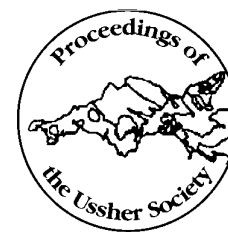


ABSTRACTS OF OTHER PAPERS READ AT THE ANNUAL CONFERENCE, JANUARY 1992



THE ALBIAN/CENOMANIAN BOUNDARY IN WEST WILTSHIRE AND NORTH DORSET

M.B. Hart, University of Plymouth

Recent excavations on the new Zeals/Bourton by-pass have exposed a succession across the Upper Greensand-Chalk boundary. This can be favourably compared to previously described successions to the east (Mere, Maiden Bradley) and the south-west (Shillingstone, Buckland Newton, Maiden Newton). The stratigraphic setting of all these localities is reviewed.

THE DARTMOOR VOLCANO REVISITED — PERMO- CARBONIFEROUS IGNEOUS ACTIVITY AND SEDIMENTATION IN THE CREDITON TROUGH, DEVON

R.C. Scrivener and R.A. Edwards, British Geological
Survey, Exeter

A revised stratigraphical sequence for the Crediton Trough is presented and the history of accumulation of these New Red Sandstone sediments is considered in relation to post-Variscan igneous events. An older sequence of Upper Carboniferous/Lower Permian rocks is interbedded with lamprophyric and basaltic lavas and has a clast population suggesting bimodal acid basic volcanic events. The later, Upper Permian strata include fragments which suggest a substantial suprabatholithic effusion of rhyolitic lavas - the Dartmoor volcano. A comparison is drawn with a similar group of strata in the Sudetic area of northern Bohemia.

SPHAEROSPONGIA, AN ENIGMATIC DEVONIAN SPONGOID FROM SOUTH DEVON

E.B. Selwood and M.R. House, Exeter and
Southampton Universities

In 1842 John Phillips described from several localities in the Middle Devonian limestones of south Devon a tessellated pear-shaped organism under the name *Sphaeronites tessellatus*, and it later has come to be referred to *Sphaerospongia* in British literature. We report on a very well-preserved specimen showing the internal wall structure of this form, which shows tetradial spicule structures which are attached to the polygonal tesserae of the outer wall. These suggest movement may have been possible to open gaps between the tesserae for inhaled current flow. The primary material available to Phillips has been re-examined and comments are made on the relationship to the Russian genus *Petropolissia* (Kutorga 1842). Some review is given of the enigmatic placing of the group among receptaculitids, sponges or algae.

EXTINCTIONS AT THE DEVONIAN TAGHANIC EVENT

M.R. House, Southampton University

The Taghanic Event is a short-term extinction event now placed within the late Givetian. It is associated with an international transgression which was used formerly to mark the base of the

Upper Devonian. The extinction is very well marked for the Ammonoidea and here the Agoniatitidae, Sobolewiidae, Maenioceratidae and Pinacitidae (s.l.) became extinct. Shortly afterwards was the radiation of the newly appearing Phaceloceratidae and soon other members of the Gephuroceratina. Comments are made on the extinctions seen in other groups, especially of corals, trilobites and Brachiopoda. The event appears to fall within the conodont Middle *varcus* Zone. Some of the evidence for the link of sedimentary perturbation and extinction is examined.

RIFT-RELATED SEDIMENTATION AND VOLCANISM DURING

THE EARLY HISTORY OF THE GRAMSCATHO BASIN

R.K. Shail, Camborne School of Mines

Recent studies have suggested that an important zone of dextral transpression on the northern margin of the Gramscatho basin was brought about by the presence of a major steeply-dipping fault system which acted as an oblique buttress during collision-related deformation. Preliminary work confirms this fault zone also controlled subsidence and associated sedimentation/volcanism during the early stages of basin development. In the northern part of the zone, significant contemporaneous volcanism occurs within the predominantly shallow marine ?Emsian Meadfoot Group: further to the south there is a transition to thickly-bedded deep marine sandstones of the Gramscatho Group. This syn-rift assemblage preserved along the northern margin of the basin is compared with syn-rift sediments further to the south.

