

THE SCOTT SIMPSON LECTURE THE RISE OF LAND VEGETATION IN THE DEVONIAN OF DEVON AND THE SOUTH-WEST OF ENGLAND.

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The Devonian period encompasses the crucial transition to a diversely forested, arguably modern, Earth. But despite the name, the terrestrial fossil record of Devon, and its neighbouring counties, is restricted in material, preservation and taxonomic diversity. However, there are key localities and finds allowing insight into the palaeo-vegetation of the area, including historical collections which have perhaps been neglected and only partially exploited.

Several significant phases of plant evolution are nevertheless represented. These include the appearance of small cladoxlopid tree-dominated vegetation ('forests') in the Eifelian (Davies *et al.*, 2024): the appearance of woody trunks likely from leafy *Archaeopteris* trees during the mid-late Devonian transition (Lang, 1929); the rise of the tree lycopods (*e.g.*, Arber and Goode, 1915); and, at the very end of the Devonian, the appearance of seed plants (Hilton and Edwards, 1999). These key stages of plant evolution in the south-west will be critically evaluated and interpreted through the lens of the global record of Devonian (Fig. 1) plants, including the occurrence of rare fossil forests.

The nature of the Devonian plant fossil record will be briefly analysed in the context of the complex tectonic setting of South-West England.

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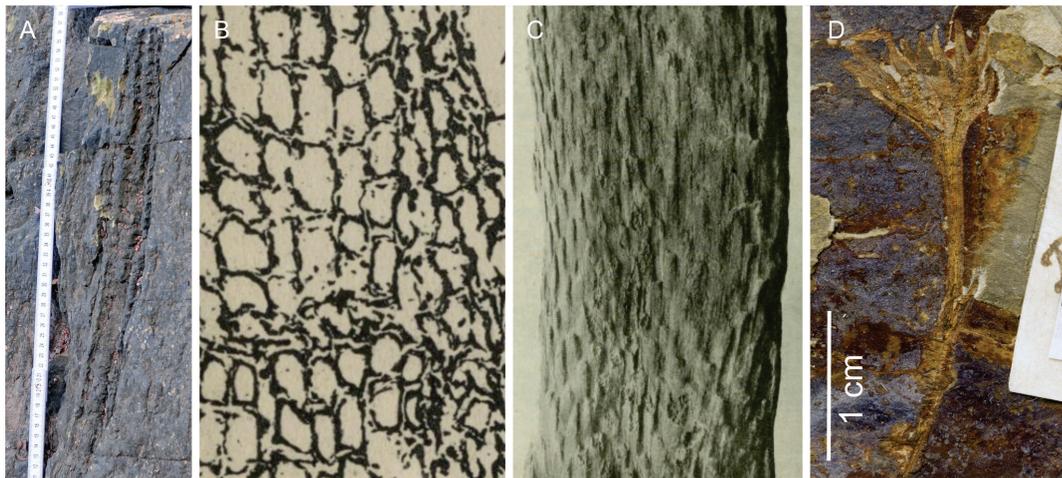


Figure 1. A). Calamophyton, Minehead, Somerset. **B).** Dadoxylon, Cornwall. **C).** Knorria, Sloy Quarry, Devon. **D).** Xenotheca, Croyde Hoe, Devon (Sedgewick Museum, N 106, CC).

NEW FIELDWORK RESULTS FROM ASH HOLE CAVERN

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This talk presents new results from recent geoarchaeological fieldwork at Ash Hole Cavern in Torbay, undertaken by the authors in close collaboration with the English Riviera UNESCO Global Geopark, Historic England and Torbay County Council. The study forms part of wider research on the Quaternary landscapes of the South-West region.

The caves of South-West England have long been recognised as important archives of Quaternary landscape

change, including fauna and archaeology. Investigation of their archaeology and palaeontology was placed on a scientific footing by William Pengelly (1812–1894). He developed sophisticated recording techniques at his excavations in Brixham Cavern and Kent's Cavern, notably the adoption of a three-dimensional grid system of recording. Continued excavations and research to the present day have permitted the application of modern dating techniques and reanalyses of fauna and archaeology from deposits spanning the last 500,000 years. However, not all caves in the region have received equal attention.

In our presentation, we provide an overview of the Ash Hole Cavern project, which involved an assessment of previous geoarchaeological fieldwork; high-specification survey; sampling for palaeoenvironmental and dating purposes; outreach and the consideration of long-term management strategies.

PREDICTING AND PROTECTING LITHIC LANDSCAPES: UNDERSTANDING PREHISTORIC LITHIC DISTRIBUTION ACROSS DARTMOOR

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This paper explores the spatial distribution of lithic scatters on Dartmoor, a granite upland in southwest England, and the surrounding lowlands. Lithic scatters, areas of worked stone tools and the waste product from their manufacture, represent some of the best evidence of hunter-gatherers in the southwest, and are the only resource available for studying prehistoric activity at a landscape scale (Bond, 2009). We present a

summary of GIS predictive modelling developed over the last four years to characterise the extent and significance of Dartmoor's lithic scatters, highlighting the relationship between lithics and the distribution of peat. We briefly describe how the model was tested using a citizen science methodology in 2023.

We present results of comparisons between upland and lowland areas. These involved the predictive model dataset, lithic scatter and control datasets from Dartmoor and lowland regions in the southwest peninsula. Analyses incorporated Least Cost Path Analysis and consideration of three environmental characteristics (aspect, elevation and slope). Combining these results with reviews of regional palaeoenvironmental change, geology and nutritional landscapes has allowed us to identify key differences between the environmental characteristics of upland and lowland lithic scatters with important implications for understanding Dartmoor's role in hunter-gatherer lifeways and future landscape management practices.

