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The Scott Simpson Lecture

Using the marine microfossil record to investigate palaeoecological responses to environmental change

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Planktonic foraminifera, a group of unicellular, biomineralising zooplankton, have one of the best species-level fossil records known to science. Using this unparalleled fossil archive we can reconstruct species ecologies and biogeographies over millions of years, allowing us to investigate the responses of organisms to long-term environmental change and to short-lived perturbations in our climate system. Here I present both micro- and macroevolutionary analysis of planktonic foraminifera that demonstrates how this group can be used to provide insight into the early warning signs of extinction risk, the origination and drivers of the modern-day latitudinal diversity gradient, and the ecological response of species to a rapid carbon-led global warming event from the past.

The Old School Borehole and the Bedminster Mudstone Member

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In the Bristol area the presence of >20 m of unmapped red mudstones beneath the supposedly basal Redcliffe Sandstone was noted at the 2016 meeting. The term Bedminster Mudstone Member (BMM) is introduced here for the basal part of the Sidmouth Mudstone Formation in Bristol. There are no accessible outcrops of the BMM, so a type section in the Old School Borehole is proposed. This 88 m deep borehole was drilled in early 2021 at Structural Soils office in Bedminster as a calibration/training hole for downhole logging. It was cored throughout and proved a continuous 30 m sequence of red mudstones between Redcliffe Sandstone and Coal Measures. The core was logged and photographed, and is retained, and geophysical logging carried out down to a collapse at 52 m depth (close to base Trias). The intention is to clear the collapse in 2024. The borehole remains accessible and uncased through the BMM and is used for calibration/training, and thus available for future geophysical logging. The BMM is restricted to the Bristol Basin, thinning out rapidly to the east, north and west, but extending south as far as the BGS Elton Farm (Dundry) borehole. In the centre of the basin mudstones rest directly on Coal Measures while around the margins breccias intervene. It is overlain by the Redcliffe Sandstone Member, which represents a pulse of coarser sedimentation within a long period of mudstone deposition. The BMM consists of cycles of mudstone and silty mudstone - the silty mudstone facies of Milroy et al (2019), in contrast to Sidmouth Mudstone along the Severn which is blocky claystone facies. Evaporite minerals are restricted but a thin pink (?)gypsum-bearing unit forms a useful marker. The possible correlations are discussed but the lack of absolute or even secure relative dates means these are speculative.

Cornubian Batholith construction and the regional heat flow anomaly viewed from the United Downs Deep Geothermal Power Project UD-1 well (5054 m)

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The United Downs Deep Geothermal Power Project, owned and operated by Geothermal Engineering Limited, is situated near St Day in Cornwall. Two deviated deep geothermal wells were completed in 2019: UD-1 (5275 m MD; 5054 m TVD) and UD-2 (2393 m MD; 2214 m TVD). UD-1 provides a hitherto, unparalleled, insight into the batholith construction process and development of the regional heat flow anomaly. The Cornubian Batholith can be divided, near surface, into five different granite types (G1-G5) that were formed by variable degrees of source rock partial melting at different temperatures, and fractional crystallisation processes. The granites have heterogeneous U, Th and K contents that control heat generation. High resolution airborne gamma ray data has demonstrated the spatial variation in near-surface granite heat production, and the Rosemanowes Hot Dry Rock (HDR) Project has provided U, Th and K distributions to depths of 2652 m in the Carnmenellis Granite. Downhole spectral gamma data and the mineralogy, whole rock geochemistry, mineral chemistry and U-Pb zircon geochronology of granite cuttings have been used to constrain the petrogenesis and construction of the upper 4000 m of the Cornubian Batholith. Four granite facies, corresponding primarily to two-mica (G1) and muscovite (G2) types were identified, and were derived from discrete batch melting events over a period of *c.* 4.3 Ma. Compositional variation was controlled by: (1) variation in source rock and melting temperature, and (2) intra-batch fractional crystallisation. Spectral gamma (U, Th) forms a reliable proxy for identifying cogenetic melt batches. The heat flow at United Downs is similar to previous estimates from the Rosemanowes Hot Dry Rock Project. However, there is a substantial increase in Th below 3000 m that indicates the deeper parts of the batholith contribute substantially to overall heat production. Nevertheless, an additional 3000 m of granite below UD-1 is required to explain the surface heat flow.