A NEW LOOK AT SOME ASPECTS OF THE PETROGENESIS OF THE DARTMOOR PLUTON

M. Stone, Exeter University

A re-evaluation of the geochemistry of the northern part of the Dartmoor granite suggests that the sequence from megacrystic biotite granite through non- or poorly-megacrystic (low femic) granites to fine-grained granites and aplites, is a magmatic one that corresponds approximately with the sequences already described from the Carnmenellis and Isles of Scilly plutons. However, the Dartmoor granites are typically richer in xenoliths from crustal and possible subcrustal sources and femic oxides/elements than these other granites. The exposed rocks are considered to represent a fractionated series derived initially from a subcrustal source, heavily contaminated by palaeogenetic magma and lower crustal restite. The general continuity of variation patterns with basic microgranites, suggests a transition from I-type to S-type granitoids, possibly as a result of early hornblende fractionation followed by dominant feldspar fractionation after the Aluminium Saturation Index had exceeded 1.

The Meldon microgranite, like the Li-mica granites elsewhere in south-west England, is considered to have been emplaced later than the biotite granites. Like the other Li-mica granites in the Cornubian batholith, its chemical (and mineralogical) features are so distinctive and so different from those of the biotite granites that petrogenetic relationship appears unlikely. It is suggested that the Meldon microgranite has been derived as a result of partial fusion of residual biotite-rich lower crust, left after extraction of the earlier biotite

Astracts

granite magmas, aided by F and alkali metasomatism derived from a subcrustal source, perhaps coincident with Permian alkali-rich volcanism.

RIDGE-AXIS TECTONICS: EVIDENCE FROM THE LIZARD COMPLEX

S. Roberts, J.R. Andrews, J.M. Bull and
D.J. Sanderson, Southampton University

Investigation of the uppermost sheet of the Lizard ophiolite, between Coverack and Porthoustock, reveals a series of discrete, but interrelated, tectonic and magmatic events that can be interpreted in terms of spreading centre processes.

In the mantle sequence, peridotite is intruded by variably dipping veins of troctolitic gabbro and gabbro. These are cut by early, flat-lying shear-zones, with top-to-east displacement, and late, steep shear-zones.

Within the overlying gabbro, early aphyric and plagioclase phyric basaltic dykes and sheets within gabbro often show intimate relationships with the gabbro and no chilled margin. These are cut by shear-zones, which dip moderately to the east, have a top-to-east sense of displacement and rotate the early dykes. Late predominantly aphyric dykes, trending 140° to 160° postdate the early basaltic dykes and 140° shear zones.

These observations indicate that deformation occurred close to the palaeo-ridge axis, and models of this will be discussed, which provide insights into the nature of the spreading process.

APPLICATION OF MATURITY MODELLING TO THE DETERMINATION OF THE TECTONO-THERMAL EVOLUTION

OF THE SOUTH WALES COALFIELD
S. White, University College, Cardiff

The South Wales Coalfield formed in a foreland basin at the northern margin of the Variscan orogen. The very low-grade metamorphism characteristic of this basin resulted from burial by significant thicknesses of Stephanian sediment. The relationships of isovols to stratigraphy and folds imply that peak metamorphism occurred after a phase of regional northwards tilting, after upfolding of the South Crop, but prior to internal coalfield folding. Palaeogeothermal gradients are considered to have been around 25°C/km, with peak temperatures of about 180°C at the Westphalian A/B boundary and maximum Stephanian thicknesses in the north of around 4.6 km. The presence of late Triassic sediments, which lie directly on the eroded southern rim of the coalfield, infers that, for the South Crop, rapid burial was succeeded by rapid uplift, erosion and Mesozoic deposition. Whether or not this burial history can be applied to the remainder of the coalfield leads to the proposition of two contrasting burial histories. By combining all this information with previously published structural models for the development of South Wales, the tectono-thermal evolution of the Coalfield will be discussed.

EVOLUTION OF THE RUHR COALFIELD: A SUMMARY

J. Cole, University College, Cardiff

The Ruhr Coalfield lies in a north-east — south-west trending basin formed during the Variscan Orogeny. The coalfield contains about 3500 m of coal-bearing strata which range in age from Namurian C to Westphalian C. The Coal Measures crop out in the south of the Ruhr area. These outcrops display many of the features typical of the coalfield, both sedimentological and structural.

The strata consist mainly of deltaic sediments as well as frequent coal seams and marine bands. There is an overall decrease in marine influence from Namurian C through to Westphalian C.

The structure of the coalfield is characterised by stockwerk tectonics, whereby the style of deformation, but not the amount of shortening, is dependent upon depth. There are three recognised stockwerks in the Ruhr area. Folds are generally upright and there

are roughly equal numbers of north-east - south-west striking fore-thrusts and back-thrusts.

