

**ABSTRACTS OF OTHER PAPERS READ AT THE ANNUAL  
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**KAOLINIZED AUREOLE ROCKS ON THE NORTH SIDE OF  
THE ST AUSTELL GRANITE — A PROGRESS REPORT**

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Kaolinization is not confined to the St Austell granite and an extensive area of kaolinized Devonian metasediments contained within the metamorphic aureole of the St Austell granite, extends at least 1 km east of Indian Queens, on the south side of Goss Moor.

Good exposures of this kaolinization were seen in the excavations for the bridge foundations for the recently constructed Highgate Hill A30/A39 interchange just east of Indian Queens [SW 924 591]. A series of samples were obtained from this location, which shows completely kaolinized rocks of the metamorphic aureole, together with some acid intrusions.

Exploration drilling and trenching for tin in the area between Indian Queens, Gaverigan and the northern end of the Wheal Remfry china clay, pit showed extensive argillic alteration varying in depth from 20 m up to over 100 m, with the deepest alteration in the area closest to Wheal Remfry. This work also showed that there is extensive development of tourmaline breccias in this area and granite was encountered in places, suggesting that there is a northward trending granite ridge extending from Wheel Remfry to Highgate, with the uppermost apophyses of this ridge being seen at the surface. A sheeted vein system composed of narrow tourmaline veins, as well as later cross-course Fe mineralization were also seen at Highgate. The latter may well be related to the Fe/Mn mineralization exploited in Toldish mine, a short distance to the north.

A deep borehole at Gaverigan [SW 932 592] showed argillitic alteration of the metasediments to be 60 m deep, with unkaolinized granite encountered at 294 m.

The kaolinization at Indian Queens has produced a soft plastic material rich in clay minerals. XRF analyses indicate that iron contents of the whiter samples are similar to china clays, but titania contents are much higher, reflecting the higher titania contents of the parent metasediments. XRD and SEM studies indicate that the kaolinite is well ordered and morphologically similar to the kaolinite in china clay.

The kaolinized zone in the Gaverigan borehole was found to be underlain by metasediment impregnated with blebs of pyrite, and it may be that acid released by the oxidation of this sulphide during deep weathering in the Mesozoic/Palaeogene may have been an important contributory factor in the kaolinization process; in much the same way that kaolinization alongside the Perran iron lode (the Treamble "fuller's earth") was attributed to the oxidation of sulphides (Sabine, 1968). Roadworks elsewhere in Cornwall have also encountered areas of bleached and kaolinized Devonian pelitic rocks (Scorrier, Sticker by-pass, Bodmin bypass, Lostwithiel).

SABINE, P.A. 1968. Origin and age of solutions causing the wallrock alteration of the Perran Iron Lode, Cornwall. *Transactions of the Institution of Mining and Metallurgy, (Section B: Applied Earth Sciences)*, 77, B1-5.

**STRUCTURE AND INTRUSIVE RELATIONSHIPS IN THE  
LAND'S END GRANITE AS REVEALED BY THE COASTAL  
SECTION AT PORTHLEDDEN NEAR ST JUST, WEST  
PENWITH**

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Detailed mapping using compass and tape has permitted a more precise understanding of the geometry of the granite contacts and peripheral dykes at Porthledden. The external contact between the megacrystic biotite granite and the Mylor Formation slates and greenstones is governed partly by the dip of the schistosity in the slates and partly by sets of sub-vertical fractures, one of which is followed by the Praze Lode at the Boswedden Mine.

The shape of the contact is thus like a pitched roof with a series of gable offsets. The composite shell structure of the granite is shown by the transgressive internal contact between the tourmaline-rich equigranular granite and the megacrystic carapace. The geometry of this internal contact is also strongly governed by the same pattern of steep fractures showing that the earlier structural control is inherited during the cooling of the outer carapace. The segregation of the quartz-tourmaline fraction in an internal cupola and the details of the quartz-shell enclosing it are also described.

**ENVIRONMENTAL GEOLOGICAL INVESTIGATIONS AT  
TWO DEVON LANDFILL SITES USING AIRBORNE  
MULTISPECTRAL SCANNER DATA**

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Applications of non-invasive remote sensing techniques for the investigation and monitoring of active and restored landfill sites are being investigated on two contrasting landfills with the support of the operators: one an unlined urban co-disposal site at Chelston Meadows in Plymouth; and the second is a rural, lined and partially restored site at Heathfield near Newton Abbot. The aims of this research programme are investigate the detection of stressed vegetation and assess the role of remote sensing in the recognition of leachate or landfill gas migration; leachate plumes or localised contamination of surface water bodies, the evaluation of clay capping layers; and in studies of vegetation growth on restored land and in the location of unrecorded landfill or contaminated sites.

