

ABSTRACTS OF OTHER PAPERS READ AT THE ANNUAL  
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**POTENTIAL FIELD TRENDS IN ONSHORE AND  
OFFSHORE SOUTH-WEST ENGLAND**

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Potential field (gravity and magnetic) data have traditionally been used in south-west England to delineate sedimentary basins, granite batholiths and zones of mineralisation using a variety of regional and detailed geophysical data. The regional gravity and magnetic data presented in the paper have been provided by the British Geological Survey. The coverage of these data is not sufficient to define individual mineralised bodies, but they do provide a consistent regional overview of the onshore/offshore area allowing structures, faults and lineaments to be identified across the coastal zone.

Transform enhancements of the basic Bouguer gravity and magnetic anomaly datasets have enabled a better definition of lineaments and transform faults which traverse the region and lie generally parallel to the NW-SE trending Sticklepath Fault. The renewed interest in the South West Approaches, St George's Channel and the Celtic Sea for oil and gas exploration has resulted in numerous new studies based on old potential field data. The aim of these studies has been to identify the transform faults and zones which compartmentalise the subsurface structures, and to define the areas where normal faults intersect the transform faults thus creating conduits for sediment transport from platform areas into sedimentary basins. There is some evidence from the onshore that the NW-SE trending transform faults have also influenced the development of mineral deposits.

This paper will hopefully provide a new insight into the structure of this region particularly the links with the offshore area, and show that geologists can still benefit from old potential field data.

**TECTONIC CONTROLS ON POST-VARISCAN  
MAGMATISM IN CORNWALL**

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The south-west England batholith is the largest in the British Isles and possibly one of the most intensively investigated in the world. During the last thirty years research has primarily been focused upon the petrological, geochemical and geochronological characteristics of the batholith, and a broad consensus has emerged regarding its temporal/spatial development and the relative contribution of crust and mantle source<sup>(1,2)</sup>. Nevertheless, many aspects of the batholith remain enigmatic, such as its anomalous position

within the external Variscides and the tectonic and structural controls upon magma generation and granite emplacement.

This study aims to address the possible role of the pre-, synand post-Variscan tectonic evolution of Cornwall<sup>(3)</sup> in the localisation and geometry of magma bodies and integrates our own field observations and structural data from the granites and country rocks with previously published field, geophysical, geochemical and geochronological data.

A tectonic control on pluton emplacement can be inferred on the basis of magmatic state NNW-SSE alignment of megacrysts with the Carnmenellis<sup>(4)</sup>, Carn Brea, Bodmin and Land's End granites and rare NNW-striking solid state shear zones on the margins of the Carnmenellis and Bodmin granites.

Our preliminary conclusions suggest that Carboniferous thrust-stacking of thermally young lithosphere caused high heat flows and high Moho temperatures prior to post-Variscan extension and decompression melting. Differential post-Variscan extensional reactivation of thrusts and strike-slip movement on orthogonal faults probably created rhomboidal pull-aparts of varying geometries above a major mid-crustal fault zone. Granite fabrics suggest emplacement during NNW-SSE extension and/or ENE-WSW shortening.

**References**

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**AN EMERGING GEOCHRONOLOGICAL RECORD  
OF THE CONSTRUCTION AND EMPLACEMENT OF  
THE LIZARD OPHIOLITE SW CORNWALL**

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An ongoing programme of laser-probe (lp) and furnace-fusion (ff) incremental-heating <sup>40</sup>Ar-<sup>39</sup>Ar and U-Pb dating delimits a protracted thermotectonic history for the Lizard Complex. The thermal events recognised (all errors, 26) are:

**(a) Construction.**

397 ± 2Ma (average <sup>207</sup>Pb-<sup>206</sup>Pb age of 3 single, concordant, magmatic zircons) -crystallization of plagiogranite (above Porthkerris Qy: NGR 806 230) during intra-oceanic metamorphism, ductile extensional shearing and mylonitization of (Landewednack-type) basalts. The preserved segment of the ophiolite is therefore of Siegenian (mid-Early Devonian) age.

