

**ABSTRACTS OF OTHER PAPERS/POSTERS PRESENTED AT THE
ANNUAL CONFERENCE, JANUARY 2008**



SCOTT SIMPSON LECTURE

**FROM DINES TO THE 21ST CENTURY:
PAST ACTIVITY, RESEARCH
AND PROSPECTS FOR METAL MINING
IN SW ENGLAND**

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After the publication, just over 50 years ago, of H.G. Dines two-volume work on the metalliferous mining region of SW England, rises in world metal prices supported a revival of interest in the mining industry of Cornwall and Devon. This occurred in the period from the mid-1960s to the mid-1980s. Geevor and South Crofty expanded production of tin concentrates, Wheal Jane, Mount Wellington and Pendarves mines were brought into production, and there were numerous prospects including the large-tonnage low-grade tungsten deposit at Hemerdon.

This revival fuelled new and important research into the nature and origin of the mineralization, of the Cornubian granites and of the geological framework around them. The scientific studies included structural analysis, mineralogy and petrology, geochemistry, fluid inclusion studies and isotopic dating. As a result of this work, understanding of the mineralizing processes and their relationship with the development of the Variscan fold belt is significantly improved. The history of mineralization in the province now extends from syn- and epigenetic processes recognised in Early Devonian to Early Carboniferous strata, through granite-related hydrothermal events in the Early and Middle Permian, to low-temperature mineralization associated with basinal brines in the Middle to Late Triassic.

This broader and better-understood scenario will assist in the next phase of metalliferous exploration and development in the province, which has already been signalled against the world background of high metal commodity prices.

**TOWARDS A MIDDLE-LATE PLEISTOCENE FLUVIAL
CHRONOLOGY FOR SW ENGLAND:
RECENT WORK BY THE
PALAEOLOGICAL RIVERS OF
SOUTH WEST BRITAIN PROJECT**

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In Britain the majority of Lower and Middle Palaeolithic archaeological finds come from river terrace deposits (Wymer, 1999). Studies of the impressive "staircase" terrace sequences of the Thames Basin and the palaeo-drainage systems of Central and Eastern England largely facilitated by aggregate extraction has greatly increased our knowledge of the Palaeolithic of Central and South Eastern England. Such research has been useful in considering rates of uplift, climatic cycles, archaeological chronologies, and the landscapes of which hominids formed a part. It has also promoted the view that south east England was a major hominid route into Britain.

By contrast the terrace deposits of the South West of England have been little studied largely due to a lack of aggregate extraction. The Palaeolithic Rivers of South West Britain project has employed a range of geoarchaeological methodologies to address questions at different scales, focussing on the rivers Exe, Axe and Otter, and the palaeo-river Washford. Preliminary analysis of the fieldwork results suggested that the evolution of these catchments is complex and that the evolution of the Axe is anomalous. This is important, partly due to the location of the most prolific Middle Palaeolithic site in South West England at Broom in the Axe Valley. Although in general the terrace deposits are less extensive than elsewhere in Britain, vertical and lateral differentiation between terraces does exist and new dates show that some of the middle altitude terraces are as old as 180+ K years. The new chronology, sedimentological studies and GIS analysis have a direct impact on our understanding of the palaeolandscapes of the south west region, and therefore our interpretations of the Palaeolithic.

**IMPROVING HEALTH AND SAFETY PERFORMANCE –
RESEARCH INTO LEADING INDICATORS
AND MANAGEMENT APPROACHES IN THE
MINERALS INDUSTRY**

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The UK quarrying industry has been working hard to improve health and safety. CSM has been conducting research as part of the industry 'Target Zero' campaign of continuous improvement. In this study several factors have been considered. (1) An organisational view of health and safety: this considers the organisational factors that have an impact upon health and safety performance and how these may be used to influence performance. (2) Leading indicators of health and safety performance: arising from field research with a major quarrying company, recommendations have been made to the quarrying industry for areas to work with across the sector in order to raise the overall standard of health and safety management. (3) Behavioural safety: as part of this programme, CSM has been running a research initiative into behavioural safety in quarries in partnership with a quarrying company. (4) Health and safety management systems: following a review of different approaches to health and safety management systems, a Quarry Health and Safety Management System has been developed and is available to the industry. This links outwards from a core of good management practice to very practical field checks that reflect the requirements of the Quarries Regulations 1999 and other important needs in the industry.