Founding of the Cretaceous System in 1822

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Following the publication of country-wide geological maps by William Smith and George Bellas Greenhough. Jean Baptiste Julien d'Omalius d'Halloy embarked on the geological mapping of France and the adjacent areas of the Low Countries and Northern Italy. publishing his map in 1822. In the legend of that map was the rock unrt identified as '*Terrain Crétacé*' and that was the birth of the Cretaceous System that we still use today. During the remainder of the nineteenth century many geoscientists in Europe, and elsewhere, worked on the Cretaceous strata and - over time - generated our present understanding of the longest period in the Phanerozoic This includes luminaries such as Alcide Charles Victor Marie Dessalines d'Orbigny. Charles Darwin, Edmond Hébert. Charles Eugene Barrois, A.J. Jukes-Browne and Arthur Rowe. Gradually the appreciation for Cretaceous climates, sea levels, oceanic anoxia, palaeontology and biogeography expanded and many of these topics will be covered in contributions to a two-volume Geological Society of London Special Publications (544, 545) that celebrates the 200th anniversary of the founding of the Cretaceous System

New records of coleoid fossils from the Lower Jurassic of South-West England

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The Lower Jurassic rocks of South-West England continue to yield new specimens of squid-like cephalopods, adding to those found over the years since the time of Mary Anning in the 19th century. In some cases, preservation is quite exceptional, with evidence of the arms, ink sacks and other soft parts while, in other examples, only the hooks are preserved scattered on a bedding surface with little – if any – indication of the parent animal. The normal, clarkeiteuthid hooks can be identified by their slender, curved appearance with a distinctive bi-lobed base. Despite some exceptional material, the hooks of *Loligosepia bucklandi* are not known, while a recent discovery on the Somerset Coast near Lilstock shows smooth, slightly curved, delicate hooks that are difficult to assign to any species or genus. One of the only groups known from this stratigraphical level is that of *Acanthoteuthis*, but there are no records of this genus in the Lower Jurassic of the UK. At present, this is the only possible identification and – if correct – would be a first record in South-West England at this level.

Mineralogical, geochemical and mineral chemistry results from the longest onshore well in the UK, EG-1, a 4.5 km deep geothermal well in the Cornubian Batholith

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The first well (EG-1) of Eden Geothermal Limited was drilled in the St Austell Granite, one of several major plutons in southwest England which together form the Permian Cornubian Batholith. Drilling started in May 2021 and reached a final vertical depth of 4,871 m and a measured length of 5,277 m in November 2021. This has provided the opportunity to examine the deepest parts of the batholith. Geophysical logs of the well were used for initial characterisation. Spectral gamma-ray logs allowed for the identification of different granite facies by their varying concentrations of K, Th and U. This was used to pick intervals for geological analysis. A total of 68 intervals were analysed along the length of EG-1 to characterise the granite facies. Data from automative mineralogy allowed for modal mineralogy, mineral associations, and for mineral texture variation characterisation. Whole-rock geochemical and mineral chemistry data were used to further constrain the variations of granite downhole, building upon the classification scheme of Simons *et al*. (2016, 2017).

The spectral gamma-ray data was used to calculate the heat production of EG-1, building upon the work of Beamish and Busby (2016). An average of 7.5 µW m-1 was calculated for the well with peaks at alteration zones. This is higher than those from Beamish and Busby (2016) for the St Austell area, but their calculations used data from shallow boreholes and airborne gamma-ray measurements. Ultimately the heat production of granite is controlled by its mineralogy which is informed by the geological evolution of the granite during its emplacement, and by post granite emplacement alteration. Characterising the granite intercepted in EG-1 will allow for a better understanding of the evolution of the Cornubian Batholith, which has potential for improving targeting for geothermal systems in the region.