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THE DARTMOOR TOR ENCLOSURES SURVEY (DATES) PROJECT, UK

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Tor enclosures, a distinctive class of monument in southwest England, are key features of broader landscape enclosure and monumentalisation practices evident across Britain during the fifth and fourth millennia BC. These practices coincide with significant shifts in landscape use, subsistence strategies, lifeways, and material culture. In Cornwall, ten tor enclosures have been identified, while four are known in Devon (Davies, 2010; Basell *et al.*, 2020, 2022). Despite variations in form, their defining feature is the enclosure of high moorland areas with stone banks, often integrating one or more prominent rock

outcrops. Of the Cornish sites, only Carn Brea and Helman Tor have been securely dated to the fourth millennium cal BC (Mercer 1981, 1997).

Dartmoor, a granite upland and national park in Devon, boasts one of northern Europe's best-preserved prehistoric landscapes due to its history of landscape use. Since 2019, the Dartmoor Tor Enclosures Survey (DATES) has conducted detailed investigations at two known tor enclosure sites—White Tor and Dewerstone—as well as a newly identified site, Knowle Wood. This paper presents selected highlights of survey work, evaluation excavations, and dates. By situating these sites within their broader temporal and spatial contexts, we explore the evolving dynamics of human entanglement with these monumental landscapes.

BASELL, L.S. and BRAY, L.S. 2022. Dartmoor Tor Enclosures Survey: "DATES". *Dartmoor Magazine*, Issue **146**, 23–24.

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DAVIES, S.R. 2010 *The early Neolithic tor enclosures of Southwest Britain*. Unpublished PhD thesis. University of Birmingham.

MERCER, R.J. 1981. Excavations at Carn Brea, Illogan, Cornwall – A Neolithic fortified complex of the third millennium bc. *Cornish Archaeology*, **20**, 1–204.

MERCER, R.J. 1997. The excavation of a Neolithic enclosure complex at Helman Tor, Lostwithiel, Cornwall. *Cornish Archaeology*, **36**, 5–63

SCHORL ROCK - WHAT IS IT AND HOW WAS IT FORMED?

Colin Bristow
Wheal Martyn China Clay Museum, St Austell, Cornwall PL26 8XG.

Veins and irregular masses, mainly composed of quartz and tourmaline (borosilicate), classically referred to as 'schorl rock', are common features seen in the western part of the St Austell granite. Adam Sedgwick speculated on the origins of schorl rock in papers read in 1822, 1831 and 1835 and was clearly familiar with the occurrences of schorl rock in the St Austell granite. This presentation will begin with some illustrations where borosilicate segregations ranging from a few metres across to pea-sized masses have been seen. All indicate that, at a late stage in the cooling history of the granite, a fluid rich in silica and boron seems to have separated out from the main granitic magma to fill fractures and larger spaces with tourmaline and quartz. Occurrences of topaz rich rocks at Wheal Remfry, St Mewan Beacon and Carliquoiter rocks may

also have some bearing on the processes involved.

The Wheal Remfry breccia throws some light on this process, and it is helpful to consider the rock mechanics involved. There is a general consensus that the crystallising granitic magma seems to have been initially under a high confining pressure, which enabled a high content of volatiles to be kept in solution. When the confining pressure was reduced and crystallisation commenced, a fluid rich in silica and boron seems to have been squeezed out from the consolidating granite and, as it was under high pressure, it began to hydraulically fracture the granite, with the fractures occurring perpendicular to the direction of least confining pressure, as is well seen at Cligga, Wheal Remfry, Goonbarrow and in many other china clay pits. These fractures were then filled with the borosilicate mixture squeezed out from the granite, gradually inflating the fracture until ultimately the rock disintegrates, forming a breccia of granite fragments floating in a borosilicate matrix – the Wheal Remfry breccia. Another illustration from Wheal Remfry shows that the molten granite and the borosilicate appear on occasion to have flowed alongside each other, indicating that the granite magma and the borosilicate could both be fluid at the same time.

At Goonbarrow a different process seems to have operated and bulbous masses of schorl rock (borosilicate) several metres across are seen. Careful observation shows that these bulbous masses are frequently connected to the main quartz-tourmaline vein system by a narrow feeder vein and it looks as if this vein could have inflated the bulbous mass. Also, the bulbous masses appear to congregate just below the stockscheider pegmatite which marks the boundary with the hanging wall composed of porphyritic biotite granite, which in turn suggests the borosilicate masses were of lower density than the granite magma. The well-defined margins of the borosilicate blobs at Goonbarrow also suggest that the borosilicate and the

granite may have been immiscible; further research is needed to determine whether such a process is feasible. Roche rock is a very large borosilicate mass which occupies a granite apophysis, suggesting that the borosilicate fluid has migrated up into the apophysis and accumulated there because of its lower density than the granite. This, in turn, suggests that the borosilicate fluid must have had a high-water content, as tourmaline density is $\sim 3.0 \text{ g/cm}^3$.

All this suggests that this is a fascinating and neglected area ripe for further research, although some china clay pits where these occurrences occur are no longer accessible because they are flooded, filled in, or re-vegetated.

THE NATURE OF MINERALISING FLUIDS IN THE CARN BREA AND POOL MINING DISTRICTS

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SW England hosts a world-class Sn-W-Cu-As-Zn-Pb-Li ore field associated with the Cornubian Batholith (Jackson *et al.*, 1989). Magmatic-hydrothermal mineralisation is localised in steeply dipping ENE–WSW extensional faults (lodes), which exhibit mineral zonation with distance from the granite source (Dines, 1956). A resurgence in exploration drilling across historic mining districts has provided an opportunity to reassess the ore mineralogy paragenesis and fluid evolution. Establishing the key controls of ore precipitation and zonation patterns will aid exploration and support resource expansion.