NERC data made available in order of usefulness in this study were Airborne Thematic Mapper with a 5 m resolution, vertical stereographic colour photography and CASI data with a 5 m

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resolution. ATM reflectance data range from short wave visible light to middle infra-red, corrected to National Grid co-ordinates, were computer enhanced and manipulated.

Preliminary results suggest that the monitoring of contamination from leachate or landfill gas via vegetation stress is extremely difficult in areas where there are other existing sources of potential contamination. The technique may be of most value in monitoring remote rural landfill sites. Near to middle infra-red data may indicate vegetation health on restored sites and in evaluation of the effectiveness of clay caps.

### GEOLOGICAL CONSERVATION IN CORNWALL

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Cornwall currently has 70 RIGS (Regionally Important Geological/geomorphological Sites), in addition to 74 SSSI's with geological interest. RIGS, unlike SSSI's, are non-statutory. There are also about 100 GCR sites associated with the SSSI's.

Sites proposed as RIGS are assessed by the Cornwall RIGS Group on four criteria: scientific, educational, historic and aesthetic. Approved sites are notified to the relevant District Council and appear on local plans, thus having parity with non-statutory nature conservation sites. Ussher Society members are requested to propose further sites.

Cornwall Wildlife Trust also recently gained its first geological reserve, Harvey's Pit in the St Earth Beds, and further sites are being sought.

### LASER ABLATION IPC-MS ANALYSIS OF MAGMATIC FLUID INCLUSIONS

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Multiphase inclusions (liquid + vapour + daughter salts) in quartz from a pegmatite lens in an aplite sill, represent the earliest magmatic-hydrothermal fluids at the Birch Tor tin deposit of central Dartmoor. A group of inclusions were analysed by laser ablation, IPC-MS (LAMP-IPC-MS). The IPC mass spectrometer is interfaced to a pulsed UV laser operating at 266 nm. This configuration allows elemental analysis of individual fluid inclusions in a wide range of mineral matrices, with a very high degree of spatial resolution (better than 2 microns). Detection limits are related to the volume of the inclusion (i.e. the mass of fluid released). For a 20 micron diameter inclusion, detection limits for Cu and Zn are estimated to be approximately 10-25 ppm. Reproducibility for the major and minor elements is generally better than 25%.

The results demonstrate the dilution of a parent fluid, without significant alteration of the elemental ratios, and also indicate the contribution of granite-derived fluids to the base metal mineralization of the country rocks.

### POST-IMPACT ASSESSMENT OF RESTRONGUET CREEK, SOUTH-WEST CORNWALL, USING BENTHIC FORAMINIFERA AS BIOMARKERS

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Since a major discharge in January 1992, of metallised acidic mine water drainage from Wheel Jane tin mine in south-west Cornwall, a

post-impact study using benthic foraminifera as indicators, has been carried out on Restronguet Creek, the receiving area of the contamination.

Benthic foraminiferal responses to heavy metal contamination include, low standing crops, high proportions of deformed tests, low diversity, temporal and spatial shifts in species dominance, high metal concentrations within the tests of deformed relative to undeformed specimens and acid alteration of the test. Due to lack of pre-discharge foraminiferal data, other estuaries, which once drained metal mining regions, have been sampled to determine background levels of foraminiferal test condition and living abundance. These estuaries are Fowey (Cornwall), Avon and Erme (south-west Devon).

The results of the past four years monitoring of Restronguet Creek, have documented improvements in the abundance of living individuals, reduced % proportions of deformed tests, less severe acid dissolution of the test walls and a seasonal species distribution which is similar to that of the Fowey estuary. Low diversity is unchanged and the agglutinated foraminifera, which form assemblage zones in the control estuaries, remain absent in Restronguet Creek. The data suggests that tangible benefits have been achieved from the water quality improvement programme inaugurated by the National Rivers Authority (now the Environment Agency).

### THE EARLY POST-VARISCAN SEDIMENT COVER IN SOUTH-WEST ENGLAND

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The early post-Variscan succession in south-west England includes the Exeter (ExG), Aylesbeare Mudstone (AyG), Sherwood Sandstone (SSG) and Mercia Mudstone (MMG) groups which outcrop from Torbay to the Bristol Channel, with a westerly extension in the Crediton Trough. The westerly depositional margins of some of the ExG formations occur in this outcrop but there is no direct evidence of the western limits of the higher units.

