

ABSTRACTS OF OTHER PAPERS/POSTERS PRESENTED AT THE ANNUAL CONFERENCE, JANUARY 2004



CHURCH BUILDING STONES IN SOUTH SOMERSET

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It is a curious fact that, whilst we are furnished with the minutiae of church architecture, church guides usually ignore geological aspects except for monuments and fonts. However, in South Somerset the parish churches have now been surveyed. As would be expected, stones show a close correlation with the outcrops of local building stones and are a useful proxy for the distribution of the various building stones. In addition, the information is useful for church restoration and highlights the role of geology in local distinctiveness.

**THE CORNUBIAN OREFIELD:
AN EDUCATIONAL RESOURCE ON THE WEB**

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An abundance of geological, mineralogical, mining and historical literature exists on the internationally important metalliferous mining region of south-west England. Rocks and minerals from the region have been collected extensively for a considerable time, probably ever since the start of mining more than 2000 years ago. Nowadays, a very large number of specimens are in geological and other public museums, academic institutions and private collections worldwide, and especially in Cornwall. Access to new mineral specimens and rocks showing the geological setting of the mineralization is no longer generally available - the metalliferous mining activities having completely ceased. Natural exposures of the ores and related minerals are rare. Collecting is not permitted on most private and public land. It is certainly not to be encouraged, and in any case, what is available does not reflect the accumulated scientific and historical knowledge of the orefield.

A virtual museum of the historic Cornubian Metalliferous Mining Region has been developed and is now established on the internet (www.ex.ac.uk/geomincentre). It contains ten main sections including geology, mineralization, exploration, field excursions, environmental impact of mining, historical, mineral collectors and a mineral gallery. It uses extensive graphics, modern and historical photographs and images of specimens to illustrate all aspects of the geology and mineralization. Field excursions are described with detailed maps. Aspects of the considerable mining heritage are described and illustrated with historical photographs and images of mining artefacts. Examples of all of the major ore and gangue minerals found in the orefield and many of the rare minerals are illustrated in an extensive mineral gallery. This features many rock and mineral specimens from the Camborne

School of Mines Geological Museum, minerals from the Rashleigh Collection of the Royal Cornwall Museum in Truro, and some from the collection of the Royal Geological Society of Cornwall. Although all images are presented as 'thumbnails', each one can be enlarged to show the details of the specimen. An up-to-date bibliography of geological literature on the Cornubian Orefield is included as a downloadable pdf file.

TUFA, A FRESHWATER LIMESTONE: CARBONIFEROUS GEOLOGY AND CONTEMPORARY PROCESSES

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Tufa (or travertine) is a sedimentary CaCO₃ deposit precipitated from calcite-saturated water. Both active and inactive deposits are recognised as having great scientific value for their diverse biota, geomorphology and fossil assemblages. Actively depositing tufa springs in Great Britain are now thought to be in decline as a result of environmental stress and the EU Directive 92/43/EEC, Annex 1 specifies tufa springs as a priority habitat for conservation. A number of tufa springs rising in a Carboniferous Limestone catchment of the Mells Valley, Somerset have been identified by the Environment Agency as "vulnerable" and this study has been designed to investigate contemporary hydro-environmental processes which lead to tufa deposition in these springs. The results of this study will be used to determine an augmentation and monitoring scheme to be put in place should any derogation of the tufa springs occur. A comparative system analysis has been made between one of these springs and a non-depositing spring in a similar, adjacent catchment. Both springs have been anthropogenically modified at different points in their stream channels. Preliminary results indicate chemical, biological and environmental differences which could have implications for the deposition or non-deposition of tufa within the streams.

TOWARDS A MODEL OF COASTAL EROSION FOR WEST CORNWALL

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The purpose of this poster is to stimulate discussion on the coastal evolution of Cornwall among Variscan, Quaternary, and engineering geologists and geomorphologists at the conference. The distribution of evidence for Mid-Late Pleistocene high sea level stands is used as a reference point. The locus of coastal erosion prior to, during, and following these high stands, is reviewed. The potential for 3-D computer coastal erosion modelling is highlighted, particularly as the key parameters used in the simulations can be checked by historical matching.