This study integrates core logging, petrography, μXRF imaging, microthermometry, and LA-ICP-MS fluid inclusion analyses to re-evaluate paragenetic sequences and fluid characteristics of lode systems from Pool and Carn Brea mining districts (Dines, 1956). Recent drilling around Carn Brea Granite indicates a six-stage paragenesis (Brooksby *et al.*, 2025). Cassiterite is either [A] massive cassiterite, with no clear vein structure, or [B] Cassiterite within fluorite–quartz±chlorite veins; both cut earlier Tur breccia.

Microthermometry of fluid inclusions hosted by cassiterite, fluorite and quartz identifies overlapping magmatic–hydrothermal and meteoric fluid contributions across the districts. In the Carn Brea district, cassiterite [A] formed from high-temperature (300–400°C), high-salinity (19.5–20.9 wt.% eNaCl) $\text{H}_2\text{O}-\text{CO}_2-\text{NaCl}$ fluids. The fluids periodically cooled and rejuvenated during cassiterite formation, combined with fluid geochemical data, suggest that precipitation was due to mixing and dilution by low temperature meteoric water (Farmer *et al.*, 1991). Primary magmatic fluids show enrichment in Sn and Cu, with a strong association with Li, Pb and As. Cassiterite within veins [B] contains both moderate-high temperature (210–375°C), moderate salinity (6.2–11.6 wt.% eNaCl) magmatic-hydrothermal fluid; and a low temperature (125–250°C), low salinity (0–0.5 wt.% eNaCl) meteoric fluid, that mixed prior to cassiterite precipitation. Geochemically similar Li-rich magmatic fluids to those within [A], carrying high levels of Sn–Cu–As–Zn. Cathodoluminescence textures support cassiterite formation through repeated dilution of waning magmatic fluids and meteoric input.

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SET IN STONE: UNDERSTANDING ANCIENT FARMING COMMUNITIES THROUGH DARTMOOR'S PREHISTORIC MONUMENTS.

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This poster outlines the methodological framework and collaborative structure of a new PhD project developed in partnership with Dartmoor National Park. It presents the

planned interdisciplinary data-collection strategies, project design and engagement pathways shaping the study.

Dartmoor is home to hundreds of prehistoric stone monuments including stone rows, stone circles, burial cists and hut circles. Stone was clearly an important material to early farming communities yet relatively little is known about how it was sourced, quarried, moved and modified for use in monuments. Through the application of novel geoarchaeological approaches and geomatics survey techniques (such as XRF, pXRF, LA-ICP-MS, SEM, laser scanning and photogrammetry), this research will provide new insights into these questions.

Preliminary fieldwork to develop the methodology is raising interesting questions and lines of enquiry based on examining the variability in granite on Dartmoor, and selected monuments. Data gathered will improve understanding Dartmoor's geology (specifically granite). It will increase our

knowledge of prehistoric people on Dartmoor allowing their lives to be viewed through a new lens.

Rapid assessments of selected monuments revealed apparent lithological variations and patterns. Developing a thorough recording system to highlight the details in these

patterns is necessary to determine their significance and to conclusively discuss results. This is a new approach to the investigation of lithic monuments on Dartmoor and shows potential to generate new insights.

SEA GRASSES IN SOUTH-WEST ENGLAND: ECOLOGY, EVOLUTION, EPIFAUNAS, CARBON SEQUESTRATION AND THEIR PROTECTION.

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Sea grasses are true flowering plants that live in near-shore marine or estuarine environments. They are considered important for their impact on biodiversity and potential for carbon sequestration. In the United Kingdom and Northern Ireland, sea grass 'meadows' are widely distributed, and their presence often promotes Marine Protected Area (MPA) status either as Special Areas of Conservation (SAC) or Marine Conservation Zones (MCZ). The oldest sea grasses yet described are from the Maastrichtian chalks of the Netherlands, but the fossil record between the Cretaceous and the present day is minimal.

In South-West England there are two distinctive species present, including:

- *Zostera marina* (Linné, 1753) – a sub-tidal species with

dark green leaves that can be < 2 m in length but are, more normally, 20–50 cm in length.

- *Zostera noltei* Hornemann, 1832 – an inter-tidal species with grass-green leaves that are normally 6–22 cm long. This species can be referred to as *Z. noltii*, but *Z. noltei* might be the correct name as it is based on the German botanist Ernst Ferdinand Nolte (1791–1875) and for names ending in a vowel, normal practice would be to add an 'i'. Many leading UK institutions, however, currently seem to show a preference for 'ii'.

In some inter-tidal areas (e.g., Thanckes Lake on the River Tamar and the Salcombe/Kingsbridge Estuary) there is a 'dwarf' form of *Z. marina* with light, yellow/green leaves that are ~15–30 cm in length. In some literature these forms have been described as *Z. marina* var. *angustifolia* Hornemann, 1816, although genetic work has shown that this 'variety' is a true *Z. marina*.