**(b) Emplacement**

(1) 381 ± 12Ma (hornblende Ar-Ar plateau-lp) - amphibolite facies metamorphism of leucogabbro, Porthkerris Pt.

(2) 377 ± 3Ma (biotite plateau-lp) amphibolite facies metamorphism of Old Lizard Head Series pelite, Venton Hill Pt.

(3) 376 ± 6Ma (muscovite plateaux-ff) dynamothermal metamorphism of OLHS pelites, Polpeor Cove;

(4) ca. 370 Ma (diffusion-modelled hornblende spectrum-ff) - prograde amphibolite facies metamorphism of mafic component of Kennack Gneiss

(5) 368 ± 2 Ma (muscovite-rich whole-rock plateau-lp) - metamorphism of OLHS pelite, Porthallow Cove;

(6) 361-364 ± 3 Ma (muscovite and whole-rock plateaux-lp) - metamorphism (?renewed) of OLHS pelites, Polpeor Cove;

(7) 363 ± 9 Ma (hornblende plateaux-ff) amphibolite facies metamorphism of Tremadocian Man of War Gneiss arc fragment during incorporation into Lizard Complex;

(8) 354 ± 3 Ma (whole-rock plateau-lp) metamorphism of OLHS pelite, in hanging wall of Most Southerly Point Thrust;

(9) 347 ± 9 Ma (hornblende plateau-lp) - metamorphism/mylonitization of Lower Hornblende Schists, Polurrian Cove;

(10) 306 ± 5 Ma (actinolite pseudo-plateau-lp) - greenschist fades metamorphism of volcanic member of OLHS, Venton Hill Pt. The ca 354-381 Ma Ar-Ar age plateaux may record distinct tectonothermal events or a quasi-continuous process of metamorphism and deformation attending underthrusting and subsequent uplift through the Middle and Late Devonian.

North of the Complex, Meneage Fm. greywackes (Poldhu and Church Coves) yield Ludfordian (415 ± 2 Ma) whole-rock plateaux (lp) recording terminal-Caledonian crystallization of muscovite, now occurring either in covert phacoids or as an homogenous detrital assemblage. These rocks were not sensibly affected by the 350-380Ma thermal events represented in the ophiolite but, to the east, the structurally-overlying Dodman Fm. experienced greenschist-facies metamorphism at 385 ± 2 Ma (whole-rock plateaux-fp) The parautochthonous Meadfoot Group of southern Cornubia, in contrast, records only (anchizonal) metamorphism at 329-331 ± 2 Ma (whole rock-lp plateaux), precisely contemporaneous with the epizonal metamorphism of the Start Schists (325-334 ± 2 Ma: whole-rock and muscovite-lp plateaux), which therefore experienced a late thermal history distinct from that of either the Lizard Complex or the Dodman Fm.

The geochronological record is largely in permissive agreement with the tectonic models of Holder and Leveridge (1986) and, particularly, Leveridge *et al.* (1990: Falmouth Memoir), which predicates an extended Middle Devonian - to - Mississippian history of burial and exhumation of Lower Devonian oceanic lithosphere in the course of the NW advance of the Normannian High.

## A HISTORY OF THE ST. ERTH WORKINGS AND ASSOCIATED MICROPALAEONTOLOGICAL RESEARCH

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Activities in and around the St. Erth deposits have recontinued for well over a century, but much of this activity is poorly documented, and evidence difficult to find. The conflicts between economic demands, public access and academic interest can be illustrated through the varying fortunes of the St. Erth beds.

## WESTWARD HO! - HUMAN AND NATURAL PROCESSES

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The form of the coast at Westward Ho! demonstrates the effects of environmental changes operating over a variety of geomorphological time scales. Most of the major landforms of the coastal landscape at Westward Ho! are directly linked to climatic changes occurring over the last 125,000 years. These include, fossil Ipswichian cliffs, a raised beach associated with the enhanced sea levels of these times - periglacially-degraded cliff lines abandoned during sea level falls accompanying the Devensian glaciation, and Holocene features related to the partial reoccupation of the older coastline by positive Flandrian sealevel changes.