Evidence suggests the coalfield formed as a foreland basin. The evidence includes : 1) Isopach maps, which show a thinning of strata to the north-west. 2) Subsidence curves which show rapid subsidence rates from Namurian A onwards. 3) Palaeocurrent and provenance studies which show a switch from a north-east sediment source to an immature southerly source.

CONJUGATE EN ECHELON VEINS IN THE CRACKINGTON FORMATION: STRESS CONFIGURATION AND ESTIMATION OF PORE FLUID PRESSURE

R. R. Jackson, University of Southampton

En echelon veins are generally described in terms of simple shear deformation with extension fractures nucleating at 45° to the array. Data collected for vein sets in the Crackington Formation from Millook Haven and for the sequence between Wanson and Foxhole Point indicate that many natural arrays contain veins with very different orientations, with the vein-array contain veins with very different orientations, with the vein-array angle typically ranging from 0-60°. Some of these en echelon veins occur in conjugate sets where σ_1 is not the acute bisector to the dihedral angle between the conjugate array. These variations are not consistent with simple shear deformation. Vein dilation and the resultant displacements are better analysed in terms of transtensional-transpressional deformation. results from this method of analysis indicate that veins in echelon and conjugate arrays are generally mode I cracks, but they are oriented with respect to the near-field (rotated) stress in zones of transtension or transpression.

Combining kinematic models of transtension with mechanical models of oblique loaded zones leads to a dynamic interpretation of vein formation. From the geometry of conjugate veins, estimates of the relative magnitude of pore fluid pressure and mean stress can be made. Analysis of vein sets in the Crackington Formation indicate that the veins developed in a stress field where the internal fluid pressure did not exceed the remote mean stress.

DUPLEX AND DETACHMENT STRUCTURES IN THE CULM BASIN: RELATIONS BETWEEN REGIONAL SHORTENING AND FOLD DEVELOPMENT

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*Also of Department of Geological Survey, Botswana

Detailed mapping of parts of the Crackington and Bude Formations has led to the identification of a number of regionally common features of early deformation. The structures identified include a suite of pre-fold contractional and extensional faults and complex vein systems. Small-scale thrusts with duplex or imbricate structures are commonly found. All these structures occur within folds which are generally cylindrical (chevron variety) with conical terminations. The duplexes range in length from <1m to >7m and are defined by planar or smoothly curved, upper and lower detachment surfaces. In all examples observed, roof stratigraphy is unrepeated. Link thrusts within these duplexes splay from the floor and merge upward with the roof thrust at cut-off angles ranging from 15° to 50°. The internal angular variation may reflect original displacement variation, or modification by back-rotation during fault propagation. Slickenfibre lineations have a broad dispersion of slip directions, relative to slip vectors on lower floor and upper roof thrusts.

Multiduplex structure is evident for some examples, with smaller splays or subsidiary floor and roof thrusts defining sub-duplexes. Commonly, the subsidiary thrusts splay from and merge with other link faults within the main duplex, without reaching the roof and floor thrusts. Internal deformation is generally limited to small-scale folding and fracturing; folded quartz veins are observed in some cases.

Other structures, newly identified are composite contractional-extensional duplexes. These contain subsidiary and link thrust faults with essentially contemporaneous extensional faults with slip in the direction of thrust transport. These structures represent shortening and local inter-layer slip transfer, which occurred during localised and distributed layer-parallel shear. Shortening and detachment was also accommodated by: (1) discrete faults and slip surfaces defined by slickenfibres (2) extreme thickening of shale horizons (3) and rare examples of fault-propagation folds.

Although the magnitudes of displacement are not well constrained, cumulatively they are significant. Transport directions are both top to the north-north-west and south-south-east, also indicating that sub-parallel, synchronous thrust faults with opposite vergence are present. The kinematics and the variety of local structural settings for these duplexes and detachment structures indicate most of them are not simply accommodation features to flexural-slip. Their formation is more consistent with initial layer-parallel shortening and thrust propagation, prior to buckling and main fold amplification.

THE ABUNDANCE OF CARBON AND THE ISOTOPIC COMPOSITION OF CO₂ FROM METABASITES AND SHEAR EMPLACED DERIVATIVES OF NORTH AND WEST CORNWALL

M. K. Durkin, R. E. Clayton, R. M. Corfield and
O. Smith, Oxford and Exeter Universities and
UKPS Ltd, Warwick

We present preliminary investigations into the carbon content and isotopic composition ($\delta^{13}\text{C}$ and $\delta^{16}\text{O}$) of various metabasites in north and west Cornwall, including shear-emplaced derivatives that have undergone extensive carbonatisation and carbonate mineralisation from cross-cutting veins.