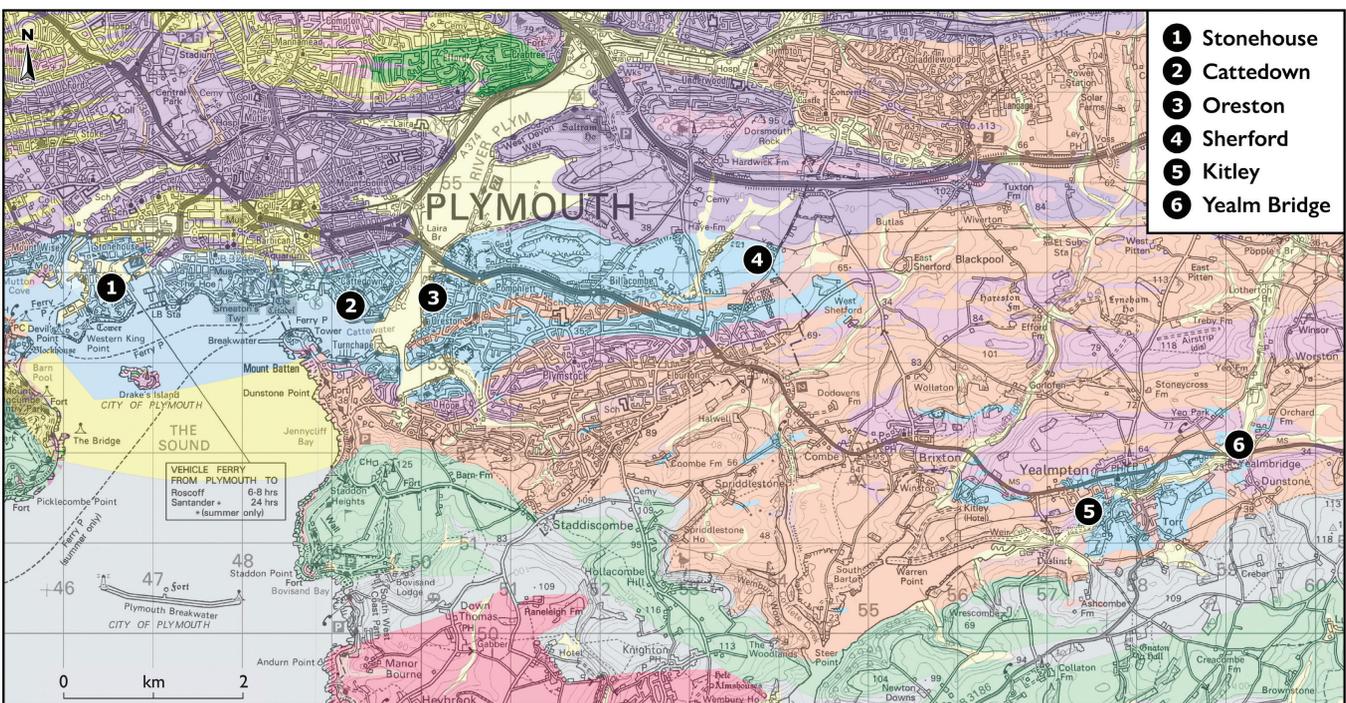
In the 1930s the sea grass meadows in South-West England were 'hit' by a 'wasting disease' which severely impacted the sea grass meadows. As part of the recovery from this many areas are being replanted with sea grass, despite being designated SSSI. Sea grass is also being replanted because of a belief that it helps in carbon sequestration and can mitigate climate change.

NEW AGE INFORMATION ON THE YEALM BRIDGE CAVERN FAUNA

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The Box, Plymouth (formerly known as Plymouth City Museum and Art Gallery) hosts a large collection of cave



Geological Map Data BGS © UKRI 2025. © Crown Copyright and Database Right 2025. Ordnance Survey (AC0000851941).

Figure 1. The mid-Devonian limestone outcrop between Plymouth and the Yealm Bridge Caverns showing the locations of the caves described in the text. Geological Map Data BGS ©UKRI 2025. ©Crown Copyright and Database Right 2025. Ordnance Survey (AC0000851941). The mid-Devonian Plymouth Limestone Formation is indicated in the light blue colour extending from the River Tamar in the west to Yealmpton in the east. The 'new town' of Sherford is indicated (Black No. 4).

faunas from the Plymouth area as well as some material from other caves in South-West England (Fig. 1). Recently a large collection of material has come from the Kitley Estate – in 2012 – including specimens of the woolly rhinoceros (*Coelodonta antiquitatis* Blumenbach, 1799) from Yealm Bridge Caverns

near Yealmpton. A tooth fragment (K.R.C. 948) has been radiocarbon dated as $44,344 \pm 210$ years BP (= 47,420–45,988 cal BP), a date which is comparable to other occurrences of this taxon in England (especially Creswell Crags in Derbyshire).

A TRANSCRUSTAL MAGMATIC SYSTEM PERSPECTIVE OF THE UPPER 4.8 KM OF THE SOUTHERN ST AUSTELL GRANITE, FROM THE EDEN GEOTHERMAL EG-1 WELL.

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The first deep well (EG-1) in the St Austell Granite, drilled by Eden Geothermal, reached a true vertical depth (TVD) of 4,871 m, and a measured depth of 5,277 m. It provides a geological insight into the nature of the Early Permian Cornubian Batholith. Combining interpretations of spectral gamma-ray log, mineralogical, mineral chemical and whole-rock geochemical data allows a geological model for the construction of upper half of the St Austell Granite to be developed.

Spectral gamma-ray logs provide a continuous record of the in-situ Th, U and K composition over a 4000 m vertical interval. These variations are used to identify geochemical evolutionary trends, within and between granite facies, which reflect different petrogenetic processes. The Th/U ratios of the different granite facies reflect the degree of differentiation, with high ratios representing more primitive granite batches (e.g., Cuney, 2014; Scharfenberg *et al.*, 2019; Regelous *et al.*, 2021). They are not necessarily representative of the anatectic magma composition as it is likely to have passed through intermediate storage and/or differentiation stages before final emplacement.

Estimated crystallisation depths and temperatures of the EG-1 granite facies are out-of-sequence and mimic the whole-rock geochemical and mineral chemical evolution. This suggests pluton construction occurred by the emplacement of

sheet-like intrusions into previously emplaced granite batches. Reappraisal of the Bouguer anomaly data of the Cornubian Batholith shows the St Austell Granite is a maximum of c.15 km thick (Watts *et al.*, 2024), whereas estimated crystallisation depths for EG-1 facies range from 2 to 40 km. This discrepancy between estimated shallow to lower crustal crystallisation depths, with the estimated thickness of the St Austell Granite supports a transcrustal magmatic system (TCMS) model for the Cornubian Batholith (Cashman *et al.*, 2017; Moyer *et al.*, 2021; Humphreys *et al.*, 2025). A better understanding of this has implications for geothermal system source targeting.

