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GEOTECTONIC INTERPRETATION OF RHENISH AND HERCYNIAN FACIES IN THE MID-EUROPEAN VARISCAN FOLDBELT

by

Jaroslav DVORAK [1]

ABSTRACT

The sediments of the Rhenish and the Hercynian Facies were deposited in the same water depth. The thick sequences of the Rhenish Facies were laid down in very agitated water during rapid subsidence of the basement. The thin series of the Hercynian Facies were deposited under relatively calm conditions ; subsidence was minimal. This facies frequently filled "relic areas" overlying thick sequences of the Rhenish Facies or very thick sequences of Early Paleozoic age.

KEY WORDS

Variscan foldbelt, Devonian, Carboniferous, facies, pelagic sediments.

1. INTRODUCTION

The geotectonic interpretation of the Hercynian Facies (Rabien, 1956) is still in discussion (most recently Engel *et al.*, 1983 ; Langenstrassen, 1983 ; Franke & Walliser, 1983 among other references).

The Hercynian Facies, a quiet-water facies containing open-marine faunas, overlies, or interfingers with the Rhenish Facies. The thickness of the Hercynian sediments is nearly everywhere smaller compared to the Rhenish sediments. It has hitherto been considered as a deeper-water deposit than the Rhenish Facies. Based on this observation, deposition of the thin sediments of the Hercynian Facies was postulated (Fig. 5 in Langenstrassen, 1983) in deep-water throughs, while Rhenish Facies sediments should have been deposited on "horsts" in an agitated water environment. This model fails to retain its validity because of hydrodynamic reasons : the currents must have brought coarse clastic material into depressions (Fig. 1).

2. INDICATIONS OF WATER DEPTH

The present author's geotectonic interpretation is based on the assumption that Hercynian Facies sediments were laid down in a shallow-marine environment without strong current caused by retarded subsidence of the basin basement (Fig. 2). These sediments often indicate regression of the sea ; terminated subsidence is followed by a break in deposition (e. g. nodular limestones at margins of extinct reefs (Dvorak, 1972, 1987 ; Dvorak *et al*, 1976, 1987). Unequivocal evidence of the shallow-marine nature of the Hercynian Facies is provided by the intimate alternation of Rhenish and Hercynian Facies in Celtiberia of NE Spain (Carls, 1988). Similar evidence is provided by the biofacies of marine shale interbeds in the paralic Upper Carboniferous : goniatites and pseudoplanktonic molluscs (Paproth *in* Paproth & Wolf, 1973).

Engel *et al.* (1983) have made an attempt to explain the small amount of sandstones in the Hercynian Facies by the presence of an "outer rise" forming a barrier to the transport of clastic material into the basin. They admit, however, that such rises occurred only locally and are not able to resolve the problem in a general way. On the other hand, accepting that the Hercynian and Rhenish Facies were deposited at the same depth, the problem of transport of coarse-grained clastic material into a "deeper" environment does not exist anymore. Thin interbeds of well sorted, fine-grained sandstone in the Hercynian Facies are generally not interpreted as sediments laid down by turbidity currents.

A gradual replacement of the Rhenish Facies by the Hercynian Facies, and a northwestward shift of the facies boundary during Emsian and Middle Devonian (see Fig. 3 in Langenstrassen, 1988) indicates a high degree of consolidation of the entire interior of the Rheinisches Schiefergebirge, showing little tendency to subsidence. Sediments of the Hercynian Facies thus fill only "residual areas" located between single inversion structures (Dvorak, 1977).