Total carbon measurements of a mixed suite of metabasites collected in the Mounts Bay area of west Cornwall vary within a range of about 100 to 500 ppm. Whilst not dissimilar in their carbon concentration to modern mid-ocean ridge basalts we believe these concentrations to have undergone minor adjustment since. By comparison our data show that sheared carbonate-bearing metabasites in the Padstow area contain > 10 wt % CaCO₃. This contrast reflects disparate mechanisms controlling fluid flow and infiltration in the region, it may imply large scale CO₂ streaming from depth accompanying a phase of ductile shear during the dismemberment, tectonic emplacement and mineralisation of some north Cornish metabasites.

$\delta^{13}\text{C}$ values of whole rock and isolated carbonates are distributed in a range, for example, for north Cornwall -2.7 to -10.9 ‰. $\delta^{13}\text{C}$ values have a limited potential for identifying source characteristics, yet are sensitive to changes in redox which we combine with other data to constrain the ambient conditions under which the CO₂ flooding and carbonate precipitation occurred. Oxidation of organic matter and decarbonation reactions in adjacent metasediments suggest important contributions from this source. In north Cornwall, the excess carbon was probably introduced during advective fluid flow involving the penetration of CO₂ 'fronts' several tens of metres into individual metabasite bodies. In the light of carbon and $\delta^{13}\text{C}$ measurements we explore the contribution of juvenile, deep crustal and metasedimentary CO₂ to the carbonate fraction of metabasites.

MECHANICAL BEHAVIOUR OF FAULTS IN SOMERSET DUE TO FLUID-ROCK INTERACTIONS

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University, USA
V. B. Sisson, Rice University, Houston, USA

East-west trending normal faults in Jurassic limestones and shales between Kilve and Lilstock, Somerset, exhibit several phases of deformation, indicated by multiple generations of cross-cutting calcite veins.

Earlier generations of veins are deformed by later episodes of fault movement, and cross-cutting fluid inclusion trails in individual veins record up to three generations of fluid flow during or following vein formation. MI observed fluids are very saline (3 to 7 times the salinity of seawater). On two faults, separated by 3.5 kilometres, the trend over time (established by cross-cutting relationships among fluid inclusions) is for fluids of decreasing salinity to be trapped at increasingly higher Thomogenisation (Th). Increasing Th could record increasing temperatures, or decreasing pressures. Variations in fluid composition and pressure-temperature characteristics from fault to fault suggest that fluid flow systems were local and bounded by the faults, which served as conduits during their deformation history, or that different faults were activated at different times during the structural and fluid-flow evolution. In addition to the fluids, preliminary observations indicate that deformation style varies from fault to fault, and that structural style for a single fault changes with time. Field observations suggest that fault zones exhibited weak behaviour relative to the adjacent rock body (which lacks extensive veining) during deformation events that were accompanied by phases of fluid flow. At the thin-section scale, deformation mechanisms in calcite veins vary from brittle (microfracturing and brecciation of calcite veins) to crystal-plastic (bowed twins and recrystallization); where both deformation styles are found on the same fault, the brittle phase appears to postdate the crystal-plastic deformation. It is hypothesized that variations in deformation style are related to changing fluid temperature, pressure or chemistry conditions during faulting. Fault-zone weakening over time is consistent with decreasing pressure and may be related to decreasing salinity, corroborative of some prior experiments on the fracture and frictional strength of rocks in the presence of saline fluids.

PLYMOUTH SOUND: QUATERNARY SEDIMENT AND FORAMINIFERA

P. Castignetti, University of Plymouth

As part of an ongoing investigation into the geology of Plymouth Sound, detailed lithological and palaeontological analysis has been carried out on material derived from two boreholes into the sediment infill of the palaeo-Tamar rock valley.

The core material is described in detail, with particle-size distribution analysis throughout. A comprehensive foraminiferal analysis has been carried out.

From this data, changes in palaeo-environment and in sea level have been derived.

LOW-TEMPERATURE ALTERATION OF THE CARBONIFEROUS MIDDLE-HOPE VOLCANICS OF WESTON-SUPER-MARE

T. Clayton, R. A. Saunders and J. Viggars,
Southampton University

Early Carboniferous volcanic rocks from Hope Bay, Weston-Super-Mare formed a localised offshore volcanic high above the outer carbonate ramp deposits of the Black Rock Limestone. The succession comprises interbedded pyroclastics, pillow lavas and limestones. A variety of low-temperature clay mineral alteration products are described and their formation is discussed.

