ABSTRACTS OF OTHER PAPERS READ AT THE ANNUAL CONFERENCE, JANUARY 1999

CARBONIFEROUS GONIATITES, TECTONIC STRUCTURE AND STRATIGRAPHY IN PINHOE BRICK PITS, EXETER, DEVONSHIRE

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Studies of the now disused and the present working brick pits at Pinhoe on the eastern edge of Exeter over 41 years show that these provide important sections for the understanding of the tectonic structure and stratigraphy of the Carboniferous rocks of SW England. Crucially, the now disused Pinhoe brick pit provided in 1957 a key section for the relationship between the Carboniferous rocks and the overlying New Red Sandstone.

FAUNA OF THE LATE DEVONIAN SALTERN COVE GONIATITE BED, GOODRINGTON, DEVON

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The recognition by J.E. Lee in 1877 of goniatites at Saltern Cove (Waterside Cove), which he related to the fauna at Bildesheim in the Eifel, Germany, was the first evidence for Upper Devonian in southern England. Van Straaten and Tucker in 1972 showed that the goniatite fauna was in an intraformational slump of Famennian age. The goniatite fauna is of latest Frasnian date and includes *Tornoceras, Aulatornoceras, Archoceras, Manticoceras, Serramanticoceras, Delphinites, Crickites* and a new genus and species. The fauna is described and the stratigraphic source related to the modem international Frasnian zonation.

GEOLOGICAL INFLUENCES ON CLIFF STABILITY AND EROSION OF THE CORNISH COAST.

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Cornwall is generally considered to be a hard-rock county and therefore not subject to coastal cliff erosion in the same way as, for example, the south-eastern parts of England. A complete survey of the coastal cliffs of Cornwall in 1997-98 as part of shoreline management planning has revealed the enormous variation in rates and styles of cliff instability. The geological influences on these variations are partly lithological and partly structural as far as solid geology goes; they are also the result of coastal exposures of Quaternary deposits and geomorphological features.

The most rapid rates of cliff retreat (averaged over 100 years) are estimated to be of the order of 0.1 m/yr. and occur in cliffs of periglacial solifluction deposits (head) and raised beach deposits. The Upper Carboniferous mudrocks of part of the North Cornwall coast are the most susceptible to erosion of the bedrock lithologies and rates there are thought to be up to 0.03 m/yr. The highly fractured nature and dipping structure of the Palaeozoic strata give rise to spectacular individual landslides ranging in style from deep-seated planar rock slides to toppling and rock falls. The rectilinear joint pattern and less tectonised fabric of the granite leads to a distinctive and more resistant style of cliffs in coastal exposures of that rock type; A system of classification and hazard zonation of the cliffs has been devised for shoreline management planning in areas such as Cornwall.

HYDROCARBON SEEPS OF THE WESSEX BASIN

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The Wessex Basin is composed of a series of Mesozoic extensional sub-basins covering an area of onshore Southern England and extending into the English Channel. Initial oil exploration in the 1930's was triggered by hydrocarbon seepages and surface anticlinal features. The area presently contains three producing oilfields; Wareham, Kimmeridge and western Europe's largest onshore field at Wytch Farm.

The presentation will discuss the nature of the oil seeps which are located at several locations along the coast (Osmington Mills, Mupe Bay, Lulworth Cove, St. Oswalds Bay & Worbarrow Bay). The oil seepages all occur in northerly dipping beds to the south of major faults and are considered to be sourced from the mature Lower Lias to the south of the Purbeck-Isle of Wight disturbance.

The oil seeps at Osmington Mills will be discussed in greater detail. Oil impregnations occur in the sandstone of the Late Jurassic Bencliff Grit with up to 12% oil yield. A small but active seepage of free oil also occurs where these beds pass below the level of high tide near the crest of an ENE plunging anticline.

THE WORLD OF KAOLIN — SOUTH-WEST ENGLAND'S CURRENT STATUS

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A brief review will be made of the world's leading producers of high quality kaolin covering the well established and newly emerging countries. The traditional kaolin producers from the USA and UK continue to supply approximately over 45% of the world's high quality kaolin but over the last 10 years countries such as Brazil, Indonesia and the Ukraine are fast developing their own deposits mainly for export.

A brief description will be given on the nature of some of these deposits and the particular markets they are, or hope to, sell to.

The deposits from SW England continue to be extremely important in creating wealth for the local economy and. despite the continuing threat from new kaolin deposits and other pigments (calcium carbonate, talc and precipitated calcium carbonate), are maintaining their competitive position. The search for new kaolin deposits by detailed exploration has reached a peak during the last five years — the main effort in future, on both well known and new deposits, will be in detailed mine planning, optimisation of the deposit and cutting costs and improving distribution channels to remain competitive. Research and Development into new products is increasing with the industrial minerals business now being driven by the high quality demanded by the customer.

