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

KELLY S.B. and OLSEN H., 1993. Terminal Fans – a review with reference to Devonian examples. *Sedimentary Geology*, 85: 339-374.

MIALL A.D., 1985. Architectural-Element Analysis: A New Method of Facies Analysis Applied to Fluvial Deposits. *Earth-Science Reviews*, 22: 261-308.

NEMEC W., POREĘBSKI S.J. and TEISSEYRE A.K., 1984. Explanatory Notes to the Lithotectonic Molasse Profile of the Intra-Sudetic Basin, Polish Part. *Veröff. Zentralinst. Phys. Erde. AdW. DDR*, 66: 267-278.

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-

as was significantly stronger than the influence of long-term RSL fluctuations. Autocyclic processes and RSL-independent variations in sediment input could have been significant only on the medium- and long-term scales, i.e., they could have modified bundling of the small-scale lithological units. Relative sea level variations (regional and local) were responsible for most of the prominent lithologic changes identifiable in subsurface data. Along with the dilution mechanisms, the RSL control was mediated by changes in the accommodation envelope: owing to the generally low-accommodation conditions, deposits of medium- and long-term lowstands show a tendency for winnowing or bypassing-related condensation. The winnowed (typically phosphate-bearing) intervals are considered lowstand deposits. In many cases, they can provide the key for sequence stratigraphic interpretation of distal hemipelagic successions.

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Depositional and Relative Sea Level History of the Cenomanian/Turonian Interval, Dakota and Straight Cliffs Formations of the Western Interior Basin, Southwestern Utah

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Continental to shallow marine deposits of the latest Cenomanian to Middle Turonian age were studied in the westernmost part of the Western Interior foreland basin, in the areas of Markagunt and Paunsaugunt plateaus. The combination of field and subsurface-based, sedimentologic and stratigraphic research allowed a relatively detailed reconstruction of depositional and relative sea level history of the interval to be made. Further correlation with the 'classic' hemipelagic succession of the Bridge Creek Limestone, in which fine orbital tuning was performed in previous studies (Meyers et al., in press), resulted in relatively precise assessment of the temporal context of the stratigraphic record.

The studied succession was subdivided into 14 informal units based on recognition of surfaces or zones of subaerial exposure, which are overlain by marginal marine deposits (typically barrier/lagoonal). Most of these depositional units formed in response to allocyclic processes, but their relationships to possible high-frequency relative sea level (RSL) changes remains debatable.

The depositional units are grouped into three packages, whose bounding surfaces can be laterally traced into erosional surfaces of probable fluvial origin. These surfaces are interpreted as sequence boundaries (*sensu* VanWagoner et al. 1988). The erosional topography is typically filled with deposits of tide-dominated estuary, which are attributable to lowstand or early transgressive systems tracts.

The sequence stratigraphic analysis suggests that prominent RSL rise and the associated transgression during early *Sciponoceras gracile* were followed by three minor (medium-term) episodes of forced regression, all during the latest Cenomanian (*Sciponoceras gracile* to early *Neocardioceras juddii*). Another prominent RSL rise took place during the latest Cenomanian (late *Neocardioceras juddii*), and culminated during Early Turonian. Its effect was, however, partly masked in the westernmost part of the study area by syndepositional deformation and uplift of the foredeep deposits.

In addition to regional changes in relative sea level, local RSL variations due to faulting in the proximal foredeep affected the geometry of the basin fill. Late Cenomanian to Early Turonian subsidence history of the study area was characterized by rapid eastward (i.e. basinward) migration of the major depocenters, which might have been related to in-sequence propagation of the Sevier thrust front.

Well-log-based correlation of the regional sequences to the coeval hemipelagic succession with well-established chronostratigraphic framework suggests that durations of the short-term depositional sequences ranged between 80 and 100 ka. These values are comparable to periodicities of the Milankovitch cycles of eccentricity suggesting a possibility of orbital forcing of the regional sea level fluctuations.

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References

MEYERS S.R., SAGEMAN B.B. and HINNOV L.A., in press. Integrated quantitative stratigraphy of Cenomanian-Turonian Bridge Creek Limestone Member using evolutive harmonic analysis and stratigraphic modeling. *Journal of Sedimentary Research.*

VAN WAGONER J.C., POSAMENTIER H.W., MITCHUM R.M., VAIL P.R., SARG J.F., LOUTIT T.S. and HARDENBOL J., 1988. An overview of fundamentals of sequence stratigraphy and key definitions. In: C.K. WILGUS et al. (Editor), Sea Level Changes: An Integrated Approach. *SEPM Spec. Publ.*, 42: 39-44.