**LANDSLIDE MECHANISMS IN THE
MERCIA MUDSTONE GROUP (TRIASSIC) OF THE
EAST DEVON COAST**

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The Mercia Mudstone Group crops out over a distance of 13 km on the east Devon coast between Sidmouth and Seaton, forming steep to near-vertical cliffs up to 100 m high. The bulk of the 450 m thick succession consists of what at first sight appear to be lithologically monotonous red mudstones and silty mudstones. The group has been divided on the basis of gross lithology into four formations and nine members each of which has different bulk geotechnical properties and each of which gives rise to different weathering and cliff profiles. There are few faults in the section and the average dip is low (<1°) with the result that discontinuities along steeply dipping and bedding-related joints are the dominant structural control on cliff falls. Failures in the stronger silty mudstones in the Sidmouth Mudstone and Branscombe Mudstone formations are initiated in the lower part of the cliffs by hydraulic stoping acting on jointing and bedding, and in the upper parts of the cliffs by joint-bounded wedge failures. Thin (<10 mm thick) beds of laminated mudstone in the Dunscombe Mudstone Formation give rise to failures on rotational slip surfaces.

**USE OF THE OBSERVATIONAL TECHNIQUE IN
FACILITATING SITE DEMOLITION AND THE
CONSTRUCTION OF A CONTIGUOUS PILED WALL
INTO THE TOE OF A RECENTLY STABILIZED
COASTAL LANDSLIP AT LYME REGIS, DORSET**

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Landslipping had caused structural damage to two properties in Marine Parade, Lyme Regis. The properties were evacuated and temporarily supported in 2002. This paper presents the geotechnical engineering involved in the construction of a reinforced concrete faced contiguous piled anchored retaining wall. The works included a provision for groundwater drainage and were constructed during the wet winter of 2006 and 2007. Pressure meter testing showed that lateral earth pressures within the landslip albeit close to its toe were significantly higher than at rest pressures. The depths of landslip material which was derived from both Lower Lias clays and the Greensand is approximately 3 m this overlaid the mid Shales-with-Beef Member. The shales slake in water.

The engineering rational included design with prediction of lateral wall displacements. Base line monitoring for pore water and displacement were carried out and maintained during the works as part of the observational approach used.

**USE OF REMOTE MAPPING TECHNIQUES FOR
ROCK MASS CHARACTERISATION**

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The use of remote techniques to capture the geometrical characteristics of rock masses has seen increased use and development in recent years. Apart from the obvious improved Health and Safety aspects, remote techniques allow rapid collection of digital data that can be subsequently analysed to provide input parameters for a variety of geomechanical models.

Recent research at the Camborne School of Mines, University of Exeter, has focussed on comparison of different remote data capture techniques for effective rock mass characterisation in order to quantify their benefits and limitations whilst comparing them with conventional mapping. This paper describes the results of a detailed comparison between hand-mapping, terrestrial photogrammetry and high definition surveying (laser scanning) methods of data collection. The key advantages of remote techniques are their speed, greater area coverage and ability to map inaccessible areas. Automated analysis of data is, however, not yet recommended and there is still a need for educated users to provide manual intervention, spot checks and associated interpretation. Experience suggests that there is also a need to establish a representative scale of measurement, so that key features of the rock mass are captured and incorporated during the characterisation process.

**THE CHRONOLOGY AND KINEMATICS
OF D₃ DEFORMATION AND ITS RELATION
TO THE EMPLACEMENT OF THE
LAND'S END GRANITE**

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The chronology of emplacement of the Land's End Granite and D₃ post-Variscan extension has been established by large scale field mapping of metasediments at Priest's Cove and Porth Ledden on the western margin of the contact aureole. Deformation phases in the contact aureole were referenced to a south coast section between Loe Bar and Megiligar Rocks which clearly displays the tectonic history of D₁ and D₂ Variscan convergence deformation, D₃ post-Variscan extension and D₄ late E-W shortening. The data set from the south coast was applied to the heavily thermally metamorphosed hornfels of the Mylor Slate Formation close to the contact with the Land's End Granite. Both the S₁-S₀ and S₃ fabrics are NW-dipping on the western margin of the pluton, whereas they dip SE (S₁-S₀) or are flat-lying (S₃) on the south coast. Also, there is an apparent anticlockwise rotation of both D₂ structures (F₂ folds and S₂ cleavages) and D₃ structures on the western margin of the pluton. These are interpreted as granite emplacement causing both inflation of the hornfels host rock, and the anticlockwise rotation of D₂ and D₃ structures observed at Cape Cornwall. D₃ deformation appears to pre-date granite emplacement. This is confirmed by the vergence of folds on the west coast, and by granite veins seen to intrude both existing S₃ cleavage and cross-cut existing F₃ folds.

