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Conference Report

Sedimentation and tectonics in the Welsh Basin

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Report of a joint meeting of the Tectonic Studies Group and the British Sedimentological Research Group of the Geological Society held at the University College of Wales, Aberystwyth on 10–12 April 1986. The organizers were Dr W. R. Fitches and Dr N. H. Woodcock.

Research into the Early Palaeozoic history of Wales is like that history itself; eventful and rarely quiescent. Recent events have been the lively debate on the tectonics of Anglesey provoked by A. J. Barber and M. D. Max, the exemplary volcanological studies in North Wales by the BGS Snowdonia unit, and the definition of Silurian world stratotypes by members of the Ludlow Research Group. The stimulus for this conference was the recently increased activity in structural and sedimentological research in mainland Wales. Twenty-eight papers were given over the first 2 days, followed by a day of field trips to Snowdonia, the Aberystwyth area, and the Wenlock of eastern Mid-Wales.

Precambrian events featured in three papers. **D. S. Wood** concentrated on the evidence for the superficial 'soft-sediment' origin of the Gwna melange of Anglesey and postulated a setting predating rather than accompanying the subduction system that produced the Anglesey blueschists. In the later deformation history of Anglesey, **D. Carter** distinguished two main deformations. A Caledonian event was preceded by one of pre-Arenig or probably pre-Arvonian age, with an unconformity present between the Monian and Lower Palaeozoic rocks. Precambrian sedimentation of the Longmyndian of Salop was described by **J. Pauley** in terms of a progradational basin fill. This is represented in upward order by basinal shale, turbidite, deltaic, alluvial floodplain and sandy braidplain facies. The major syncline in the Longmydian is confirmed, but the age of this and subsequent faulting is a sinistral strike-slip system is uncertain.

Cambrian sedimentation and diagenesis were covered first in two studies of the Harlech Grits Group of North Wales. **C. Griffiths** identified a transgressive sequence, with shallow marine sediments overlain by turbidites deposited in confined fault-controlled basins. Some well-sorted, cross bedded tops to turbidite beds indicate traction current reworking, though the type of flow is problematical. **M. Bennett** described stratiform manganese mineralization in the turbidite units, considered to be syngenetically to syndiagenetically formed in anoxic marine conditions. Lower greenschist facies metamorphism has formed new Mn-bearing minerals without destroying sedimentary and diagenetic textures. The sedimentology of the Cambrian in the Fishguard area of South Wales was interpreted by **C. Cornelius & A. Hartley** as shallow marine to tidal facies preserved in fault-repeated slices. Early to Mid-Ordovician sedimentation is dominated by the Arenig transgression and the subsequent basin deepening. The transgression was documented by **C. Cornelius & A. Hartley** in the Fishguard area, where a local deltaic facies is important, and by **J.-J. Traynor** in southern Dyfed, where local facies control by pre-Arenig topography is especially evident. New biostratigraphic correlation of the Arenig in North Wales by **A. J. Beckley** showed that the transgression was strongly diachronous. Early to Mid-Arenig deposition occurred in small fault-controlled basins, with a major Late Arenig foundering initiating more widespread basinal marine conditions. **R. Trythall *et al.*** described oolitic ironstones deposited during the Mid-Ordovician continuation of this basinal history in North Wales. Iron was sourced from a nearby landmass, possibly the Irish Sea Landmass to the northwest, and deposited under local tectonic control on upthrown fault blocks in the basin.

Late Ordovician sedimentation and volcanism were intimately linked in North Wales. **G. Orton** showed how volcaniclastic sediment distribution and facies were strongly controlled by volcanotectonic uplift and subsidence. Palaeogeographic configurations in the shallow marine to emergent setting changed dramatically after each volcanic episode. **S. D. G. Campbell *et al.*** showed how the siting of these eruptions was itself influenced by basement faults. Some faults are attributable to caldera formation and other volcanotectonic processes. Latest Ordovician post-volcanic sedimentation in South Wales was described by **J. M. Anketell.**

Early Silurian sedimentation was described mainly from Mid-Wales. **J. M. Anketell** documented the latest Ordovician to Llandovery lithostratigraphy over a large area of central Dyfed and, with **T. Kishimoto**, focused on the sedimentology of one Lower Llandovery turbidite unit. A steady downcurrent and crosscurrent waning of flow strength is apparent in the axially transported main system, but a separate western system was supplied laterally from local fault scarps. **N. H. Woodcock** gave evidence for syndepositional fault control in the shallow marine Llandovery sediments across the SE margin of the basin. The Wenlock turbidites in Powys were detailed by **A. J. Dimberline & N. H. Woodcock**. An axially supplied high efficiency system was laterally confined by a fault-controlled southeastern margin to the basin, which the system first onlapped then offlapped. Thin storm-triggered events also reached the basin from the bordering shelf, whose carbonate facies were interpreted by **K. Ratcliffe**. The Much Wenlock Limestone Formation apparently shows two sea-level

controlled cycles of increasing depositional energy, reflected in facies and morphologies of Cyanophyte algae.