COPPER MINERALISED WOOD FROM THE MERCIA MUDSTONE GROUP, SOUTH-EAST DEVON

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Well-preserved wood fragments, some in excess of 30 cm long, are present at one horizon at the base of the Little Weston Mudstone Member of the Sidmouth Mudstone Formation of the Mercia Mudstone Group, south east Devon. Initially, numerous wood fragments were recovered from an outcrop and fallen block at Hook Ebb, approximately 500 m west of Weston Mouth. The enclosing marker bed, a laminated green mudstone, crops out over a distance of about 1000 m in the coastal cliffs. Although less abundant, wood fragments and associated copper minerals occur sporadically in the same bed along the outcrop length. The cellular structure of the wood is clearly preserved with chalcocite infilling pore spaces and replacing cell walls although in heavily mineralised areas the cellular structure is disrupted. Inclusions of a copper chloride phase (?atacamite) are abundant within the chalcocite whilst thin rims and vermicular intergrowths of copper oxides and copper chlorides are present throughout. Trace phases include abundant native silver and a silver chlorine-bromine phases (?embolite) which occur as disseminated blebs up to 1 mm in diameter. Argentian chalcocite also occurs as flames and blebs within chalcocite. In addition, a uranium-yttrium silicate, probably coffinite, also occurs as fine filaments rimming chalcocite. It is possible that this wood-bearing bed and its associated mineralisation, may be a useful stratigraphical marker within the Wessex Basin.

VERY HISTORIC PROPERTIES – RAISING THE PROFILE OF GEOLOGY WITHIN THE NATIONAL TRUST

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The National Trust for Places of Historic Interest or Natural Beauty is an independent charity founded in 1895. It now owns more than 240,000 hectares in England, Wales and Northern Ireland, and over 200 buildings of outstanding or historic importance, and over 230 significant gardens. It also owns very significant geology. Much of this was acquired for aesthetic or wildlife conservation reasons, often as part of Enterprise Neptune, the project to acquire as much of the highest quality coastline as possible. The Trust owns over 40% of the Cornish coastline, and parts or all of 48 of the 79 GCRs (Geological Conservation Review Sites) in Cornwall. It also owns part or all of a significant proportion of RIGS (non-statutory Regionally Important Geological/Geomorphological Sites) in Cornwall. Beyond Cornwall the Trust owns a significant proportion of two natural World Heritage Sites designated for geological interest, the Giant's Causeway and the East Devon and Dorset Coast.

In 2003 English Nature part-funded a geological pilot project to see how geoconservation groups were working with the Trust in the SW and to produce recommendations for the whole of England, Wales and Northern Ireland. The project has gone beyond just looking at geological sites per se, into looking at buildings, small objects, education, interpretation and the use of volunteers.

THE LAST 3 YEARS OUT OF 400 MILLION: A PROGRESS REPORT ON STEPS TOWARDS A POTENTIAL PROPOSAL FOR EUROPEAN GEOPARK STATUS FOR CORNWALL

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At the first meeting of the European Geoparks Network in Molinos in 2000, an overview of Cornwall's geology was presented (Macadam, 2003). As well as an outline of the geology, the state of geotourism, geoconservation, and geo-education in 2000 was reported. At the 2001 Ussher Society meeting the new designation was described and discussed (Macadam and Page, 2001). Developments since 2000 are highlighted. These include progress in research, progress in education at all levels from primary to postgraduate, publication of material for local people and visitors (some is available in major European languages), developments in visitor centres, development of a virtual museum of Cornish mining, and an audit of resources for the proposal for World Heritage status for the Cornish Mining Landscape. Much of the material is also available via the world-wide web.

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LOESS-RICH HEAD DEPOSITS, EASTERN LIZARD PENINSULA, CORNWALL

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Loess in West Cornwall occurs as a thin cover over inland bedrock plateaus and is generally perceived as only capping adjacent periglacial head deposits. Recent fieldwork on coastal outcrops of up to 15 m thick 'head' deposits, developed on rocks of the Lizard Ophiolite Complex, indicates that their matrix contains more than 50% loess. Sample grain size modes vary from 10–60 µm, averaging 33 µm. The loessic component is most readily apparent along the coastal sectors dominated by shallow weathering serpentinite and hornblende schists. The 'head' in these areas is confined to the distal end of the coastal slopes. Pleistocene higher sea levels formed compound shore platforms and steep walled coves, subsequently buried by remobilised loess and frost shattered debris from upslope. On the more deeply weathered Crousa Gabbro, loessic head is best developed on the rocky promontories, and passes laterally into more granular gabbroic head exposed in the intervening bays.