**SOME MICROSCALE ANALYSES
OF PERIGLACIAL AEOLIAN SANDS
IN WEST CORNWALL**

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In west Cornwall, aeolian sands that are interbedded with solifluction breccias (periglacial slope deposits) are often observed within the Quaternary sedimentary record of coastal lowlands. These aeolian sands are usually located towards the bottoms and tops of the solifluction units (and sometimes as stringers and lenses between individual breccia beds), and reflect periods of enhanced wind activity over stable land surfaces. As such, the accumulation of aeolian sand represents a transient landscape response to climatic disturbance that usually terminates as land surface destabilisation (climate cooling) or soil/vegetation development (climate warming) takes over. It is uncommon, therefore, for thick sand sequences to accumulate, hence the potential importance of multiproxy microscale analyses to characterise and thus identify aeolian sands. Some preliminary results of microscale analyses of aeolian sands are shown from Pendower (which shows clear outcrop-scale evidence for wind deposition), and from Godrevy, whose outcrop-scale evidence is less clear. Some climatic and palaeoenvironmental deductions are presented based on evidence from these two sites.

**THE TECTONICS OF MINERALIZATION
ASSOCIATED WITH THE
LAND'S END GRANITE**

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Granite-associated mineralization across SW England is diachronous, and reflects a complex interaction of magmatic, hydrothermal and post-Variscan tectonic processes over *c.* 40 Ma. Previous models invoking contemporaneous batholith-wide stages of mineralization (e.g. Dines, 1934, 1956; Moore, 1975) are unsustainable. Mineral vein geometries, kinematics and relative chronologies in the Land's End Granite have been re-assessed and do not support the hypothesis of an approximately synchronous radial fracture system (Moore, 1975). Instead, data are consistent with repeated changes in the regional/local stress regime during pluton assembly and the release/mixing of magmatic-hydrothermal and other fluids.

The data presented here, when combined with published geochronological data (e.g. Chen *et al.*, 1993; Chesley *et al.*, 1993), indicate the Land's End Granite evolved as follows: (1) Emplacement of the Zennor Granite, ~275 Ma, followed by the St Buryan Granite, ~274 Ma. (2) Formation of ENE-WSW trending schorl veins, across the Zennor and St Buryan granites, under conditions of NNW-SSE extension. The emplacement of the St Just Granite. (3) ENE-WSW shortening (D₄ of Shail and Alexander, 1997); formation of E-W veins with sinistral displacements. (4) Transition to N-S shortening (D₅ of Shail and Alexander, 1997). Mineralization associated with the St Just Granite in NW-SE and NNW-SSE trending fractures. Early movements are strike-slip dominated (Garnett, 1961, 1962; Jackson, 1977), but most Sn-Cu mineralization is associated with ENE-WSW extension. (5) Formation of iron-rich, jasper-quartz-siderite infilled guides under NE-SW shortening (Garnett, 1962) or N-S shortening; these structures fault lodes sometimes host Sn-Cu mineralization. (6) Quartz-infilled N-S trending tensile veins cut all other vein sets; their timing is unconstrained but may be an early expression of 'cross-course' mineralization in the Middle Triassic (Scrivener *et al.*, 1994); this is a province wide ENE-WSW extensional event recorded by lower temperature chalcedony-dominated assemblages and a hydrothermal overprint (secondary clays) within the optimally orientated lodes around St Just. The 'anomalous' orientation of the majority of the Sn-Cu lodes around St Just (and elsewhere around St Austell) reflects a coincidence between the latest stages of magmatism and a changing regional stress regime.