THE ENVIRONMENTAL IMPACT OF MINING ON THE FOWEY ESTUARY, CORNWALL

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In order to assess the impact of historical mining on sediment supply to the Fowey Estuary, Cornwall, we have recovered 17 cores from the inter-tidal mud/sand flats in the upper reaches of the estuary. After detailed description, each core was sub-sampled at 5 cm stratigraphic intervals. Each sub-sample has been analysed by XRF for Sn, Cu, As, W, Zn and Pb. The mineralogy of the cores has been examined using scanning electron microscopy and x-ray diffraction. Although variable, many of the cores show a clear peak in Sn concentration with maximum Sn values of up to 1210 ppm at a depth of approximately 60 cm below present day sediment surface. The heavy mineral fraction is dominated by zircon, tourmaline, cassiterite, ilmenite, rutile, chalcopyrite, galena, arsenopyrite, pyrite, apatite, xenotime and monazite; importantly mine smelt products also occur. In comparison with work on the Fal Estuary, the cassiterite is coarser grained (average 35 mm) and occurs as both liberated grains and locked within silicate hosts. We interpret this geochemical peak as representing a major input of tailings and smelt products in to the estuary. Preliminary dating of one of the cores using ^{210}Pb and ^{137}CS suggests a sediment accretion rate, of 3 mm/yr. implying that the pulse in mine waste contamination dates to approximately c.1800.

DEEP LEACHING OF ATRAZINE AND WATER FLOW THROUGH THE UNSATURATED ZONE ABOVE A REGIONAL GROUNDWATER RESOURCE IN THE SOUTH WEST OF ENGLAND.

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The Otter Valley Triassic Sandstone aquifer is situated 10 miles to the east of Exeter and is the main water resource for East Devon. The predominant land use within the catchment is agricultural with a widespread use of fertilisers and pesticides. The extensive use of the herbicide Atrazine on maize has lead to concentrations in the groundwater which have exceeded the EC limits on several occasions culminating in one borehole being permanently taken out of service. The origin and pathways of Atrazine into the groundwater are currently unknown and no information is available on how much non-point source pollution, point source pollution and the infiltration of surface water into groundwater contribute to the overall problem. The phenomenon of contaminant flow cannot be explained without the knowledge of the physical properties of the unsaturated zone above the groundwater table. Rate and timing of recharge, preferential flow and chemical properties of the soil are important factors in the leaching behaviour of any contaminant. In this study extensive field experiments have been undertaken to investigate the recharge to the groundwater and the real leaching potential of Atrazine.

MANTLE CONTRIBUTIONS TO PERMIAN GRANITE MAGMATISM AND MINERALIZATION IN SW ENGLAND - A PRELIMINARY HE ISOTOPE STUDY

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A mantle component within the Permian granites of SW England has been previously inferred on the basis of wholerock geochemistry, Sm-Nd isotope systematics, enclave compositions and a close spatial and temporal association between granite magmatism and volumetrically minor mantle-derived volcanics (e.g. Leat *et al*., 1987; Chen *et al*., 1993; Darbyshire & Shepherd, 1994; Stimac *et al*., 1995). Although the evidence remains largely circumstantial, the recognition of such a mantle component has significant implications for models of both granite generation and associated magmatic-hydrothermal W-Sn-Cu mineralization.

We have tested the mantle component hypothesis by analysing the He isotopes in volatiles hosted by fluid inclusions in wolframite/arsenopyrite separates from magmatic-hydrothermal veins (quartz ± k-feldspar ± wolframite ± arsenopyrite ± chalcopyrite). These represent paragenetically early mineralisation associated with the Land's End (Geevor Mine), Carn .Brea (South Crofty Mine), Cligga Head and Hingston Down granites.

Where fluid inclusions are trapped by dense U- and Th-poor minerals, the outward diffusion rate of He is low and the isotope ratios are essentially unmodified from the time of trapping (Stuart *et al*., 1995). Subcontinental lithospheric mantle is characterised by ^{3}HeI/^{4}He of 6-8 Ra (atmospheric ratio), whereas crustal radiogenic He is charactensed by ^{3}He/^{4}He of approximately 0.01 Ra. As a consequence, ^{3}He/^{4}He is a sensitive indicator of the presence of mantle-derived volatiles in crustal fluids.

Four of the five samples yield ^{3}He/^{4}He (0.2 - 2 Ra) that can only be accounted for by the presence of mantle He. This is the first unequivocal evidence for a mantle source for volatiles in the fluids associated with the Permian granites of SW England. The high diffusivity of He, and its likely transport in a gas phase, decouples ^{3}He/^{4}He from conventional tracers of fluid sources and hydrothermal fluid-rock interaction (e.g. L^{18}0; Stuart *et al*., 1995). The high ^{3}He/^{4}He of fluid inclusions do not require that SW England granites are composed of mantle-derived material, or even that the aqueous fluids are mantle-derived, but they are indicative of a (partial) mantle source for the heat responsible for the crustal melting which formed the Permian granites.

