Climatic vs. Tectonic Controls on a Shallow-Water Hemipelagic Carbonate System (Turonian of Western Bohemia)

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Hemipelagic carbonate systems are generally sensitive to orbitally-driven climatic oscillations, as suggested by spectral analyses of their geochemical and lithological properties. The mechanisms mediating this climatic control and their interplay with climate-independent processes are, however, poorly understood.

The middle Turonian through early Coniacian Jizera and Teplice Formations of the western part of the Bohemian Cretaceous Basin record a close coexistence of a mixed carbonate-siliciclastic hemipelagic system with a siliciclastic, deltaic/shoreface depositional system. This setting makes it possible to examine the effects of different depositional processes (e.g. transgressive-regressive changes vs. changes in carbonate production) and primary factors (tectonics vs. climate) on the hemipelagic system.

Facies and stratigraphic geometries suggest that the onset of carbonate-dominated hemipelagic conditions coincided with relative uplift of basement blocks along the Labe Fault zone that partly separated the siliciclastic and hemipelagic systems. Faunal (e.g. Švábenická, 1999) and oxygen-isotope changes across the base of the hemipelagic succession suggest that the tectonically-induced change in basin geometry promoted the carbonate-dominated conditions by facilitating communication of the Bohemian basin with the pelagic-carbonate factories of northwestern Europe. These background conditions were modulated on shorter-term scales by changes in terrigenous input due to transgressive-regressive changes along the adjacent basin margin. A combination of biostratigraphy-based time constraints (Laurin and Uličný, in press) and spectral analysis of well-log signatures of the hemipelagic strata strongly suggests that Milankovitch-driven changes in seasonal insolation provided the ultimate control on the internal cyclicity of the emipelagic system.

To test the above interpretations and to constrain the sensitivity of the hemipelagic system to different forcings, we performed a set of numerical stratigraphic simulations with SedTec2000 (Boylan et al., 2002). The model results suggest that the key prerequisites for establishment and long-term persistence of the carbonate-dominated hemipelagic conditions in the immediate vicinity of a siliciclastic margin included (i) secular increase in the local background carbonate production, (ii) presence of short-term transgressive episodes (irrespectively of whether sea level-driven or not), and possibly (iii) long-term deceleration of mud flux into the hemipelagic setting. The Milankovitch control might have been mediated by changes in relative sea level or changes in river runoff and sediment yield. An "in-phase" combination of these mechanisms (i.e. low sediment flux accompanying sea-level lowstands) contradicts the observed stratigraphy. Changes in carbonate production mostly followed the changes in terrigenous and freshwater fluxes, being inhibited by high concentrations of suspended load and lowered salinity. Finally, short-term accelerations in the rate of subsidence of the siliciclastic depocenter were capable of outpacing the simulated Milankovitch-driven falls in relative sea level. However, superposition of an isolated subsidence/uplift event upon periodic, "climate-driven" relative sea level history generated distinct harmonic distortions in spectral estimates of the simulated hemipelagic rhythmites. This feature makes it possible to distinguish the background climatic signal from episodic events, and partly explains the persistence of Milankovitch-like spectral estimates even in 'noisy' epicontinental settings.

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References

BOYLAN A.L., WALTHAM D.A., BOSENCE D.W.J., BADENAS B. and AURELL M., 2002. Digital rocks: linking forward modelling to carbonate facies. *Basin Research*, 14: 401-416.

ŠVÁBENICKÁ L., 1999. Braarudosphaera-rich sediments in the Turonian of the Bohemian Cretaceous Basin, Czech Republic. *Cretaceous Research*, 20: 773-782.

LAURIN J. and ULIČNÝ D., in press. Controls on a shallow-water hemipelagic carbonate system adjacent to a siliciclastic margin; example from Late Turonian of Central Europe. *Journal of Sedimentary Research*.