RHENOHERCYNIAN PASSIVE MARGIN EVOLUTION IN SW ENGLAND

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Mapping and research in the province over the last 25 years has refined understanding of the Rhenohercynian in SW England. Its passive margin developed over ~80 Ma from the Lochkovian and involved sequential northwards formation of sedimentary basins. Convergence and closure of the southernmost Gramscatho Basin (and Lizard 'ocean') from the late Eifelian, continued for some 30 Ma, and was contemporaneous with rifting further north. The onset of continental collision was marked by the emergence of nappes, comprising, upwards, deep marine sedimentary and volcanic rocks, oceanic lithosphere pre-rift basement, and upper plate high-grade gneisses, onto the passive margin by the earliest Carboniferous. Deformation migrated through the margin during the Dinantian and early Namurian (~30 Ma) inverting the rift basins filled with Devonian deposits and the southern parts of the Carboniferous Culm Basin. Styles of deformation, including 'facing confrontations', were largely determined by basin geometry. The Culm Basin rift became a late Namurian-Wesphalian foreland basin with its sediments, derived from east and north, probably products of movement and overthrusting along the Bristol Channel-Bray Fault. As this basin locked, late in the Westphalian (c. 305 Ma), province-wide deformation occurred and the Silesian fill of the Culm Basin was inverted and deformed for the first time. Latest Carboniferous regional extensional structures continued to reflect the influence of the earlier basinal architecture. It is unclear how recent models invoking Middle Devonian northwards subduction of the Rheic Ocean, as a cause for Acadian deformation in Wales, can be reconciled with synchronous passive margin development in SW England.

PUBLIC DOMAIN GEOLOGICAL DATA FOR CORNWALL IN THE AGE OF GOOGLE EARTH

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The advent of Google Earth (and similar products) has revolutionised the availability of non-copyright topographic data using high resolution air photography and LANDSAT data. It is relatively straightforward to add (mesh) user defined data, locations and photographs. The easy availability of geological data would encourage more interest in geology amongst the general public and in schools. There have been some attempts to add data for Cornwall, in particular, the location of mines, but these are, like much of the data on the internet, partial and flawed. An initial attempt to add comprehensive data on mineral vein location for Cornwall will be discussed, as will possible sources of non-copyright geological mapping and the scope for further work.

THE ENGLISH RIVIERA EUROPEAN GEOPARK: GEODIVERSITY AND COMMUNITY IN TORBAY

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In 2007 Torbay became SW England's first European Geopark, a designation recognised by UNESCO. The area has a rich and well-exposed geological heritage, from Devonian reefs to Pleistocene bone-caves, with strong links to the cultural history of the region. Not surprisingly, Torbay includes one of the highest concentrations of protected geological sites in the UK with 11 nationally protected Sites of Special Scientific Interest and at least 14 County Geological Sites (or 'RIGS'). Every year, large numbers of educational groups visit the bay and use this resource and the area is ideal as a base for heritage tourists exploring other areas of south-west England. With the establishment of the Geopark, new approaches to presenting geological interpretation are being developed – the concept of a Geopark as promoting the sustainable use of a geological resource being extremely relevant in the context of existing nature conservation strategies and philosophies within the bay. Crucially, the Geopark has the potential to become a framework for other heritage tourism initiatives in the area and an identity through which Torbay can be identified globally for the excellence of its facilities. The unique combination of a superb geological resource, well developed site management frameworks, established tourism facilities and partnerships between the public, private and voluntary sectors makes Torbay well placed to develop a dynamic and successful Geopark, promoting geological heritage and sustainable development for the 21st Century.

GEODIVERSITY AND CONSERVATION IN DEVON: INTEGRATED APPROACHES TO HERITAGE MANAGEMENT

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The conservation of bio- and geodiversity in Devon is integrated, reflecting long established principles in UK practice, as recently confirmed by the central Government Planning Policy Statement 9, on Biodiversity and *Geological Conservation* (2005). This process is underpinned by the Devon Biodiversity Action Plan, first established in 1998 and revised in 2007, which informs similar integrated nature conservation action plans elsewhere within the boundaries of the historical county. The document includes 40 action plans to guide the management of key 'habitats' within the County, 10 of which have significant or dominant geological components (such as quarries, caves, cliffs, mines and periglacial landforms). A range of other initiatives also contribute to the process of raising awareness of and managing the County's rich geological heritage, including the ongoing work of the Devon RIGS Group, geodiversity audits and interpretative and educational provision by local authorities and trusts. In several cases, these projects have been integrated with historical and archaeological initiatives, for instance within the Mining Landscapes World Heritage Site in West Devon and the national Palaeolithic Rivers project. This range of initiatives will be reviewed and demonstrates the truly holistic approach to heritage conservation that is now developing within the county.