BGS studies have produced new evidence for the age of the post-Variscan succession, its relation to the post-orogenic igneous and tectonic events and for the regional palaeogeography. The ExG accumulated partly in rift basins created by the north-south extensional reactivation of Variscan thrusts. Acid igneous debris in the lower ExG came from east Cornwall, indicating that this was a non-depositional area in Early Permian times. Intrusion of the Dartmoor Granite, followed by regional uplift, interrupted Permian sedimentation for at least 20 my. The clast succession in the upper ExG records the progressive denudation of the region in the Late Permian. In Mid-Triassic times, intrastratal brines, probably derived from a former cover of sediments correlatable with the SSG or lower MMG, contributed to the formation of north-south veins created by east-west extensional stress.

### THE RELATIONSHIP BETWEEN THE DEVELOPMENT OF MAGNETIC FABRICS AND VARISCAN STRUCTURE, WIDEMOUTH BAY, NORTH CORNWALL

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At Widemouth Bay rocks of the late Carboniferous Bude and Crackington formations are exposed along the southern limb of the Culm Synclinorium. Mesoscopic folds, superbly exposed along the foreshore and cliff section are generally open in style, with mainly shallowly west-plunging hinge-lines and axial planes that are upright

that are upright or steeply inclined to the north. A slaty cleavage is locally well developed in thin grey-black shale beds but generally absent from interbedded laminated sandstones and siltstones.

A single anticline has been sampled and analysed in order to determine the Anisotropy of Magnetic Susceptibility (AMS) in several of these lithologies. Both the limbs and the hinge region have been sampled in order to examine the relationship between the measured "magnetic fabric", the observed petrofabric and conventional structural orientation data. All lithologies have low degrees of anisotropy ( $k_{\max}$  and  $k_{\min} < 1.08$ ), indicative of low bulk strains. The sandstone beds display prolate AMS ellipsoids, suggesting that the anisotropy is controlled by grain shape alignment of a carrier with primary spherical or prolate susceptibility ellipsoids and low degree of anisotropy (e.g. Magnetite). Shale beds, with variably developed slaty cleavages, are dominated by AMS ellipsoids, suggesting that the anisotropy is controlled by rotation and alignment of phyllosilicates with primary oblate ellipsoids and low degree of anisotropy.

The maximum axes of the AMS ellipsoids ( $k_{\max}$ ) consistently parallel the orientation of the fold axes and typically cluster obliquely within the plane of the bedding, irrespective of the lithology from which the samples are taken. The other axes of the AMS ellipsoid ( $k_{\min}$  and  $k_{\text{int}}$ ) rarely lie within the plane of bedding, suggesting a dominantly tectonic origin rather than primary (compaction) origin for the magnetic fabric. In sandstone beds, these axes may parallel the mean pole to the fold axial plane but appear to be inter-changeable at such low degrees of anisotropy. In shale beds, however, the orientations of  $k_{\min}$  and  $k_{\text{int}}$  are often transitional between bedding and cleavage orientations, possibly reflecting rotation of a primary, phyllosilicate-dominated bedding fabric.

#### **HENRY DE LA BECHE AND THE GEOLOGICAL SURVEY OF SOUTH-WEST ENGLAND**

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Henry De la Beche (1796-1855) was a key figure in the development of geology in the first half of the 19th century, though he is less well known at the present day than his contemporaries: Lyell; Murchison and Sedgwick. Born to a well-to-do family with an estate in Jamaica, he was privately educated and showed an early interest in geology. After a short stay at Marlow Military College, he lived at Lyme Regis and worked on the vertebrate remains in the Lower Lias, in particular the ichthyosaurs. Later interest in geological mapping and stratigraphy resulted in surveys of parts of Devon and South Wales, and of Jamaica.

In 1832, with his private income much reduced, De la Beche requested government funding to complete his mapping of Devon; this was granted and the first Ordnance Geological Survey maps were available in 1835. Extension of the original grant to complete Cornwall and west Somerset followed, the maps and a report — the first Geological Survey Memoir — were published in 1839.

In 1845 the Geological Survey was recognised by an enabling act, and De la Beche became the first director of the new institution. In addition to the Survey, De la Beche had a more extended view of the role of geology in the public domain: both the Museum of Practical Geology and the Royal School of Mines were the result of his initiatives and were under his direction. All of these public institutions survive at the present day and are a lasting memorial to his vision of geology in public science.