WHERE ARE THE CORNISH MINES (ENVIRONMENTAL PROBLEMS) OF TOMORROW? THE GEOCHEMICAL EVIDENCE.

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Although there have been a large number of geochemical surveys of Cornwall, there is no single source that details the known geochemical anomalies. Most of these anomalies have been followed up by drilling or further sampling and this data is often difficult to access. This study attempts to put together the data available on open file or in theses to build a comprehensive picture, together with a large amount of sampling collected by the author. These data have been entered into a Geographical Information System as this method is ideally suited to the task with the ability of handling both quantitative data and semi-quantitative patterns. Overlaying different surveys provides confidence in interpretation. The data have been interpreted using digital elevation models from the ordnance Survey as well as Landsat and SPOT imagery. Digital coverage of geology, known veins and mining output have been used to highlight or eliminate previous mining. The data highlight a number of areas away from known mineralisation in North Cornwall as well as better known areas in West Cornwall. User input is requested to improve the coverage and it is intended the non-copyright parts of the database will be freely available.

GOLD MINERALISATION IN THE EXETER VOLCANIC ROCKS

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Exploration for gold within the Crediton Trough has been undertaken by Crediton Minerals Plc following-up the drainage and lithogeochemical anomalies indicated by the Mineral Reconnaissance Programme (MRP) undertaken by the British Geological Survey on behalf of the Department of Trade and Industry. To date, 16 cored boreholes, all at 100mm diameter, have been drilled in the target, a sill of alkali basalt which crops out in the northern part of the Crediton Trough to the west of the village of Thorverton. Elevated gold values have so far been reported from an area measuring 150m x 500m. Two of the boreholes assayed 3.63 g/tonne Au (mean) and 3.36 g/tonne Au (mean) over core lengths of 0.9m and 1.9m respectively both at depths of almost 30m: the maximum assay value recorded was 7.03 g/tonne over 0.45m. Elsewhere in the basalt, elevated gold values up to 180 ppb were recorded. Three other boreholes also showed elevated gold values of up to 400 ppb over core lengths of up to 7.6m. The higher assay values are associated with native gold in narrow, subvertical carbonate veinlets cutting the basalt host rock in the lower part of the sill. Integrated petrographic and fluid inclusion studies have demonstrated that the auriferous veinlets comprise multiple generations of dolomite and calcite that were deposited from cool (<130°C) highly saline brines. Results are awaited from the most recently drilled boreholes which encountered the basalt, with similar subvertical carbonate veinlets, at depths up to 100m below surface.

ENGINEERING GEOLOGY OF PLYMOUTH

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The main problems relating to geology include limestone cavities, steep rock faces, other steep slopes subject to failure, waterlogged deposits and the potential for block failure in deep excavations. The Devonian slaty mudrocks and associated sandstones, volcanics and limestones generally provide reasonably safe foundation and slope conditions. In the past they have also provided a variety of construction materials. Limestone provides excellent conditions except where karstic features are encountered. Cenozoic tectonics and sometimes load release have formed joints and crushed zones introducing stability problems during excavation of the older rocks. Extensive deep weathering of the pre-valley landscape, and the subsequent valley formation and Quaternary erosion and soil forming processes have resulted in a wide range of depth of poor-quality ground-surface materials. These materials are presently stable under natural conditions, but may cause minor problems for small structures and are usually removed or penetrated by piles for major ones. Old waste fills and World War Two bomb rubble require considerable care even for small building construction.

MINERALIZATION AND STRUCTURE OF CALC-SILICATES AND METAPELITES AT TRELIVER, RUTHVOES, MID-CORNWALL.

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Soil geochemistry revealed a significant anomaly in the Treliver area. Follow-up trenching and diamond drilling confirmed that the underlying rocks were mineralized. Sn values lie in two fracture systems which are N/S and NW/SE trending, with the mineralization hosted in metapelites and calc-silicates. Both brittle fracture, semi-ductile fracturing and chevron and similar folding have occured.

RELATIVE CONTRIBUTIONS OF TOP SOIL AND BEDROCK SOURCES TO FINE-GRAINED FLUVIAL BEDLOADS IN AGRICULTURAL CATCHMENTS WITHIN SW ENGLAND

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Magnetic characterisation of environmental materials provides a rapid and sensitive method of tracing sediment pathways in hillslope and fluvial systems. Soil materials have distinctive magnetic signatures which allow their detection in fluvial bedload and suspended sediments. In particular, the top soils frequently have higher magnetic susceptibilities (c) than the underlying parental bedrock and lower soil horizons.

Analysis of cultivated top soils and fine-grained (<2 mm) fluvial bedloads in the Dawlish Water (Devon) and Polperro (Cornwall) allows the relative contributions of pedogenic and lithogenic sediment sources to be assessed. Both catchments are developed on sedimentary bedrock. Significant frequency dependency of magnetic susceptibility (c_{FD}) in the soil materials suggests that their magnetic properties are dominated by the presence of ultrafine (superparamagnetic)