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Patterns of sedimentation in Lower Silurian Wales

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Wales in early Silurian times was the site of a deep marine basin, in the order of 1 km deep, adjacent to an area of shallow seas, now the Welsh Borderland and English Midlands. During the late Silurian to Devonian, collision occurred between the microcontinent, "Avalonia", on which the Welsh basin was situated and a large plate, "Laurentia". To the north the sedimentary fill of the basin underwent compression. This resulted in the development of folds, cleavage and faults.

In his doctoral research, the author had selected a 'slice' of basin fill which accumulated during a period lasting about 1 million years. This 'slice' is presently discontinuously exposed over a distance of about 100 km in a NNE-SSW direction in Central Wales and is characterised by a single graptolite zone – the *griestoniensis* Zone.

The first task in reconstructing the nature of the basin during the period of the chosen time slice was to work out the present day structure of the sequence and then "unravel" the folds and remove displacements on the faults. This done, it was then possible to describe and interpret lateral variation in features of the sediments.

The basin fill consists dominantly of turbidites – the deposits of turbulent sediment-water mixtures called turbidity currents which travel down slopes by virtue of their density exceeding that of water. As the slope decreases towards the basin floor these currents decelerate and deposit progressively finer grainsized material as the current loses its energy. This results in the deposition of graded beds which often show a characteristic vertical sequence of structures called a Bouma Sequence. Turbidity current heads are frequently strongly erosive and may create scours such as flute marks, and tool marks such as prods and grooves on the sea floor. These structures provide indicators of palaeocurrent directions which in the *griestoniensis* Zone system reveal dominantly NE and N directions.

Modern turbidite systems (or 'fans') of about the same scale as the *griestoniensis* Zone system (over 100 km long) are all fed by actively prograding river deltas. A broadly analogous modern system would be the Magdalena deep-sea fan in the Caribbean.

The *griestoniensis* Zone system was fed, almost certainly, by a delta system from a tectonically-uplifting land area in SW Wales and clast types in the basinal sedimentary sequence can be matched with Precambrian basement rocks currently exposed in SW Wales. Turbidity currents would have been initiated by failure, probably often seismically induced, or unstable accumulations of sediment on the southern shelf edge.

Study of the distribution of 'biofacies', i.e. preserved remnants of the animal communities of the time, enabled inferences to be made about such parameters as dissolved oxygen contents in bottom waters, water turbulence and distance from nearshore and surface water nutrient sources. For the time slice in question five biofacies could be recognised along a shelf-to-basin transect across the Midland Platform into the Welsh Basin. They comprise, from shallowest to deepest, four 'communities' of shelly benthos (bottom dwellers), the *Eocoelia*, *Pentameroides*, *Costistricklandia* and *Clorinda* communities, followed by a diverse trace fossil assemblage with no associated shelly fauna.

This biofacies pattern could be interpreted in terms of a stratified water column model with a distribution of dissolved oxygen in the water column closely analogous to that in the modern Santa Cruz basin of the California continental borderland. In the basin, bottom water oxygen

levels were too low to support shelly benthos and at times excluded even soft-bodied animals.

In conclusion the author considers this to have been a difficult exercise in integrating several different lines of research in order to reconstruct an ancient deep-water environment.

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