CASHMAN, K. V., SPARKS, R.S.J. and BLUNDY, J.D. 2017. Vertically extensive and unstable magmatic systems: a unified view of igneous processes. *Science*, **355**(6331), p.eaag3055. <https://doi.org/10.1126/science.aag3055>

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AI FOR GEOLOGICAL MAPPING: INCREMENTAL PROGRESS OR REVOLUTIONARY SHIFT?

Charlie Kirkwood
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Note: (Recording taken from Artificial Intelligence for Geological Modelling and Mapping conference (AI-GMM) at the University of Exeter, 2024)

Charlie Kirkwood is a research fellow in the University of Exeter's Institute for Data Science and AI (IDSAD), where he works to develop and apply data-scientific solutions for a range of pilot projects proposed by academics from across the University. He has also developed his own research programme in artificial intelligence for geological mapping, for which his article 'Geological Mapping in the

Age of Artificial Intelligence' featured on the front cover of the Geological Society of London's 'Geoscientist' magazine (supported by technical papers dating back to 2016).

Charlie has given several invited lectures on this topic, including to EuroGeoSurveys; the consortium of national geological surveys of all European countries. In May 2024 Charlie hosted the first Artificial Intelligence for Geological Modelling and Mapping conference (AI-GMM) at the University of Exeter and it is a recording of this talk is available on-line. If you are interested in AI and geology, or have questions about this talk, please feel free to get in touch with the author at c.kirkwood@exeter.ac.uk.

Kirkwood, C. 2022. Geological mapping in the age of artificial intelligence. *Geoscientist*, Geological Society of London.

<https://geoscientist.online/sections/features/geological-mapping-in-the-age-of-artificial-intelligence/>

COMMUNICATING THE GEOHERITAGE OF ROCHE ROCK: THE GOOD, THE BAD ...AND THE VANDALISED

John Macadam
Earthwords, Bodmin, Cornwall

A panel at Roche Rock was included, with the landowner's (Tregothnan Estate) agreement, in a successful bid in 2006 by Cornwall Wildlife Trust to the Aggregates Levy Sustainability Fund for interpretation and management at Tresayes Quarry Nature Reserve. The board (by the author) was figured in the chapter on interpretation ('Geoheritage: getting the message across. What message, and to whom?') by the author in Reynard and Brilha's *Geoheritage: Assessment, Protection, and Management* (Elsevier, 2018, 2nd edition, 2025). The same image has been included in interpretation workshops conducted by the author for participants from all continents (excluding Australia and Antarctica).

The GOOD elements are a clear theme (*i.e.*, take-away message: 'Roche Rock is a special place – special for its geology, its wildlife and its history, and special for local people, and to visitors for hundreds of years'...so it's more than the ruined medieval chapel!), simple language, layered text, conservation message in words and icons, and the plinth (granite boulder from a nearby china clay pit) is part of the interpretation (Fig. 1). It's also half-buried, like the surrounding quartz-tourmaline boulders, and it's off the path, and is mostly green (like the vegetation) so can be ignored by visitors if they prefer the historic site unaltered. Local people were involved



Figure 1. Interpretation panel at Roche Rock.

at all stages. The plinth is reusable (and easily removable by a Hi-Ab truck).

The BAD elements are that the panel is laminated fibreglass and is not recyclable. Also the parish council decided to put a concrete plinth around it, plus a crushed granite path leading from the roadside stile to the panel, so the interpretive panel was hard to ignore. The VANDALISM has involved various pointed objects...and the colours have faded. Plans to update and replace are being discussed with Tregothnan, possibly involving a QR code linked to an interactive drone survey.

THE FINE-GRAINED DARTMOOR GRANITES, CHEMISTRY AND RELATION TO MINERALISATION: EVIDENCE FROM THE MARGIN

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The Dartmoor Granites have been the subject of a number of studies of their nature and chemistry, but most of the recent studies have concentrated on the megacrystic and medium grained varieties. An exception is the study of Clemens *et al.* (2021) which suggests the finer-grained "aplitic" granites have a different genesis. Older comprehensive studies, which include the finer-grained-varieties, such as Brammall and Harwood (1932), lack any trace element determinations.

Two areas near the margin of the granites have been examined and sampled to assess these finer-grained granites: in the north, near Okehampton, and in the south, but excluding the well-studied Hemerdon- Crownhill Down areas (Smith *et al.*, 2021).

At the northern margin, the relationship of the Meldon Aplite to the main megacrystic granite is not well exposed. However field mapping supports the suggestions of Worth (1919) and Dearman (1959) of the occurrence of a number of sheets of fine-grained granitic material rather than the single granite shown on the BGS sheet. Some sheets appear to be tourmaline-rich rather than the simple aplite of Worth and

correlate with the Sn skarn of Red-a-Ven.

In the south, tourmaline-rich granites are present at the Dewerstone and Legis Tor areas, the latter where tourmaline veining forms areas analogous to luxullianite. The felsites of Worth (1902,1903) are present at Legis Tor and Moorhaven and may correlate with newly discovered G5 dykes in the Yelverton area.

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STRATIGRAPHIC AND STRUCTURAL MODELS OF THE VARISCAN-DEVONIAN CONTINENTAL MARGIN IN SOUTH DEVON: A COMPARISON AND LESSONS LEARNED WITH THE INDOSINIAN-PERMIAN CONTINENTAL MARGIN IN THAILAND

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Many Victorian and twentieth century quarries, now lost, provided stratigraphic and structural information crucial to detailed geological mapping (away from the coast) of the Variscan Orogen in Devon. Structural-stratigraphic models arising from this mapping emphasize inheritance of Devonian rifted margin architecture (e.g., carbonates on structural highs, deepwater clastics in depocentres), and the subsequent inversion-style deformation during the Variscan Orogeny. Yet, the extent of individual carbonate platforms is disputed.