THE TRIASSIC-JURASSIC BOUNDARY

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The base of the Hettangian Stage, marking the base of the Jurassic and, *inter alia*, the top of the Triassic, is not yet defined in a Global Stratotype Section and Point (GSSP). Four candidate GSSPs are under consideration by the Triassic-Jurassic Boundary Working Group (TJBWG) of the International Subcommission on Jurassic Stratigraphy. These are in Europe (Somerset, England), North America (British Columbia, Canada; Nevada, USA) and South America (Peru). A summary of the attributes of the four candidate sections in relation to the requirements for selection of a GSSP.

EVIDENCE OF PALAEO, QUATERNARY, ANCHIALINE KARST DEVELOPMENT BELOW PRESENT DAY SEA LEVEL AND ITS EFFECT ON FOUNDATION DESIGN, OF THE RECENTLY REFURBISHED TINSIDE POOL, PLYMOUTH

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Anchialine cave development occurs at the interface between saline and meteoric groundwater zones in a coastal karst aquifer. It has been described in detail for the submerged Blue Holes of the Bahamas and is typified by the concentration of shallowly dipping solution cavities. Anchialine cave development has been described from the karst Middle Devonian limestone aquifer above sea level at Berry Head. Similar horizontal cavities occur above present day sea level in the coastal aquifer of the Middle Devon limestone of Plymouth. Analysis of borehole information from two site investigations along the coastal edge of the Plymouth limestone indicates that concentrations of solution features can also be identified at various levels below the present day sea level. The effects of those cavities on the foundation design of the recently refurbished Lido of Tinside Pool, Plymouth and other structures is discussed. Interpretation of the geotechnical behaviour of sediments infilling the solution features suggests rapid pulses of cave infilling.

TURONIAN FORAMINIFERA OF SOUTH-WEST ENGLAND

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The early Turonian (mid-Cretaceous) marks the highest sea levels and sea water temperatures of the Mesozoic. The foraminifera of the Turonian reflect this with a low diversity benthic fauna and much increased numbers of planktic taxa. This abundant and diverse planktic fauna is characterised by the occurrence of many species normally associated with more southern latitudes, with many of the taxa being at the very northern limit of their distribution. The planktic assemblage can also be used to correlate the successions in southern and southwestern Britain with the standard international zonation; the only part of the UK Cretaceous succession where this is

possible. In the mid- Upper Turonian there is a dramatic reduction of the planktic fauna, which is associated with a change to more nodular, bioturbated chalks that appear to have been deposited in shallower water. This major shallowing event is global in nature and can be identified in a variety of successions world-wide. The successions in Devon (Beer, Hooken, Membury) have a key role to play in our understanding of these global changes in climate and sea level.

THRUSTS, FOLDS AND RAMPS: NORTH SOMERSET, BRISTOL CHANNEL, SOUTH WALES

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Three persistent problems haunt us in the study of Variscan structures north and south of the Inner Bristol Channel: 1. The Cannington Inlier. How to place Carboniferous Limestone some 5 km east of the Devonian Quantock "massif". 2. The sub-Exmoor Thrust. Does it exist? What does it look like? 3. The Watchet – Cothelstone – Hatch Fault. Who is right, Webby (1965: 3 km dextral) or Milliorizos and Ruffell (1998: 14-16 km dextral). This presentation uses, and amplifies the current work by Milliorizos *et al.* (2004) in resolving these problems. Furthermore, we can now gain a picture of the "Bristol Channel Variscides" to the base of the crust. Why are these problems still here? Largely because the structures controlling them are concealed beneath a Mesozoic and Quaternary cover. Offshore seismic reflectors (Bristol Channel) show two major WNW-ESE striking thrusts within the Palaeozoic succession. The Bristol Channel Thrust occurs to the south and the previously undescribed Gravel Margin Thrust has been identified in the eastern part of the inner Bristol Channel and lies to the north (in the footwall) of the Bristol Channel Thrust. These thrusts together juxtapose the contrasting Palaeozoic successions of South Wales and southwest England: they have orientations and geometries typical of several mesoscale thrusts observed and measured at Foreland Point, north Devon. Along-strike structural changes beneath the inner Bristol Channel seen on seismic sections provide evidence for the offshore continuation of the NW-SE trending Watchet-Cothelstone-Hatch Fault and its linkage with the previously described Central Bristol Channel Fault Zone. The Bristol Channel and Gravel Margin thrusts are interpreted to be offset from the Cannington Park Thrust in north Somerset by a 14-16 km dextral strike-slip displacement across the Watchet-Cothelstone-Hatch Fault. The Gravel Margin Thrust and Cannington Park Thrust are interpreted as syngenetic structures linked by their lateral ramp, the Watchet-Cothelstone-Hatch Fault. The structure of the Variscides of the inner Bristol Channel is re-evaluated and new tectonic models presented.