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Figure 1. *Example of automated mineralogical analysis of 'Granite B' drill cuttings from 2330 m (MD) in United Downs well EG-1. Cuttings are mounted in a resin block and run through QEMSCAN©; the false colour image and modal mineralogy were generated from over 2.3 million EDS analyses*

Floating offshore wind in the Celtic Sea

Steve Jermy
Celtic Sea Power, Room 7, Chi Gallos, Hayle Marine Renewables Business Park, North Quay, Hayle, Cornwall, TR27 4DD

A presentation about the Celtic Sea floating offshore wind initiative and Celtic Sea Power's involvement in the project. Along with introducing the wind initiative, the presentation will also cover geoscience-specific topics, including existing knowledge and questions about the geology of the Celtic Sea, likely anchoring technologies and the next steps.

Corals, dirt and carbon: new investigations of the Devonian limestones of Eastern South Devon

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The limestones of the Torbay and Newton Abbot areas are crucial in the history of geology, containing key locations for the definition the Devonian Period such as Lummaton Quarry. The limestones contain a wide range of fauna that were studied fairly extensively until the mid-late 20th century, particularly the coral-stromatoporoid platforms of Eifelian-early Frasnian age. In the past forty years, however, there are few reported studies on these limestones, with seemingly very little in the way of geochemical investigations until now. Consequently, we return to these classic, Type-Devonian localities, to answer the question "*What might have been missed?*". Here we report results of sedimentological fieldwork, optical and electron microscopy, and stable isotope and elemental geochemical results from the mid-Frasnian limestone-mudstone interbeds at Saltern Cove, Paignton. Fieldwork at this locality suggests that many of these corals grew *in situ* in this muddy environment in small (3 m wide, 1.5 m tall) bioherms rather than being washed in in from a shallower carbonate platform, with the interbedded sediment draped over each mound. Acid digestion experiments suggest that corals in these proposed bioherms were able to grow under high siliciclastic input (50-60wt%) and survive or quickly re-establish themselves after short periods of almost pure (>90wt%) siliciclastic input. Corals throughout the succession are commonly partially or fully replaced by silica, an observation not notably recorded in previous studies. Beyond these build-ups, there is a current lack of reported geochemical data from the marine Type-Devonian of the UK. We suggest that while the region undoubtedly includes exposures that are significantly affected by tectonism, it may be possible to develop a carbon isotope curve for the succession of limestones present. This could help show how global and local events, including for example evolution and radiation of land plants, impacted on the Devonian carbon cycle.

Geochemistry of the Gunnislake Granite: an example of small granite variability

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The Gunnislake Granite forms a small stock at the East end of three bodies exposed between Bodmin Moor and Dartmoor, immediately adjoining the Hingston Down Granite. Intrusion is spatially related to major NW–SE faulting, along the current Tamar Valley, which has been active over a long time period. Despite significant quarrying and past metal mining, there has been no reported systematic survey of the granite. Overall, the 20 samples analysed by major and trace element whole rock chemistry plot in the G2/G4 fields of Simons *et al.* (2016). The quarried granite, at Pearsons and Newbridge Quarries, is similar to Hingston Down in Na_2O but the northern part has been extensively greisenised and kaolinised and has low Na_2O and high Rb. These greisened areas are chemically comparable to the Hemerdon granite and report high arsenic and sporadic tungsten. Fluorine is generally enriched, reaching levels (together with Ta) seen in G5 granites, especially near NW–SE faults in the northern part. The composite nature of the granites explains the disparate age data of cassiterites directly dated by Moscati and Neymark (2019) as well as the greisen age of Chesley *et al.* (1993). The fluorine rich G4 granite correlates with the occurrence of secondary torbernite