**REDCLIFF POINT, WEYMOUTH, DORSET,
SW ENGLAND AND SAVOURNON, SERRES,
HAUTE PROVENCE, SE FRANCE:
CANDIDATE GLOBAL STRATOTYPE SECTION
AND POINTS (GSSP)
FOR THE BASE OF THE OXFORDIAN STAGE
(UPPER JURASSIC)**

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In the global search for a stratotype at which to define the base of the Oxfordian Stage and hence the base of the Upper Jurassic, two candidates remain: Hamcliff near Redcliff Point, Weymouth, Dorset (SW England) and the Peyral section, near Savournon and Serres, Haute Provence (SE France). Both sites show an expanded sequence in mudrock facies across the Callovian-Oxfordian boundary and both have now provided a range of stratigraphically useful data which can aid the correlation of the base of the latter stage. First and foremost are the ammonite faunas, which although having overall characteristics typical of different faunal provinces, include a remarkably detailed sequence of cardioceratid species which, by convention, are used to correlate the boundary. Crucially, both sites have now yielded the basal Oxfordian indicator species *Cardioceras redcliffense* Page, Meléndez & Wright so can be correlated precisely. In addition, supporting geochemical and micropalaeontological information is now available from both sites, although only the Redcliff section has yielded magnetostratigraphical results. The results from both sites will be presented and discussed in the context of their suitability as GSSPs for the base of the Oxfordian Stage. Formal selection of a GSSP, however, must wait until later in 2008 when both sites will be presented to the International Subcommission on Jurassic Stratigraphy (ISJS) in 2008 as part of a voting process, with ratification of the successful candidate GSSP expected at the International Geological Congress in Oslo later in the year.

**THE CORNISH BUILDING STONE
AND SLATE GUIDE AND ASSOCIATED
PLANNING CONSIDERATIONS**

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The Cornish building stone and slate guide was produced as a handbook for developers, architects and householders on where to source new and reclaimed building stone and slate. It also includes information on local stonemasons and other skilled trades associated with the working of natural stone. Information on training courses available is also included. The aim of the document is to promote local distinctiveness and reduce distance materials are transported. Policies produced by the mineral planning authority (Cornwall County Council) underpin the aims of the guide and a brief overview of associated planning matters is given.

**LOWER JURASSIC MUD VOLCANOES
AND METHANE,
KILVE, WEST SOMERSET**

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A series of mud volcano structures from Kilve, west Somerset, UK are described. They occur within the *Psiloceras planorbis* ammonite zone of the Lower Jurassic (Hettangian) Blue Lias Formation. The flanks of each of the three mud volcanoes consist of micritic limestone and alternating shale beds, whilst tufa-like deposits cap the top of each structure. Two of the mud volcanoes contain a mud breccia which includes dark grey lithoclasts, red mudstone clasts and abundant crinoidal fragments together with an abundance of the benthic foraminifera *Involutina liassica*. Evidence for methane associated with the mud volcanoes is derived from the isotopic analysis of the tufa deposits. All three structures yielded very negative $\delta^{13}\text{C}$ values (-21.4 to -32.4‰), which are considerably lighter than associated sediments. Such negative $\delta^{13}\text{C}$ values typically occur when authigenic carbonates incorporate variable proportions of carbon derived from the anaerobic oxidation of methane. Relative to modern mud volcanoes the structures present in Somerset are small, which may indicate limited activity and limited volume extruded. Much methane released from submarine mud volcanoes is commonly oxidised, as evidenced by the tufa caps at Kilve. Hence in conjunction with low activity levels this may suggest that only a modest amount of methane may have reached the atmosphere during the Jurassic from this source.