The Indosinian (Triassic–Early Jurassic) Orogeny, Saraburi

region, Thailand, exhibits juxtaposed Permian carbonates and deepwater clastics, similar to those proposed for the Devonian margin. Recent quarrying (60 active and abandoned quarries), has provided excellent exposures in an E-W oriented area of 450 km². Stratigraphic models prior to 2013 interpreted a single, large Permian carbonate platform. However, new analysis shows four belts of small carbonate platforms were separated by deepwater clastic basins. These sequences are juxtaposed by major thrusts. This once broad (>200 km) region of carbonate highs and deep clastic basins was shortened into a remarkably narrow belt (c. 40 km N-S in the tectonic transport direction) during the Triassic. Seismic reflection data provide evidence for Permian rift basin normal fault control on deposition in less deformed areas but remains difficult to identify in outcrop.

Looking at the Variscan stratigraphy and structure of Devon with the experience of the Saraburi region suggests: 1) without exposures that reveal major thrusts it can be remarkably difficult to use stratigraphic evidence alone to constrain carbonate platform size; 2) large amounts of shortening (c. 60%) can be concentrated in deepwater sediments: possibly the Variscan inversion models do not account for sufficient shortening; and 3) all quarries provide valuable, often unique, information that is unfortunately transient.

GEOSITES IN DEVON AND WHERE TO FIND THEM: IMPROVING ACCESS TO THE RESOURCE FOR SCIENCE AND EDUCATION

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Geodiversity & Heritage/ProGEO

South-West Britain's rich and unique geological heritage covers virtually all aspects of the geological sciences, crucially including the historical type area for the Devonian System. To conserve key aspects of this geodiversity for future generations, the first selection of sites gained legal protection under the National Parks and Access to the Countryside Act 1949, with a second tranche emerging from the systematic Geological Conservation Review from 1977, as notified under the Wildlife and Countryside Act 1981.

In Devon, the Geological Conservation Review (GCR) selected around 140 sites, the majority now protected within formally designated Sites of Special Scientific Interest. The emphasis on selecting sites of at least national scientific significance, however, meant that many locally and regionally important sites, especially of educational importance, remained unprotected and hence primarily voluntary county-based groups were established to develop site inventories based on local criteria, for protection through local development plan systems. Known collectively as 'Regionally Important Geological Sites' (RIGS) – or County Geological Sites (CGS)

in Devon - this process was particularly active from the 1990s until around 2010, in Devon, selecting around 232 sites. Surveys were often supported by local governmental authorities and the group was also consulted by the same bodies, both on a site-by-site basis, but also as part of the development of strategic plans. After 2010, however, national government austerity policies removed most of this local government support and the Devon RIGS group effectively ceased to function, including its website through which the inventory was publicly available. In addition, without regular site visits to assess, there is no mechanism to ensure that listed sites remain in accessible and usable condition. This issue of site deterioration, however, also affects the GCR/ SSSI network, as revealed by a recent programme of Site Condition Assessment commissioned by Natural England. Nevertheless, the latter surveys have produced a new and detailed photographic survey for the sites included, potentially important for planning fieldwork.

It is suggested, therefore, that the Ussher Society's website might be an appropriate place through which to make this information openly available and hence start to develop a resource informing fieldwork and educational activities. Subsequently, links could be developed to other websites providing information for other parts of the regions, hence establishing an invaluable tool for anyone planning research or educational visits – or even just 'geotourism' - to the region. The increased throughput through the Society's website could also lead to increased support for other aspects of the Society's activities.

BARIUM BUILD-UP IN THE TEIGN REVISITED

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As a consequence of mining activity in the southwest of England, contamination of soils and sediments through the discharge of particulate mining waste and metal rich waters from abandoned mines, and associated ore processing and transportation are among the highest recorded in the UK.

Previous studies in the 1970's and 1980's, of the river and estuarine sediments of the Teign revealed anomalous accumulations of Ba, Pb and Zn. Particularly high

concentrations were found in the middle Teign River adjacent to streams draining former spoil tips and mining areas. Notably these studies show that element concentrations in the sediments are rising since the last mine closed in the 1950s.

In order to determine any longer-term pattern of the geochemical properties of surficial sediments, various locations in the river and estuary were re-sampled. Bulk sediment geochemistry was determined by XRF and data for Ba, Pb and Zn are presented here. The data show, for the middle part of the Teign river adjacent to the streams draining the former spoil tips, high concentrations, particularly for Pb and Zn are again observed and attest to the longevity of such pollutants in the environment. The highest concentrations are, however, less than previous observations. The concentrations of Ba, Pb and Zn show little change in the estuary.

CLIMATE CHANGE ACROSS THE MIDDLE – LATE JURASSIC TRANSITION: EVALUATING THE ISOTOPIC EVIDENCE FROM DORSET.

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The Jurassic greenhouse world is punctuated by short cooling intervals, with at times postulated polar ice-sheet development. Key published data used to support such inferences has been derived from stable isotope data from Middle and Late Jurassic successions exposed in Dorset (including Burton Cliff, Tidmoor Point and Sandsfoot Castle, Weymouth). Using these published data, combined with new

stable isotope data, we evaluate the evidence for climate change through this greenhouse interval. Despite some gaps in the record, belemnite carbon isotope trends are consistent with bulk carbonate carbon isotope records displaying systematic fluctuations, the largest of which (Bathonian – Callovian/Early Oxfordian) corresponds to previously identified phases of environmental perturbation. Such a trend may have resulted from burial and preservation of organic matter, leaving the seawater more positive in terms of carbon. Inferred cooling, derived from our oxygen isotope data from southern England, occurs within the Late Callovian and Oxfordian. Cooling post-dates the positive carbon isotope excursion. Therefore, enhanced carbon burial and atmospheric carbon dioxide draw down may have induced cooling. If Jurassic polar climates were truly warm, such a degree of cooling could have led to cooler polar temperatures.