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A TEMPORARY EXPOSURE IN THE MIDDLE AND UPPER LIAS (PLIENBACHIAN-TOARCIAN, LOWER JURASSIC) AT CHAPEL CROSS, SOUTH CADBURY, SOMERSET, U.K.

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Temporary exposures in 1989, during improvements to the A303 highway near South Cadbury (Somerset, UK) revealed a new section in the "Middle" and "Upper" Lias, (Lias Group), including the Thorncombe Sand Member of the Dyrham Formation (formerly "Pennard Sands"), the Marlstone Rock Formation, and the lower part of the Beacon Limestone Formation (formerly "Junction Bed"). Significantly, the Thorncombe Sand Member contained two intraformational pebble beds, which have not been observed elsewhere in south Somerset, although similar features have been reported near Gloucester and Aynho, in Oxfordshire. As Chapel Cross is near an extension of a major regional structure, the Mere Fault, it is possible that the intraformational pebble beds reflect synsedimentary tectonic activity. The Pliensbachian-Toarcian boundary is known to lie in the district within the top 10-15 cm of the Marlstone Rock Bed which is here overlain by black bituminous, laminated shales, the local expression of the well known early Toarcian anoxic event. These organic-rich shales are only locally recorded in South Somerset, and their preservation at South Cadbury may also be related to contemporary movement on the nearby Mere Fault.

THE SUCCESSION OF AMMONITE FAUNAS IN THE LOWER LIAS CLAYS (SINEMURIAN-LOWER PLIENBACHIAN, LOWER JURASSIC) OF EAST SOMERSET (U.K.) AND THEIR CORRELATION WITH THE NORTH WEST EUROPEAN STANDARD ZONATION

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The Charmouth Mudstone Formation in east Somerset, although extensively outcropping in the Vale of Ilchester, is very poorly exposed - as a consequence little has been known about its stratigraphy and palaeontology. However, systematic recording over 40 years, of temporary exposures in the district has now revealed a remarkably complete sequence of ammonite faunas from the Lower Sinemurian, Semicostatum Chronozone to the Lower Pliensbachian, Davoei Chronozone. In particular, many levels have been identified which are missing in major non-sequences in the more famous sections on the Dorset coast, thereby revealing a much more complete stratigraphical sequence than previously acknowledged. Only one subchronozone remains to be conclusively proven - the Aplanatum Subchronozone of the Raricostatum Chronozone - although this could still be due to collection failure as nodular facies do not appear to be present at this level and clay exposures are commonly too degraded to yield determinable specimens. This faunal succession is correlated with a contemporary Standard Zonation for the Lower Jurassic of North West Europe and the significance for regional correlations of the Lower Lias discussed.

BASILINE GEOCHEMISTRY OF DEVONIAN AND CARBONIFEROUS METASEDIMENTARY ROCKS IN CORNWALL

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A total of 468 samples of metasedimentary rocks from across five Devonian-Carboniferous sedimentary basins have been analysed for a suite of 40 major and trace elements. These samples span a range of lithologies and have been taken from locations free, as far as possible, from the effects of weathering and pre-, syn- and post-granite mineralisation. The resulting analyses have been used to establish current baseline levels for the various elements within the metasedimentary rocks across Cornwall and to highlight areas of enhanced background levels of elements that have geological and environmental significance. Interpretation of the dataset is on-going and it is expected to yield, in conjunction with other techniques, important information on the characterisation, provenance and mineralogy of the metasediments. The dataset, which is to be placed in the public domain, will also be of value to those working within environmental planning, hydrology and water supply and the study of metal transfer from bedrock into the biosphere.

