Zone (LEPFZ) is the most south-westerly NW-SE fault zone to be identified in the area. It comprises a number of fault strands that total >4 km in length that are favourably oriented in a WNW- to NW-trend, within granite. There are multiple strike-normal sections through the fault zone that constrain its geometry and kinematics. We present structural data from direct and remote (drone-based) measurements and attempt to characterise the tectonic history of the fault system. We consider the LEPFZ to be a potential field analogue for fault-hosted geothermal reservoirs in SW England and a valuable resource for current and future deep geothermal projects.

The Hestercombe Intrusives – Geochemical Evidence for a Non-Lamprophyric Origin

Charlie Moon

cjm@moongeology.co.uk

The Hestercombe and Coombe intrusive bodies, ~4 km N of Taunton, have long been the subject of debate due to their structural setting and distance from any similar lithologies.

Their outcrop lies on one of a pair of pronounced aeromagnetic anomalies, at least 130 km in length, which also coincides with the only onshore Tertiary dolerite dyke in Devon, iron lodes in the Brendon Hills and pyrrhotite occurrence on Exmoor.

The intrusives were described as 'Hestercombe Syenite' by Ussher in 1908 and quartz-diorite by Evens and Wallis (1930). Edmonds and Williams (1985) reclassified the Hestercombe intrusive as lamprophyre on the basis off petrological work of Hawkes. As far as is known there has been no previous whole rock analysis, although Edmonds and Williams quote a Rb/Sr age of 264 ± 36 Ma. A new whole rock analysis with low K_2O and Ba confirms the older identification.

The implication of this analysis will be discussed.