TRIASSIC (ANISIAN) CALCRETES IN SE DEVON: WHAT CAN THEY TELL US ABOUT THE CLIMATE?

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The Mid-Triassic Helsby Sandstone in SE Devon comprises intervals extensively cemented by calcretes formed during the deposition of the host sandstones in an arid continental environment. The calcretes are present both as horizontal, bed-parallel sheets, and elongate, cylindrical concretions (rhizocretions), the latter formed around the tap roots of vegetation.

Recent U-Pb age dating of a rhizocretion has shown that most of the calcite retains its original age of formation (c. 245 Mya) and has not been modified or recrystallized. A later phase of calcite (<10% of the total) was dated as Mid-Eocene (c. 42 Mya Lutetian). This calcite formed on the pre-existing calcite when the sandstones became an active aquifer during the hot and tropical environment during the Mid-Eocene Climatic Optimum (MECO).

Previous isotopic analysis has largely been undertaken on bulk samples of calcite and supports an arid continental environment. However, the rhizocretions have a complex fabric that is evident in hand specimen and under microscopic analysis (Fig. 1). This study involved the micro-sampling of the different calcite phases to determine if their C and O stable

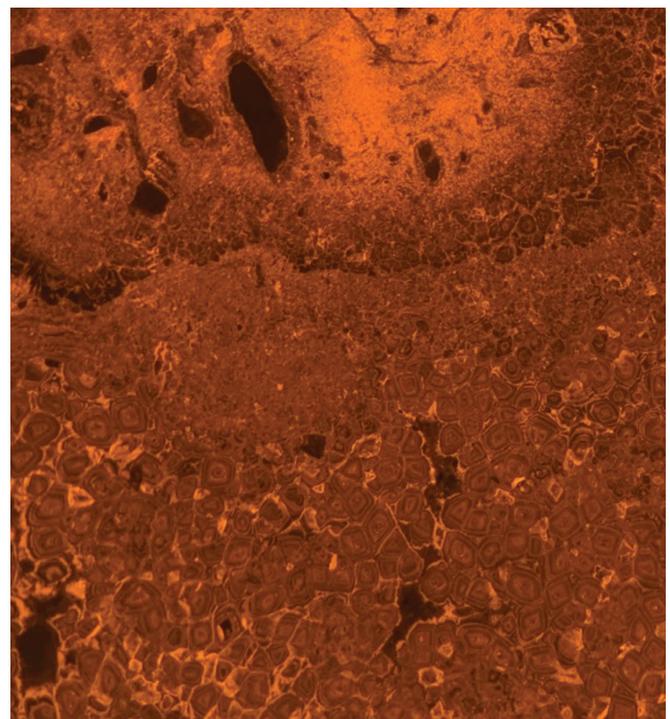


Figure 1. Cathodoluminescence photomicrograph of rhizolith. Field of view 3 mm

isotopic composition (and clumped isotopes) could be utilized to improve our understanding of the ancient climate during both the Mid-Triassic and Mid-Eocene.

BRE 365 SOAKAWAY TESTING: SHOULD IT BE UNDERTAKEN IN GEOLOGIES THAT PREVIOUS TESTING HAS SHOWN TO BE UNSUITABLE FOR SOAKAWAY/ INFILTRATION DRAINAGE?

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The BRE 365 soakaway test is widely accepted and requested as the field test that is to be carried out to assess the suitability of the ground for soakaway/ infiltration drainage (Fig. 1). However, the test is not without danger, mainly due to working at height risks, and it is relatively wasteful of resources, including fuel and water. If previous testing results consistently and convincingly show that certain geologies are unsuitable for soakaway/ infiltration drainage, should a relatively unsafe and not particularly sustainable test be carried out?

Using data from over 5,000 tests on more than 1,200 sites investigated by one company – Ruddlesden geotechnical – over the last 20 years, mainly in the South West, there is a clear and understandable correlation between unsuccessful tests and the underlying geology, where the underlying geology comprises predominantly lower permeability mudstones and clays, notably the Mercia Mudstone Group, Lias Group and Oxford Clay Formation. However, there are a number of anomalies, which can usually be explained by a closer inspection of the local geology, including superficial deposits.

More data and research will be required for regulators to accept that no testing is required in certain geologies. It is suggested that additional companies, initially in the South_



Figure 1. Soakaway testing in the field and the data-set on regional sites.

West, collaborate and provide their data, to add to the existing database, to provide greater statistical confidence on the likelihood of unsuccessful soakaway tests in certain geologies. This increase in data will inevitably need additional input from others, preferably skilled in GIS, to process and interpret it.

COMMUNITY RESPONSE TO GLOBAL CHANGE: A PALEONTOLOGICAL PERSPECTIVE

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Rapid global change is reshaping the Earth's ecosystems, but the short timescale of human observation limits our ability to predict long-term ecological responses. Palaeontology offers the only deep-time records of community responses to repeated climatic disturbances, how they reorganise, collapse, and recover. The Silurian period (443–419 million years ago) is a useful example, with a dynamic climate marked by multiple global events in association with major carbon-isotope excursions, linked to climatic fluctuations, sea-level change, and widespread ecological turnover. Gotland – which at the time was close to the equator, captures shallow-marine carbonate reef ecosystems at low latitudes to these events at high stratigraphic resolution. Its excellent fossil preservation makes it valuable when examining responses to environmental change.

This project investigates how Silurian shallow-water reef communities responded to repeated intervals of climatic instability. By sampling comparable habitats across multiple stratigraphic levels, we can assess both within-location variance and long-term patterns of community turnover. Community composition will be quantified through specimen photography, fossil identification, and PCA to examine how global change events influenced community composition. Species will also be separated by functional group to investigate changes in functional diversity.