On a different timescale, extensively chronicled changes occurring over the past 200 years demonstrate a human-induced "coastal erosion problem" that has developed at this location. An increasing knowledge of the behaviour of the coast littoral system illustrates the opportunity for the coastal geomorphologist to contribute to efforts to establish SUSTAINABLE COASTAL MANAGEMENT.

It may be suggested that sustainable coastal management can be achieved by a balance of inputs from three systems; the economic, the bio-geo system, and the sociocultural system. However, the degree to which the geomorphologist may contribute to decision making in the area may be limited by the geomorphologists' own perception of timescale and a lack of acceptance of the reality of the time dimension under which 'political' decision making must work.

## ASPECTS OF QUATERNARY SEA LEVEL AND CLIMATE CHANGE IN THE ST AUSTELL BAY AREA

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The late Quaternary was a period of considerable variability in climate and sea level, causing great changes in coastal morphology. These changes are well demonstrated in the St Austell Bay area.

A raised beach at Carlyon Bay and between Fishing Point and Spit Point shows the typical arrangement of a raised beach composed of sand and gravel overlain by periglacial head (*cf* Fistril, Pendower and Godrevy). The upper part of the raised beach near Spit Point shows structures which may indicate the former presence of ice wedges. A period of temperate climate with a sea level about 5m higher than present appears to be indicated, succeeded by a cold period, possibly corresponding to the Devensian glaciation.

The sediments laid down during the Flandrian transgression, following the Devensian cold period, were preserved in the buried

valleys at Par and Pentewan. Numerous detailed contemporary accounts, written during the period of alluvial tin working around 200 years ago, plus some drilling in the early 1970's, show that there was an oscillation between marine and land conditions as the overdeepened valleys filled with sediment. At least one period of rapid sea level rise is attested by oysters attached to the boles of oak trees still apparently in their position of growth. Human remains were also found in these Flandrian sediments. A recent exposure in the excavations associated with the construction of a supermarket at Holmbush has exposed sandy Flandrian sediments, much disturbed by tin streaming two hundred years ago. A 'submerged forest' a few metres below current O.D., was recently exposed at Portmellon. In historic times, the area has seen an influx of sediment from alluvial tin and china clay mining, which has built up several large beaches, notably at Carlyon Bay, Pentewan and Par.

### **THE RECORD OF CHINA CLAY MINE WASTE WITHIN THE ESTUARINE SEDIMENTS OF THE FAL ESTUARY, SOUTH WEST ENGLAND.**

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The extraction of china clay (kaolinite) has been carried out in the St Austell district for nearly 250 years. China clay is hydraulically mined and for every tonne of clay produced, there are nine tonnes of waste, of which 4.5 tonnes is rock and overburden, 3.5 tonnes sand and one tonne is micaceous residue. In the early days of the industry, most of the micaceous residue along with the sand waste was discharged into the local rivers, including the River Fal. The River Fal drains into the eastern side of the Fal Estuary and previous work has shown that the sediments deposited within the Fal River valley comprise china clay waste to a depth of one metre (Billiton Minerals 1980).

The effect of mining on the sedimentology of the Fal Estuary has been examined by a regional coring programme of the intertidal mudflats. The recovered cores have been subdivided into 5 cm stratigraphical intervals and have been examined both mineralogically and geochemically. The mineralogy of the < 20 µm grain size fraction has been examined by Scanning Electron Microscopy (SEM), whilst the < 20 µm grain size fraction has been examined by X-Ray Diffraction (XRD). In addition the geochemistry of the sediments has been examined by XRF. Our previous work has shown that the down-core geochemistry reveals a discrete pulse in metal mine waste throughout the estuary (Pirrie *et al.*, 1996, 1997; Hughes, 1997). Recent XRD work on the < 20 µm grain size fraction has shown a distinct change in clay mineralogy, is interpreted to represent the sudden influx of china clay mine waste into the estuary. The change in clay mineralogy always post-dates the main pulse of metal-related contamination within the estuary, and may be used as a datum, in terms of the stratigraphy of the recent estuarine sediments.