SUBMEDITERRANEAN AMMONITE FAUNAS IN THE LOWER TOARCIAN (LOWER JURASSIC) OF SOUTH-WEST ENGLAND AND THE AGE OF THE LOWER TOARCIAN $\delta^{13}\text{C}$ MINIMUM IN EUROPE

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Recent road building schemes and a reappraisal of the only significant surviving exposed section through the "Upper Lias Junction Bed" (= Barrington Member of the Beacon Limestone Formation) in Somerset has confirmed that the ammonite faunas of Lower Toarcian in south-west England have greater affinities to those of the historical type locality of the stage at Touars in western France than to the UK's own classical sections of this age on the North Yorkshire coast. The former faunas are characteristic of a Submediterranean [faunal] Province and the latter are considered to represent a Subboreal Province. The south-west England faunas are here correlated with the established sequence of sub-subchronozonal "horizons" (or zonules) for submediterranean regions and their relationship to northern British assemblages discussed. A lack of appreciation of both the nature of the faunal provincialism demonstrated during the Lower Toarcian of Europe and recent advances in high-resolution correlation using ammonites, has led to a number of assumptions and fantasy correlations being published in connection with an apparent extinction event close to the Pliensbachian-Toarcian boundary and its alleged correlation with a $\delta^{13}\text{C}$ minimum (presumed to be linked to an "oceanic" anoxic event).

**SEQUENCE STRATIGRAPHIC SIGNIFICANCE OF
SKELETAL ACCUMULATIONS:
A CASE HISTORY OF THE WESTBURY FORMATION
(UPPER TRIASSIC, WATCHET, NORTH SOMERSET)**

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Skeletal concentrations ('shell-beds' and 'bone-beds') are relatively rare in siliciclastic mudstone dominated successions. The levels where they occur are commonly interpreted to be significant stratal surfaces within the sequence stratigraphic paradigm. In this paradigm "shell-beds" are widely interpreted to form at sequence boundaries. In contrast there is some debate about the significance of "bone-beds" with some workers arguing they occur particularly at transgressive surfaces and others arguing they have no particularly sequence stratigraphic significance but formed in response to local/regional environmental and taphonomic processes. This paper seeks to address this problem by describing the detailed stacking patterns within a siliciclastic mudstone-dominated succession that contains both 'shell-beds' and 'bone-beds', and interpreting the resulting data both within a detailed sedimentological and sequence stratigraphic framework.

Lithofacies analysis, utilising combined field logging and thin section analyses (optical and electron optical analyses) has been undertaken on 'shell-beds', 'bone-beds', concretionary limestones, calcareous sandstones and mudstone samples collected from the well exposed Westbury Formation (Upper Triassic), at Doniford Bay, Somerset, UK. Using these techniques 8 lithofacies have been recognised in this succession: clay-rich mudstone; silt-bearing, clay-rich mudstone; sand and silt-bearing, clay-rich mudstone; microsparry carbonate cement-dominated mudstone; bioclastic carbonate-cemented sandstone; biolithoclastic packstone; biolithoclastic grainstone; and, intraformational conglomerate.

Within the Westbury Formation, lithofacies and successive units were found to stack systematically into both upward-coarsening and upward-fining successions at a variety of scales. At a 'micro-scale' (10^{-3} to 10^{-2} m) upward-fining and upward-coarsening units were observed within individual thin-sections with for instance sand and silt-bearing clay-rich mudstones fining-upward into clay-rich mudstones. Analyses of successive thin sections revealed that 'small-scale' (10^{-2} to 100 m) upward-coarsening packages separated by intervals where there appears to be rapid fining were also present. At a 'large-scale' (100 to 101 m) both upward-fining and upward-coarsening units were found. Skeletal accumulations and cemented horizons occur at the inflexion points between the 'large-scale' upward-coarsening and fining units with 'bone-beds' being best developed on the tops of 'shell-beds' below much finer grained siliciclastic mudstones. No unequivocal evidence of sub-aerial exposure was found in the studied succession although an angular rip-up clast conglomerate was found associated with the basal 'bone-bed'.

