Fluvial Sedimentation of the Słupiec Formation (middle Lower Permian) in the Nowa Ruda Area (Intra-Sudetic Basin, Sudetes, SW Poland)

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The Słupiec Formation comprises the majority of clastic sediments within the middle Lower Permian strata of the Intra-Sudetic basin. Its maximum thickness reaches approximately 600 m. The base of the formation is defined by a horizon of fine-grained lacustrine sediments called the Upper Anthracosia Shale. Its top corresponds to the boundary with the overlying conglomerates of the upper Lower Permian Radków Formation (Nemec et al. 1982).

The lower part of the Słupiec Formation, referred to as the Building Sandstone Member, is mostly composed of sandstone with intercalations of conglomerate. The amount of fined-grained sediments of the Walchia Shale gradually increases towards the top of the formation. The Building Sandstone usually comprises arkosic or subarkosic arenites. The subordinate conglomerate generally displays polymictic composition whereas shales are mostly arkosic mudstones enriched in fine-grained sand and carbonates. The distinct reddish colour is characteristic of all textural varieties of sediments from the Słupiec Formation.

The Słupiec Formation represents facies association showing very variable structural features. Consequently, a detailed characteristics of its structural disparity allowed a new classification of sediments among several lithofacies. Since the Słupiec Formation was deposited mainly in a fluvial environment,

		Facies association	Facies code after Miall (1985)	Sedimentary structures and textural characteristic of deposits	Interpretation
I	1	G Conglomerate and sandy conglomerate	Gms	Massive or graded conglomerates and sandy conglomerates	Gravity flow deposits
	2		Gm	Massive conglomerate and sandy conglomerate, sometimes imbrication and pebbles lineation	Lag deposits, internal parts of the bars (upper flow regime)
	3		Gc*	Pebbles horizons in conglomeratic sandstone, often imbrication and pebbles lineation	Lag deposits (channel pavement), (upper flow regime)
II	4	S Sandstone	Sm*	Sandstone, massive, medium to very coarse, may be pebbly sandstone	Minor channel fills, rapid sedimentation of clastic material, (upper flow regime)
	5		Sh	Fine to coarse sandstone with horizontal lamination, often streaming lineation	Planar bed flow (upper flow regime
	6		Sl	Fine to medium sandstone with low angle crossbeds	Minor channel fills in upper flow regime conditions (antidunes phase)
	7		Sp	Medium to coarse sandstone with planar crossbeds (solitary or grouped), often intraclasts and admixture of gravel	Transverse bars, side bars, lower flow regime (rhythmical phase of transport)
	8		St	Fine to coarse sandstone with trough crossbeds, often intraclasts and admixture of gravel	Channel deposits at all, dunes, lower flow regime (rhythmical phase of transport
	9		Sr	Fine grained sandstone with ripple crossbeds	Minor channel fills, lower domain rhythmical phase of transport (lower flow regime)
III	10	F Fine grained deposits	Sr/Fl*	Fine to very fine sandstone and mudstone with ripple cross lamination of all types	Levee and flood plain deposits, lower domain rhythmical phase of transport/lower planar bed
	11		Fl	Mudstone with horizontal lamination	Levee and flood plain deposits, lower planar bed condition

*Lithofacies distinguished by the present author and not described in Miall (1985).

Tab. 1. Sedimentary facies of the S³upiec Formation.

the slightly extended lithofacies code of Miall (1985) was used herein, as it used to be commonly applied to similar sedimentary successions. A summary of the distinguished lithofacies and their brief characteristics are presented in Table 1.

Detailed lithofacies analysis of the Słupiec Formation suggests rather exceptional conditions of its sedimentation. There occurs a vast majority of channel facies comprising gravelly (Gm, Gc) and sandy material (mainly Sm, Sh, Sl) deposited by high energy flows. They are mostly accumulated under the upper flow regime conditions (planar bed and antidunes phases) or conditions corresponding to the upper range of the rhythmic transport phase. Channel facies produced by lower energy flows (Sp, St, Sr) and overbank facies, usually related to lower planar bed conditions (Sr/Fl and Fl), are relatively rare. Quite important for the studied sediments is the presence of the lithofacies Gms (see Tab. 1), interpreted as the product of debris flow. Examination of palaeochannel forms yields results compatible with lithofacies analysis. Usually, they are very shallow with respect to their width and show width/depth ratio between 10 and 15(20). Furthermore, they are characterized by a flat distinctly erosional relief of bottom. Sometimes, channel banks are shaped by local terraces. Altogether, these features are typical of ephemeral channels rapidly filled by high energy flows. Such channels apparently played a minor part in the whole drainage system. Besides numerous small channels, there are few large ones filled with gravelly or sandy-gravelly deposits (Gm, Gc, Sm, Sp, St). They probably represent major distributary channels in the fluvial system of the Słupiec Formation. The palaeotransport indicators unequivocally point to the westward direction of palaeocurrents with a slight deviation to the north (280–285°).

Features of the described fluvial system correspond well to those typical of the terminal fans environment (Kelly and Olsen 1993). A source area of the Słupiec Formation was located along the S and SE margins of the basin. Clastic material was transported towards the W and NW into shallow lakes forming the inland playa system. The latter was developed in the central part of the Intra-Sudetic basin during the Early Permian. The reddish colour of the sediments may indicate arid or semi-arid climate conditions during their deposition.

References

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Sequence Stratigraphic Relationships of Rhythmically Bedded Hemipelagic Deposits and Coarse-grained Deltas in an Epicontinental Setting; Example from the Turonian of the Bohemian Cretaceous Basin

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The Upper Turonian stratigraphic succession of the NW part of the Bohemian Cretaceous Basin – a shallow, intracontinetal strike-slip setting – is represented by deposits of shallow-water coarse-grained deltas in the northern part of the basin, and by rhythmically bedded hemipelagic marlstones and limestones on a ramp-type margin in the southern part of the study area. Regional subsurface (well log-based) correlation suggests that the accumulation of hemipelagic deposits was coeval with long-term progradation of the deltaic complex fed from a major source area to the north. This provided a unique opportunity to address the tricky question of sequence stratigraphic signatures in distal hemipelagic settings. Since preliminary results of spectral analysis (mutitaper method; Meyers, 2000, unpubl.) suggest that the hemipelagic rhythms reflect Milankovitch-driven climatic changes, this study has a potential to contribute to the discussion on orbitally-driven eustasy during the Cretaceous.

Our objective was to provide a) detailed tectonic, sequence stratigraphic and chronostratigraphic framework of the studied interval, b) identify the effects of regional changes in relative sea level on the hemipelagic sedimentation, and c) consider the potential of a causal relationship between relative sea level changes and the hemipelagic cyclicity. Our conclusions are summarized below.

The onset of hemipelagic sedimentation was *not* triggered merely by regional changes in relative sea level (RSL). Instead, tectonic reactivation of the area together with specific circulation patterns (along-strike redistribution of most of the suspended load) are likely to have been the principal factors responsible for the unusual coexistence of carbonate-dominated and coarse clastic-dominated depositional systems.

A minimum of three orders of depositional cyclicity, all in the Milankovitch band, could have been distinguished in both the clastic-dominated and hemipelagic settings.

Regional correlation suggests a genetic link between the depositional variations in the clastic and hemipelagic settings.

The lithologic variations in the hemipelagic setting were dominantly controlled by changes in terrigenous dilution, which usually (not always) went in tandem with regional changes in pelagic productivity. These mechanisms were governed by both allocyclic and autocyclic processes whose effects varied with the time-scale: e.g., the impact of short-term RSL changes on sediment delivery into the basinal are-