TIMING OF THE CADOMIAN OROGENY IN THE CHANNEL ISLANDS - LA HAGUE REGION: EVIDENCE FROM ⁴⁰AR/³⁹AR AND U-PB MINERAL AGES

R. A. Strachan, R. D. Dallmeyer, R. S. D'Lemos
and P. A. Mueller, Oxford Polytechnic,
Universities of Georgia and Florida

The Channel Islands of Guernsey, Sark and Alderney, together with the La Hague region of Lower Normandy, expose the north-westernmost segments of the Cadomian belt of the Armorican

Abstracts

Massif. Evolution of this late Proterozoic orogenic belt has been interpreted in terms of the amalgamation of arc complexes and synorogenic supracrustal rocks within a sinistrally transpressive plate boundary at the north-western margin of Gondwanaland. Recently acquired isotopic data provide new constraints on the evolution of the Channel Islands - La Hague region. The Perelle quartz diorite of Guernsey records U-Pb zircon ages which suggest crystallization at *c.* 700 Ma. This may provide a lower age constraint for early subduction-related magmatism in this part of the belt. Hornblende Ar⁴⁰/Ar³⁹ isotope correlation ages of *c.* 600 Ma obtained from penetratively deformed quartz diorites on Guernsey and Sark are interpreted to date cooling following early Cadomian deformation and metamorphism of the arc complex. Similar ages have been obtained from host (Icartian) amphibolite orthogneisses on Sark and at La Hague. Post-tectonic calcalkaline plutonic rocks have yielded a span of hornblende cooling ages ranging from *c.* 605 Ma (Bon Repos meladiorite, Guernsey; Jardeheu quartz diorite, La Hague) to *c.* 570 to 560 Ma (Northern Igneous Complex, Guernsey; Alderney quartz diorite; Moulinet quartz diorite, La Hague). Post-tectonic magmatism was broadly coeval with post-metamorphic cooling around the Baie de St. Brieuc on the adjacent French mainland, and occurred *c.* 30 Ma prior to regional strike-slip deformation and anatexis in the St. Malo area.

GEOCHEMISTRY OF THE START COMPLEX METAVOLCANICS

P. A. Floyd, R. Holdsworth and S. A. Steele,
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The metavolcanic greenschists of the Start Complex, south Devon are geochemically distinct from the northern Lower Devonian basic volcanics, from which they are divided by a terrane boundary. The Start greenschists are a two-suite basaltic sequence characterized by high Cr, Ni and Sc, generally low (stable) incompatible element abundances and (chondrite-normalised) depleted light REE patterns. These features are typical of normal-type MORB.

If these rocks are Devonian in age, it is suggested that they were originally part of the local Rhenohercynian Zone oceanic crust. Relative to other southern Cornish MORB-types they have very primitive compositions, but incompatible element ratios and REE patterns similar to the late set of Lizard dykes, rather than basic clasts within the southern Cornish mélange, or the Landewednade schists.

RELATIONSHIP BETWEEN STRIKE-SLIP DEFORMATION AND GRANITE MAGMATISM, NORTH ARMORICA

R. S. D'Lemos, R. A. Strachan and M. Brown, Oxford

Polytechnic and University of Maryland

The St Malo and Mancellian regions of northern France expose granitic rocks relating to the later stages of the late Precambrian Cadomian orogeny. Around St Malo, anatexis of Brioverian metasedimentary rocks took place at mid-crustal levels at *c.* 550 to 540 Ma. High T, low P melting resulted from transpressional inversion and thickening of a Brioverian basinal sequence. Field relationships indicate that anatexis was broadly coeval with formation of steep sinistral strike-slip shear-zones. The Mancellian granites to the east are approximately the same age as the anatectic granites, they also exhibit similar petrographic, geochemical and isotopic characteristics and are hence inferred to be genetically related. The Mancellian granites are discordant to country rock structures and develop postkinematic contact metamorphic porphyroblasts in host Brioverian metasediments. The contrasting syntectonic nature of the St Malo migmatites, and apparently "post-tectonic" nature of the broadly coeval Mancellian granites reflects different crustal levels during late Cadomian orogenesis. The regional strike-slip deformation seen in the mid-crust was accommodated by faulting in the brittle upper crust. These shear/zone fault systems provided the channelways along which magma was able to ascend. Releasing bends within the fault systems may have provided developing pull-apart voids into which granite magmas were emplaced.