The 'micro-scale' upward-fining and upward-coarsening units are interpreted to be depositional beds variously deposited from waning flow currents (either storms or tides). The 'small-scale' upward-coarsening packages are interpreted to be parasequences and to have formed in response to sediment infilling accommodation space created by relative sea-level change. The 'large-scale' upward-fining successions are interpreted to be transgressive systems tracts, and the 'large-scale' upward-coarsening successions are interpreted as amalgamated highstand, forced regressive, and lowstand systems tracts. Microsparry carbonate cement-dominated mudstone occur at the top of 'large-scale' upward-fining successions at maximum flooding surfaces where there was

sufficient time for bacterially mediated cements to precipitate and infill the majority of the pre-compaction sediment pore space. 'Shell-beds' that occur at the top of upward coarsening successions are interpreted to have been deposited in settings where there was reduced accommodation availability and the sediment was being reworked by storms. The thick 'bone-beds' that overlie 'shell beds' are interpreted to have formed in association with subsequent flooding on the transgressive surfaces. While the thinner 'bone-beds' are interpreted to have formed on marine flooding surfaces between parasequences. Smaller-scale processes such as storms, tides and biological activity also reworked the skeletal accumulations on these stratal surfaces.

**SALTASH COMMUNITY SCHOOL
LIVING EARTH CENTRE – A NEW APPROACH TO
TEACHING EARTH SCIENCES?**

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Young children are fascinated by our living earth. They are interested in dinosaurs, earthquakes and volcanoes, and yet by the time they reach secondary school they have been totally switched off learning about the Earth Sciences. The Saltash Community School Living Earth Centre is in its early stages of planning. We are hoping to get our local academic institutions and the local earth science industry on board to help us create a "specialist" learning centre for the teaching of geology across the age ranges. We want to create a centre where children from our feeder primary schools, other schools within our network learning community and also local clubs and societies can get involved with the subject and we also want to provide a high quality INSET facility for teaching staff.

Support is required to get this project off the ground and we are looking for sponsors and also staff from Higher Education getting involved with the school to further these aims.

**GEODIVERSITY AUDIT OF ACTIVE AGGREGATE
QUARRIES - A PROGRESS REPORT**

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Working quarries offer some of the best and most extensive geological exposures available. They offer a unique opportunity for three-dimensional observation as the geology continues to be revealed by ongoing operations. This detailed information can provide a developing insight to the geology at locations where surface exposure may be poor and interpretation of the underlying geology from surface features alone may be difficult.

The nature of the quarrying business rarely permits detailed geological study other than that necessary for commercial quarry planning required for long term operations. Much valuable geological information goes unrecorded and is therefore lost. In partnership with the Devon Stone Federation, a pilot project has been undertaken during 2003 to collect, collate, investigate, interpret and record available information on diverse features of geological interest revealed in 16 active quarries in Devon. The Devon Stone Federation has strongly supported the project because it will provide each quarry with information useful for educational purposes especially for visitors and for their own staff. Results so far will be summarised at the meeting. Other project partners are Devon County Council, the British Geological Survey and the Mineral Industry Research Organisation. The project is supported by the Aggregate Levy Sustainability Fund.

SEDIMENT CIRCULATION IN BARNSTAPLE BAY AND THE TAW TORRIDGE ESTUARY

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Two issues are addressed in respect of better understanding. The first is the drawing together of all the disparate published and unpublished items of site-specific local work on sediment exchanges. The second is a dedicated embayment-wide "sediment trend analysis", based on the order of 800 disturbed bed samples from the confluent estuaries, beaches and subtidal zone. The results from the latter link together and amplify local site specific understanding. For the first time sand circulation in the offshore zone is correctly documented, as are the exchanges between the coast and subtidal zone. The sand beaches emerge as a source for sand, which is being drawn down and lost into a number of large offshore sediment gyres, which are driven by the wave-induced circulation. The entrance to the Taw-Torrige forms a coastal sediment convergence zone into which coarse sediment is driven from the west and north by the, at times, powerful coastal boundary currents. From this convergence, marine sand is driven up-estuary into the Taw and Torrige.

A legally-binding prohibition on the removal of coastal sand and gravel along and off the beach at Westward Ho! was granted in 1956. Regrettably, it took until 1997 to obtain a comparable ban for Crow Point. The evidence supporting this ban is presented. The prohibition now permits a shoreline management policy in keeping with the needs of this fragile and sensitive coastline.