[1] Ustredni ustav Geologicky, Leitnerova, 22 - 60200 Brno, CSSR

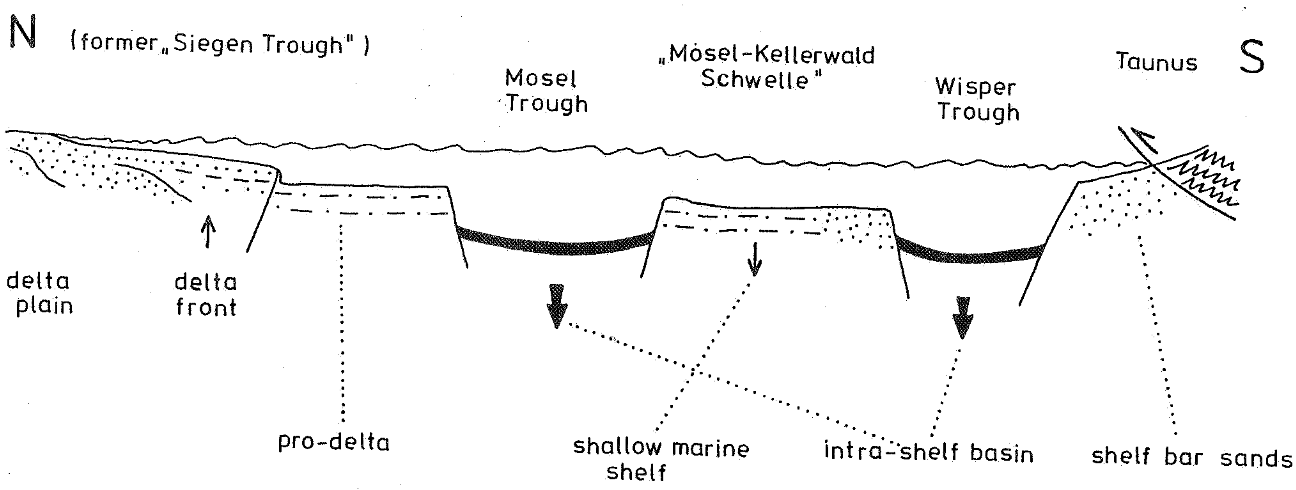

Figure 1. : This figure shows the idea of the Göttingen School about the relationship between the Rhenish and Hercynian Facies on the beginning of the Emsian in the Rheinisches Schiefergebirge. From the hydrodynamic point of view this model is not realistic - the currents transported the coarse clastic material in the depression (Fig. 5 in Langenstrassen 1983, a little simplified).

3. THE CASE OF THE EIFEL

What may serve as a classical example of sedimentation in a "residual area" is the Eifel area, unaffected by inversion in the Lower Devonian and thus nearly unfolded and not deeply eroded later. Struve (1963) showed clearly that synclinal areas filled with Middle and Upper Devonian sediments are bounded on the northeast and southwest by synsedimentary faults trending NW-SE (Dvoràk, 1973, Fig. 4). Carbonate rocks of reduced thickness deposited here during the Middle Devonian were later not covered by thicker sequences of younger sediments as evidenced by the weak alteration of organic matter (M. & R. Teichmüller, 1951). The basement mobility considerably decreased as early as the Middle Devonian. Biofacies analysis of the Middle Devonian sediments (Faber, 1980) has shown that in the northwestern part of the area deposition took place in an environment with strong currents, whereas in the southeastern part sediments were deposited in the quiet environment of an embayment. In no case was the southerly part deeper than that in the north. Like the laminated bituminous claystone facies of the Bildstock Horizon in the Salmerwald syncline, the Wolfenbach Facies (Lauch-Schichten) may be interpreted only as consisting of sediments deposited in a shallow, poorly aerated embayment without water movement at the bottom. Supply of the terrigenous deposits (land-derived material) of this facies took place from the nearest southeastern surroundings and was essentially weaker than that coming from the north.

Struve's (1963) reconstruction of palaeogeographic conditions established around the Eifel synclines still retains its validity. The Paffrath Syncline east of the Rhine, with a comparatively lower paleothermal gradient attaining a value of 40°C/km (Wolf *in* Paproth & Wolf, 1973), had a similar history of development. A similar or still lower paleogradient is believed to have prevailed throughout the Eifel block during the Middle and Upper Devonian.

4. OTHER AREAS WITH "PELAGIC" SEDIMENTS

Slow "pelagic" marine sedimentation started in the Middle Devonian in England and persisted to the Carboniferous, known as "the bathyal lull" (Goldring, 1967). This "bathyal" interval was diachronous and spread across the British continental shelf from south to north. There is the same situation as in the Rheinisches Schiefergebirge : thin Hercynian Facies on top of thick Rhenish Facies and migrating to the north.

Under this viewpoint also the Devonian sediments in the Barrandium with Hercynian or Bohemian bio- and lithofacies have to be interpreted as shallow-marine deposits in an open bay. Especially the red-colored nodular limestones are typical of a shallow and oxidized environment. The synclinorium of the Barrandium is no erosion relic of a deep-water trough.