Late Silurian sedimentation began in the Powys area with a facies of laminated hemipelagites interbedded with thin silt-mud event deposits. The hemipelagites, common throughout the Wenlock and into the Ludlow, were interpreted by **A. J. Dimberline & J. E. Tyler** in terms of annual or seasonal alternation of phytoplankton and silt supply, with deposition in poorly oxygenated conditions. **J. E. Tyler & N. H. Woodcock** demonstrated that the low oxygen zone impinged on the outer part of the shelf as well as the basin. In Early Ludlow time the outer shelf also received abundant carbonate silt and shell debris during events attributed to major storms. Major slumping occurred in this area in mid Ludlow time. It is also widespread in the North Wales Silurian, from where **A. Maltman** described the microstructural characteristics of the deformed sediments. He was able to match field structures with those formed in experiments on clays, and therefore make estimates of the water content of the Silurian sediments during deformation.

Caledonian deformation in North Wales was described mainly with reference to the pre-Silurian rocks of the mainland. **I. Wilkinson** reported a strain determination study on the Caradoc volcanics of Snowdonia. Local strain heterogeneity was particularly apparent but the averaged regional finite strain is close to plane strain and indicates a strong component of simple shear in the deformation of North Wales. Fracture pattern studies of one group of Snowdonia folds were described by **G. Jenkins**. He highlighted methodological problems, particularly conflicting patterns obtained from ground survey and Landsat imagery. A detailed Landsat study of part of western North Wales was described by **R. Maude**. Here the main lineament sets could be reasonably correlated with fractures on the ground. N–S and NW–SE fractures are important as well as Caledonoid trends. A supposedly major fracture, the Tremadoc 'Thrust', was reassessed by **M. Smith** who found little evidence for its existence. The Cambro-Ordovician boundary here is seen as essentially unfaulted, and deformed Ordovician rocks are associated with a steep shear zone rather than a low angle fault. An undoubted major fracture zone, the Bala Fault lineament, was reviewed by **W. R. Fitches & D. G. Campbell**. It was not a discrete long narrow tectonic zone in Early Palaeozoic time, when N–S structures were equally important, and is essentially a Variscan structure. The Bala Fault does not link obviously with offshore structures active in Mesozoic and Tertiary time. Nor can it have post-Carodoc strike-slip displacement of more than a few kilometres. **D. G. Campbell *et al.*** demonstrated this point by correlating Caradoc volcanic facies and isopachs across the fault. The Caledonian history of Anglesey was analysed by **D. Carter**, who showed how consistent SE-facing structures are superimposed on the earlier pre-Arvonian episode. The same folds and cleavage cut the Lower Old Red Sandstone suggesting a late age for the Caledonian episode.

Caledonian deformation in South and Mid-Wales is still hard to correlate with that in the North, despite Fitches' and Campbell's evidence that the two regions were not widely separated. **J. M. Anketell** described the common pattern of SE-verging folds and NW-dipping cleavage cut, in central Dyfed, by a fault belt with sinistral strike-slip components. Traced across strike to the NW, the structures become vertical at a major vergence divide, the Llangranog lineament, and verge NW on the Ceredigion coast. **J. Craig** showed that this lineament is characterized by major inward dipping oblique-slip faults and oblique cleavage-transected folds. He interpreted it as a positive flower structure later disrupted by post-Caledonian extension. **N. H. Woodcock** described major SE-verging structures in the Llandovery area of east Dyfed, localized partly by underlying basement fractures and partly by lenticular sand bodies. The major folds here affect Lower Old Red Sandstone rocks, again suggesting a late age for Caledonian deformation. The NE–SW trending structures across Mid-Wales swing towards E–W when traced westward. On the coast near fishguard **C. Cornelius & D. D. Hawkes** have identified a major N-dipping thrust system repeating large sections of the stratigraphy, and cut later by minor dextral strike-slip faults.

Post-Caledonian events were mentioned in several contributions but were the focus of two. **D. Wilson *et al.*** showed how inherited basement fractures in SE Wales controlled Devonian and Carboniferous sedimentary patterns. Dextral offsets on a Severn Estuary lineament were particularly important. **R. J. Whittington** used seismic profiles to constrain fault locations and histories in Cardigan Bay. Upper Jurassic/Early Cretaceous and Late Tertiary movements were particularly important offshore but faults may be substantially decoupled from those onland by N–S transfer faults.

Most of the presented papers described new field data in their local tectonic context. There was uniform caution in speculating on models for the plate tectonic setting of Early Palaeozoic Wales. However, certain recurrent themes are highlighting some of the components of any admissible model. The Welsh Basin was tectonically active throughout its Early Palaeozoic history, without lengthy quiescent periods. This activity, particularly of basement fault zones, markedly controlled the siting and facies type of sediments and volcanics. A deep basin is proved only in Llandovery and Wenlock time in Mid-Wales. There are no major terrane boundaries of Caradoc or later age within the basin, but lineaments played a persistent role during sedimentation and the Caledonian deformation. This deformation had a strong basement-involved component, responsible for strain heterogeneity in North Wales and localizing significant strike-slip displacement in Mid-Wales. Thrust tectonics may be important in South Wales. The Caledonian climax probably post-dates the Lower Old Red Sandstone. The lineaments reactivated at this time continued to influence sedimentation through Late Palaeozoic and, at least offshore, later time.

The list of authors and titles of papers presented will be given in the Proceedings. The papers will be published in the *Geological Journal.*