MICROFABRIC CONTROL OF ENGINEERING PROPERTIES OF KAOLINITIC GRANITE DURING THE CONSTRUCTION OF THE EDEN PROJECT, BODELVA, CORNWALL

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Samples of partially kaolinized granites were observed to swell substantially during the saturation phase of consolidated underturned triaxial tests. Scanning electron microscopy indicated that large kaolin stacks were disrupted by this saturation phase. Microfabric changes were initiated by an increase in pore water pressure. As part of the Eden project a 17 m high structural embankment was constructed in the base of the pit and on similarly partially traditional granite. Biome foundation was constructed on the embankment. The rigorous settlement criteria which applied meant that volume changes on the partially kaolinized granite were critical. To facilitate the construction programme and control critical settlements, band drains were installed into the granites beneath the embankment. The embankments were surcharged by means of a ground anchor arrangement. This paper describes the behaviour of the granite, engineering and monitoring. Correlation between the proposed engineering classification and that of Anderton (1988) is given. Further laboratory work of Bai and Smart (2000) indicated disruption did not occur until excess pore pressures of 200 kN/m² were achieved. Full consolidation modeling by Finite Element Analysis (FEA) was carried out for the design of the proposed new 3rd biome rear retaining wall to model excess pore pressure during proposed construction.

THE LAND'S END GRANITE, CORNWALL: THE EVOLUTION OF A COMPOSITE AND MINERALISED PLUTON

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Analysis of minor and trace elements and growth textures in rock-forming minerals from the Variscan Land's End granite provided new perspectives on the evolution of the pluton and the associated Sn-Cu mineralisation of the St. Just mining district. The marked variation of mica chemistry allows a classification of the intrusive stages of the Land's End pluton into early megacrystic biotite (Mg-siderophyllite) granites, and younger Li-siderophyllite granites, tourmaline granites and albite microgranites. The trace element patterns recorded in K-feldspar megacrysts from different textural varieties of the older biotite granites indicate derivation from a single moderately evolved source though they now occur in different granite fractions among which no equilibrium persists. Geological, textural and mineralogical data confirm that the tourmaline granites evolved mainly from fractionated Li-siderophyllite granites. Fine-grained quartz-tourmaline rocks, which are associated closely with tourmaline granites combine magmatic and hydrothermal features revealed by cathodoluminescence studies of quartz. The smooth transition of magmatic quartz growth into hydrothermal quartz growth at a micro-scale provides evidence of the crystallisation of tourmalinites from a fluid in coexistence with the silicate melt.

SPY IN THE SKY: REMOTE SENSING IN THE ST AUSTELL CHINA CLAY REGION, CORNWALL

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Hyperspectral remote sensing is a new powerful form of airborne remote sensing developed predominantly for environmental monitoring and mineral exploration. The St Austell Granite of Cornwall, UK contains internationally important deposits of kaolin (china clay), the formation of which resulted from the alteration of a composite pluton of mineralogically and texturally different primary granite units. One line of airborne HyMap[®] hyperspectral data was acquired over the china clay region. Images produced by analysis of the hyperspectral data allow for the identification of the different primary granite units and enables fingerprinting of the source of mined waste material as originating from specific pits. Mineral maps illustrating the relative abundance of the minerals: kaolinite, kaolinite with smectite, montmorillonite, muscovite, lepidolite (a lithium mica) and topaz further show the distribution of these minerals. The effect of mining and mineral processing in the china clay region is evident. Waste tips are classified as containing the greatest abundance of mica. This distribution results from the separation of kaolinite during the mineral processing stages. Kaolinite in lower abundance is also identified within these waste areas and is the result of a less than 100% recovery during mining and processing.

ORGANIC MATTER OF THE LIASSIC 'OIL SHALES' OF KILVE, WEST SOMERSET

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In the 1920s there was a failed attempt to exploit the organic rich shales outcropping at Kilve Pill Mouth on the north coast of West Somerset. The enterprise is recorded as a geo-technical 'scam', an attempt by a known trickster to float shares in a largely illusory venture. But why was it such a failure? Olfactory screening of freshly fractured shale gives a clear smell of a rather terpene-rich oil. Collecting some screening data, suggests abundant organic matter (TOC = 4.5 - 7.5 wt%) and a low level of organic maturity, but microscopy and molecular fingerprinting suggests a rather unusual kerogen type. Transmitted white-light microscopy of the isolated kerogens of the laminated and blocky shale shows little preserved algal-derived tissue (alginate), but rather clumps of light brown amorphous matter containing part-degraded tabular darker brown particles and angular to sub-angular grains of fossil charcoal (inertinite). Occasional spores (sporinite) are seen but vitrinite, resinite and cutinite particles are rare. Switching to UV-excitation-fluorescent microscopy provides further characterisation of the kerogen. The brown amorphous masses show dull darker yellow-light brown fluorescence, placing the material in the oil-prone liptinite group. Marine amorphous kerogen at the maturity levels encountered at Kilve, would typically be yellow in transmitted light and display bright yellow fluorescence, deriving from bacterially-degraded algal tissue. Some other origin is indicated for the brown dull fluorescing amorphous clumps of Liassic kerogen at Kilve (and elsewhere in SW England).