The same applies for the thin calcareous sediments of the Middle and Upper Devonian (including Tournaisian) of the Montagne Noire in southern France. Feist (1985) thought the biodetritic shallow-marine limestones have been deposited upon red-colored deep-water nodular limestones. Since there is no proved gap between the nodular limestones and the biodetritic limestones, it seems to be impossible that a shallow-marine limestone overlies directly a deep-water limestone. In my opinion the biodetritic limestones have been deposited during relatively quick subsidence of the crystalline basement ; currents have leveled the depressions filled inmediately by biodetritic material. The condensed nodular limestones, on the other hand, were deposited in well-aerated embayments under oxidizing conditions without strong bottom currents and during very slow subsidence.

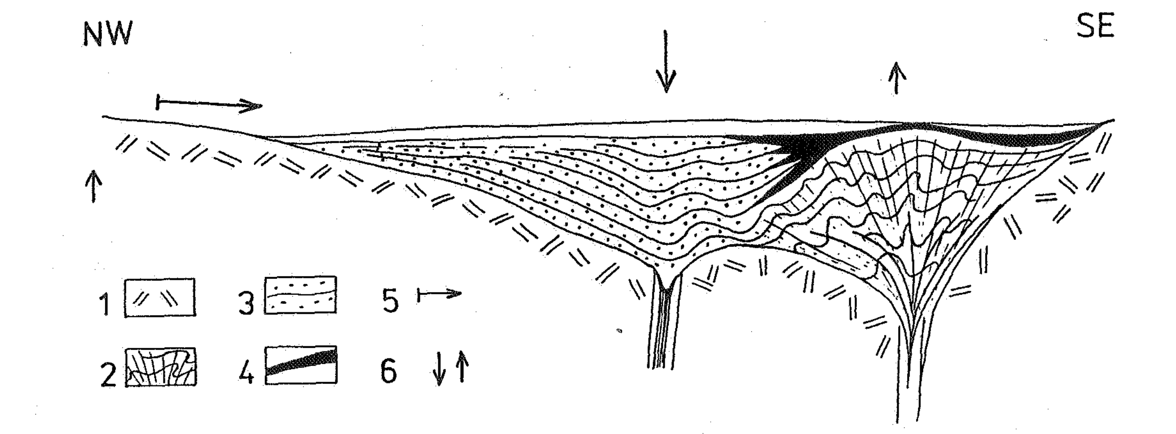

Figure 2. : Schematic cross-section of the Rheinisches Schiefergebirge illustrating the relationship between the Rhenish and Hercynian Facies. Development and migration of inversion structures is shown. Without scale. 1 - the crystalline basement, 2 - Rhenish thick Facies of the older inversion structure, 3 - Rhenish Facies of the younger inversion structure, 4 - Hercynian Facies, filling the residual areas between the single inversion structures, 5 - direction of the transport of clastic material, 6 - subsidence and uplift.

No exception is known from the sedimentation area in the Saxothuringian either. The highly condensed shales and nodular limestones of Devonian age have been deposited likewise in an embayment. Oxidizing conditions predominated at the margin of the basin only, e. g. in the Famennian. In the *P. marginifera* conodont zone, red nodular limestones have been deposited only at the western margin of the basin (Bohlen near Saalfeld). In this case the red coloration is primary and not secondarily derived from the overlying Zechstein. The sandstone intercalations in the uppermost Famennian and in the lower Tournaisian were deposited by ordinary, non-turbiditic currents. In the basin center prevailed rather reducing conditions.

5. CONCLUSIONS

The sediments of the Rhenish and the Hercynian Facies were deposited in the same water depth. The thick sequences of the Rhenish Facies were laid down in very agitated water during rapid subsidence of the basement. The thin series of the Hercynian Facies were deposited under relatively calm conditions ; subsidence was minimal. This facies frequently filled "relic areas" overlying thick sequences of the Rhenish Facies or very thick sequences of early Paleozoic age (e. g. Barrandium, Saxothuringian, Montagne Noire). The "pelagic" fauna of the Hercynian Facies lived in very shallow water, only a few meters deep. It can not give any hint at the depth of the sedimentation area. In these pelitic sediments this fauna is preserved best.

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