**THE STRATIGRAPHY OF THE
CHARMOUTH MUDSTONE FORMATION
(LOWER JURASSIC) OF THE VALE OF ILCHESTER
AND ADJACENT AREAS
(SOMERSET, SW ENGLAND)**

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Although famously well exposed on the West Dorset Coast, inland in SW England the mudrocks of the Lower Jurassic, Charmouth Mudstone Formation are poorly exposed. Not surprisingly, details of their stratigraphy and faunas have consequently remained poorly known. The systematic recording of temporary exposures in excavations in southern and eastern Somerset by HCP over 40 years, has however, now revealed one of the most complete sequences of ammonite faunas known in Europe for the Upper Sinemurian and Lower Pliensbachian stages. These results have now been supplemented from other temporary section records including by KNP and Mr M. Harvey, Chilthorne Damer. Additional information is available from other sources. This succession can be correlated with that known on the Dorset coast and key areas elsewhere in the UK and across Europe to provide a high-resolution time-scale against which other Lower Jurassic processes and events, including sedimentological and tectonic, can be accurately compared.

THE WATER ISSUE IN JERSEY: 1987 TO 2007

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A significant number of private and commercial boreholes have been sunk in Jersey during the last 40 years, and concern about over extraction increased over the years, until the issue was taken up seriously in the last years of the 1980s by the Public Works Department of the time. The British Geological Survey (BGS) was employed to research the groundwater potential and assess its ability to satisfy estimated demand. A vociferous group of water diviners and borehole drillers were resolutely opposed to any restriction on what they considered an unlimited supply of water recharged from France. Another group, consisting of local geologists, was appointed to advise on the work of the BGS.

A water law was finally agreed and implemented by the States of Jersey in the summer of 2007, but only after a protracted series of reverses, occasioned by the differing views of the water diviners and borehole drillers on the one hand and geologists and the staff of the Public Works Department on the other.

The experiences of the geologists, during their efforts to convince sufficient politicians of the need for a water law to safeguard the island's aquifer, raise issues that are considered of real importance to scientists of whatever discipline when confronted by persons or groups using a different set of criteria, ultimately non-scientific, to form their opinion.

A NEW STUDY OF PLEISTOCENE SEDIMENTS ALONG THE NORTH DEVON COAST

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This paper presents some of the recently discovered, and re-discovered Pleistocene sediments which can be found in pockets along the North Devon coast which have prompted a project re-examining the Pleistocene history of this area. Previous studies of supposedly glacial or proglacial sediments near the coast have been used as evidence for postulating a glacial limit adjacent to the coast during the middle-late Pleistocene. Both the postulated sedimentary environment and age of these sediments has been controversial. It is also not easy to reconcile the most commonly quoted age and genesis of the North Devon sediments, especially those in the Barnstaple area, with recent work in South Wales, the north coast of Cornwall and the Scilly Isles. The paper presents preliminary work on these new sedimentary deposits in the Lynton area and outline future plans for the project. The area and the questions these deposits raise are regionally important as the location of ice sheet margins in the Northern Hemisphere is an important boundary condition in global climate modelling of past climatic fluctuations in the Pleistocene.

THE GEOLOGY OF PENLEE QUARRY ITS IMPACT ON PREVIOUS QUARRYING AND FUTURE USE

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This paper sets out the geology of the currently dormant Penlee Quarry that lies just south of Newlyn, Cornwall. It largely comprises a dolerite altered by low grade metamorphism with two distinct phases of later mineralization. The quarry is a Geological SSSI designated in 1997 due to its diversity of mineralization types, having been identified in the JNCC book on Igneous Rocks of SW England (1993). This paper sets out the findings of a more detailed investigation of the features of geological interest appropriate for geoconservation undertaken on behalf of the quarry owners, MDL Developments Limited.

Quarry development started in the late 1880s near Newlyn as a hillside operation advancing to the west and subsequently south. The impact of geological features and related geotechnical constraints on subsequent quarry development is outlined. The rock has a characteristic high density of ca. 2.95 t/m³ and for England, an exceptional strength of up to 350 MPa. Workings ceased in the early 1990s due to a combination of problems relating to access and transport, and to the non-acceptability of the aggregate for road surfacing due in part to its low PSV. In 1999 planning permission was obtained for revised conditions that permitted the further extraction of 28 Mt of rock, extending to a depth of 100 m below sea level. In practice little is recoverable under the constraints of the Quarries Regulations 1999.

The intended future after-use of the quarry is as a marina with housing and commercial development following the production of armourstone for nearby coastal works, during which further development benches will be formed. The geotechnical and other controls on this proposed development is outlined.