As a clue to the origin of the Kilve kerogen, the fluorescence confirms the presence of a few spores, and occasional brightly fluorescing algal particles. Such intense fluorescence is attributable to alginite or resinite, but the diaphanous nature of the particles in transmitted white light indicates the former. The occasional more solid vitrinite particle always appears 'coated' in fluorescent amorphous matter: the inertinite particles appear not to 'coat'. Some dull orange fluorescing spores may be reworked. Brown amorphous kerogen with dull fluorescence could be bacterially degraded ligno-cellulosic tissue from land plants, though the lack of corroborative evidence for terrigenous input to the kerogen allows for another possibility. The organic input is however, consistent with kelp (seaweed), the photic zone of the shallow Liassic seaway containing the gently waving fronds of brown, green or red kelp beds which die to be bacterially degraded in the anoxic bottom waters. Arguably, as a result of this unusual kerogen type being only partially oil-prone, the location has remained as Wordsworth's 'delightful shore'.

SOME ASPECTS OF QUATERNARY GEOLOGY IN SOUTH-WEST ENGLAND

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This presentation reviews the history of Geological Survey practise in respect of the mapping of 'superficial' or 'drift' deposits in SW England. These include Alluvium and River Terrace Deposits as well as periglacial Head deposits. The methodology for mapping the various classes of Head will be discussed, as will some problems in respect of the higher level terraces and 'clay-with flints'. There will be a short review of the BGS Quaternary Methodology and Training Project.

MICHAEL HOUSE AND THE DEVONIAN OF SOUTH-WEST ENGLAND

N.E. Butcher

From the start of his academic career at the University of Durham through to his retirement at Weymouth in Dorset, via Oxford, Hull and Southampton, Michael Robert House (1930-2002) enjoyed an international reputation as one of the world's leading authorities on the Ammonoidea. This was firmly rooted in his work on the marine Devonian of Devon and Cornwall. Beginning in 1956, he maintained an unbroken contribution to the work of the Conference of Geologists and Geomorphologists in the South-West of England and its successor body, The Ussher Society. With a major review of Devonian ammonoid successions and facies published in 1963, his work focussed particularly on the Padstow area of north Cornwall, around Torbay and adjacent to Dartmoor, especially at Chudleigh in south-east Devonshire.

DEVELOPING A CHRONOLOGY FOR THE RIVER TERRACE DEPOSITS OF THE RIVER EXE, DEVON

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The Quaternary record in southwest Britain is dominated by the study of caves, coastal sections, shore platforms and for the palaeoenvironmental record of the regions uplands from recent blanket peat. These features provide valuable insights into aspects of the Quaternary of the region, but attempts to correlate them with the ocean record of OIS has been fraught with difficulty, and reliant on geochronological techniques or mammalian biostratigraphy. Within British and European Quaternary studies, the development of fluvial landforms has been used to successfully link the ocean and terrestrial records. With the exception of the River Axe, there has been little attempt to understand and develop the fluvial record in southwest England. This paper presents the first such attempts, using the Exe basin.

The Exe basin differs from the majority of river systems within Britain as it was beyond the limits of ice advance during the last glacial period. Nevertheless, it has a well-developed series of river terrace deposits, and drains the upland areas of Exmoor and the Blackdown Hills. Unlike many other river systems in Britain there is as yet no clear chronology for these terraces due to a lack of extensive exposures and a dearth of organic material recovered from on or within the sequences. As a first attempt to date some of these surfaces, OSL (optically stimulated luminescence) has been used and fixed points for a chronology have been obtained. Stratigraphic relationships have also been investigated, and the results of further research on higher terrace material will also be used to attempt some correlation with river systems further to the east (Axe and Solent). The valley floor geomorphology has been mapped in six areas, concentrating on the lower three terraces (BGS 1-3). These generally fall with wider basins that are separated by significant valley constrictions. These lower terraces do not show any pronounced altitudinal separation; terrace 4 is the first that is altitudinally separate from the valley floor. A chronology for these lower four terraces will be proposed, and a first attempt to model climatic changes from this chronology will be suggested.