Beyond reconstructing Silurian marine ecosystem dynamics, this study offers opportunities to contribute to the wider evolutionary, ecological and palaeoecological context. Identifying patterns in ecological turnover and associated processes, such as trait filtering, is the first step to a better understanding of how biological systems respond to global change over long timescales. If similar trends emerge in more complex Paleozoic ecosystems, such as those of the Devonian, this may indicate that shallow reef communities respond to environmental stressors in comparable and predictable ways across geological time. Thus, establishing baselines is essential both for understanding ancient ecosystem dynamics and potentially, for informing how modern marine communities may respond during in this age of intense global change.

LANDSCAPE TEXTURE AND GEOLOGY IN THE DARTMOOR AREA

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The texture, or grain, of the land surface, can be studied in detail using DEFRA 1m DTM last-return data. In hillshade images covering an area 50 by 50 km centred on Dartmoor, the human eye perceives that there are several distinct textures which reflect lithology and structure; Dartmoor and its metamorphic aureole is smoother and has a lower density of valleys than the surroundings, which themselves show several

textures. This subjective perception is confirmed by statistical analyses, which highlight how texture is scale-dependent. Further, the granite shows many lineations in the form of straight valley segments and linear steep slopes, which appear to be exploited fractures. They form a trellis pattern, with a strong nearly N-S component, which does not usually extend into the country rock. This does not accord with the NW-SE orientation of the Sticklepath-Lustleigh Fault Zone, suggesting two different origins. The topography in the fault zone is different from that in the surrounding granite.

This is part of a larger piece of work on the evolution of the post-granite surface of the area, including Permian unroofing, Mesozoic marine transgression and erosion, uplift history, and drainage patterns.

A DRONE SURVEY BETWEEN PORTHLEVEN AND LOE POOL

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An aerial survey conducted in 2021 identified the current status of coastal retreat along the coastline between Porthleven and Loe Pool, Cornwall. Comparative analysis with historic imagery from Cornwall and Isles of Scilly Historic Environment Record (HER) reveals a significant impact over the past century of the combined influence of geological controls, high-energy marine processes, and increasing storm impacts revealing the nature and extent of coastal retreat.

The study area is underlain by structurally complex Devonian–Carboniferous metasedimentary rocks, locally weakened by faulting, jointing, mineralisation, and historic mining activity. Coastal erosion is dominated by hydraulic action, and abrasion at the cliff toe, particularly during storm events. These processes promote episodic mass movement in the form of rockfall and rotational failure. Storm surges temporarily elevate effective sea levels, allowing wave attack on higher sections of the cliff profile. As a result, cliff retreat occurs in discrete events rather than as a continuous process (Fig. 1).

Significant impacts on infrastructure and heritage assets have been identified, including two separate inland realignments of

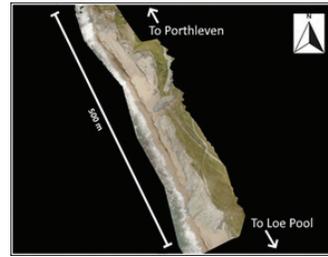


Figure 1. Area of the drone survey between Loe Pool and Porthleven.

the South-West Coast Path, a highly recognised walk globally, and responsible for a significant economic contribution to the southwest. Additionally, the loss of the coastal access road between Porthleven and Loe Pool has occurred within the lifetime of a Cornwall Geoconservation Group (CGG) member. Workings associated with Wheal Penrose Mine, a designated County Geological Site (CGS), have further reduced rock mass strength, predisposing the cliffs to instability. Differential erosion along structural discontinuities is a primary control on cliff morphology and failure mechanisms has increased geotechnical risks.

The findings highlight the necessity for regular monitoring of cliff stability and erosion rates. An integrated approach combining field-based geological assessment with drone-derived aerial surveying is recommended to support effective coastal management, risk mitigation, and long-term conservation of this dynamic geologically and economically significant coastline.

COBALT – A REVIEW OF EXPLOITATION IN CORNWALL AND CHESHIRE

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Cobalt (**Co**) was discovered in 1735 by a Swedish chemist (Georg Brandt, 1694–1768). It occurs in sulphides, arsenides and secondary minerals, typically in association with **Ni** and **Mn**, and is a minor component in mineralisation in the British Isles.

Occurrences in Cornwall and Cheshire were deposited from low temperature, high salinity brines. Those in Cornwall are associated with NNW-SSE-trending cross-courses into which brines were expelled from former super-incumbent Permo-Triassic formations. The cross-courses post-date **Sn** and **Cu** mineralization in the area; one in the Tamar valley has an Rb-Sr age of 235 ± 3 Ma (late Mid- to early Late Triassic). In Cheshire migrating intratratral brines accumulated in Anisian

(early Mid-Triassic) fluvial and aeolian deposits in a structural trap beneath a seal of younger Mid-Triassic mudstones.

Co minerals are known from many Cornish mines but there are definite records of **Co** ore production from only six, with possible production from a similar number. Wheal Sparnon, Redruth, was an important source of **Co** ore which was produced from at least 1808 until shortly after 1827. Output included 80 tons raised in one year from ‘a large and valuable cobalt lode’ which was eventually worked down to 70 fms below adit. By 1826 this mine was unique in Cornwall as being worked solely for **Co**. Produce went mainly to the ceramic industry, some as **Co** oxide which was produced on-site though before 1817 some Sparnon ore was refined in Hanley, Staffordshire.

In Cheshire **Co** minerals were recognized at Alderley Edge in 1806 and disseminations and thin seams in sandstone around a north-south fault were mined from about 1808 until 1810. The output went initially to a Yorkshire pottery. Mineralization at Alderley includes **Cu**, **Pb**, **As**, **Mn**, **Co**, **Ni** and **V** and was worked mainly for **Cu** between 1857 and 1877. **Cu** was recovered using an acid-leaching process and **Co**-rich residues were recovered as a by-product of this between 1860 and 1864.