

# ORBITAL FLUCTUATIONS AND PALEOCLIMATE CHANGE RECORD IN RHYTHMIC ROCK SEQUENCES

J. MICHALÍK<sup>1</sup>, O. LINTNEROVÁ<sup>2</sup>, J. SOTÁK<sup>3</sup> and N. HUDÁČKOVÁ<sup>4</sup>

<sup>1</sup>*Institute of Geology, Slovakian Academy of Science, Dúbravská 9, 842 26 Bratislava;* <sup>2</sup>*Economic Geology Department, Faculty of Science, Comenius University, Mlyny B-1, 842 15 Bratislava;* <sup>3</sup>*Institute of Geology, Slovakian Academy of Science, Severná 5, Banská Bystrica;*

<sup>4</sup>*Geology and Paleontology Department, Faculty of Science, Comenius University, Mlyny B-1, 842 15 Bratislava*

**Abstract:** Laminated sequences are extremely interesting from point of view of paleoclimatic reconstructions, as they indicate range of seasonal changes. Although the interpretation is often complicated by interference of sediment supplying mechanisms, biogenic factors, or syntectonic processes, this method offers new, little evolved way of sedimentologic and paleoenvironmental research.

**Key words:** Laminated texture, orbital rhythms, climate turnovers

Periodic climatic and oceanographic changes and the resulting rhythmic sedimentation patterns can be preserved in the sedimentary record, providing that the sediment supplying mechanisms and the relative sedimentary facies are sufficiently sensitive (DeBoer & Smith 1994). Although stratigraphic column never gives a precisely linear representation of fluxes of sediment components over time, four types of harmonic distortions were recognized by Herbert (1994): self-, cyclical-, linear- and step-function modulations. The 100 and 400 ka eccentricity Milankovitch cycles were recorded in limestone – marl cycles (Schlicht et al., 1999). Similarly, Tithonian Solnhofen Plattenkalk (Park & Fürsich 2001) sequence shows alternation of purely micritic limestone layers rhythmically interbedded with marly micritic limestone, formed under orbital control. Although laminae formation may result from the composite effect of two or three distinct climatic processes, the main cycle correspond to precessional one, a single lamina represents a multi-(22?) -year interval.

Two examples, well illustrating climate regime at the beginning of Late Triassic and Late Badenian, as well, were selected for comparison.

❖ Middle Triassic accumulation of huge carbonate shelf sediments was interrupted by sudden terrigenous influx. Although this influx affected only part of the Triassic carbonate platform complex in the Mediterranean Tethys (Roniewicz & Michalík, in print), abrupt facies change in northernmore units proves for important paleoclimatic and paleoenvironmental turnover at the Ladinian/Carnian boundary. Enormous masses of fine

clastics transported into nearshore shallow carbonate basins evoke sudden increase of precipitation on the land.

Detailed investigations of the lowermost part of the Hauptdolomit in the Liptovský Hrádok section shows typical extremely fine lamination: 22 pale laminae of yellowish to gray-brown subhedral dolosparite alternate with black dolomicrite with increased organic matter content in one centimeter. Primary textures including ooid phantoms, pseudopellets, sparite voids (bird eyes), evaporite nodules, microbial laminations, and ostracod shells were observed. Moderately increased total organic carbon content (TOC = 1-1.5 %) is typical in almost all dolomite samples. Thicker, less frequent white bands of grained dolomite are tuft- or enterolithic-like deformed. This deformation affects also several adjacent higher-up lying laminae, where roof-like “tee-pee” structures, subrectangular slabs and “platy” collapse breccias were produced. These phenomena were probably connected with anhydrite-to-gypsum transformation (Kendall 2001, Lugli 2001).

Interpretation of the  $^{13}\delta\text{C}$  and  $^{18}\delta\text{O}$  isotopic composition indicates change in dolomitization fluids (sudden decrease of  $^{18}\delta\text{O}$  values in range of  $-6\text{‰}$ ) connected with occasional marine- or meteoric water influx saline lagoon. Probably, these changes were controlled by orbital insolation variations and connected eustatic fluctuations. The sequence indicates seasonal character of the climate with occasional dry episodes, which has been affected by last relicts of the humid Rheingraben / Lunz event regime.

❖ Another example of well preserved paleoclimate record is represented by sediments of Badenian Studienka Formation exposed in the Devínska Nová Ves brickyard pit near Bratislava (Bolivina/Bulimina foraminiferal biozone, or Late Badenian nannoplankton NN6 Zone). Planktonic assemblages indicate warm to less temperate paleoclimatic trend from the bottom to the top of the section. The sea floor was subjected to suboxic episodes. The fish association indicates deep neritic conditions. Arctotertiary floral elements dominated over Paleotropical ones. Pollen spectra character indicates swamp forests development in gradual cooling conditions.

Several tenths of meters thick laminated clays sequence comprises several apparently massive, bioturbated intervals, fossiliferous beds rich in echinoids remnants, fish scales and floral debris. 0.3 to 1,8 mm thick laminae of greenish gray clay with fine skeletal debris alternate with dark gray bituminous clay. This lamination indicates seasonal climate with rainy seasons accompanied by stronger terrigenous input alternating with more dry intervals with raised organic matter productivity.

## References:

- DeBoer P.L. & Smith D.G., 1994: Orbital forcing and cyclic sequences. *Spec. Publs. Int. Assoc. Sedimentol.* 19., 1-14.
- Herbert T.D., 1994: Reading orbital signals distorted by sedimentation: models and examples. *Spec. Publs. Int. Assoc. Sedimentol.* 19., 483-507.
- Kendall Alan C., 2001: Late diagenetic calcitization of anhydrite from the Mississippian of Saskatchewan, western Canada. *Sedimentology* 48., 29-55.
- Lugli S., 2001: Timing of post-depositional events in the Burano Formation of the Secchia valley (Upper Triassic, northern Apennines), clues from gypsum-anhydrite transitions and carbonate metasomatism. *Sedim. Geology* 140., 107-122.
- Park M.H. & Fürsich F.T., 2001: Cyclic nature of lamination in the Tithonian Solnhofen Plattenkalk of southern Germany and its palaeoclimatic implications. *Int. Journ. Earth Sci.* 90., 847-854.
- Roniewicz E. & Michalík J. (in print): Carnian (Triassic) corals from the Malé Karpaty Mountains, Western Carpathians, Slovakia. *Geologica Carpathica*.
- Schlicht P., Bengtson P., Hambach U., Krumsiek & Koutsoukos E., 1999: Limestone- marl cycles from the Maastrichtian of the Pernambuco-Paraíba Basin (NE Brazil) – evidence for orbital forcing ? *Boll. Simposio Cret. Brasil*, 121-124.
- Tomašových Adam (1998): Badenian macrofauna of the Devínska Nová Ves brickyard-pit (Bratislava). *MS, Geological and Paleont. Dept. Comenius University Bratislava*, 103.