

Orbitally forced sequences in the Lower Carboniferous and the onset of Carboniferous glaciations at the Tournaisian Viséan boundary

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Investigations realized in the Belgian Tournaisian and Viséan to record the sedimentary cycles allowed to the recognition of eustatic third-order cycles (Hance *et al.*, 2002), which were later extended to Poland and South China. Most of them could correspond to excentricity cycles, of about 2.4 Ma (Poty *et al.*, 2013). Shorter cycles were also recognized and differences in their nature and stratigraphic distribution were enhanced. The Lower Tournaisian (Hastarian substage) and the lower part of the Upper Tournaisian (Ivorian substage) show only short cycles, not grouped in bundles, considered as due to only one orbital parameter corresponding to precession cycles (Poty *et al.*, 2013). They correspond to alternations in monsoon and dryer climates, without strong marked changes in the sea level. Similar cycles are recognized in the rest of the Upper Tournaisian.

The latest Tournaisian third-order sequence (sequence 4 of Hance *et al.*, 2002) is characterized by a very high high-stand system tract, and a flooding of lowlands previously emerged (« Avins event » of Poty, 2007). This very high-sea level caused good connections between marine basins, and thus favours the widespread of foraminifers, brachiopods and corals, through Australia, Japan, China, and the rest of Eurasia. Its falling stage systems tract is characterized by a very strong fall in the sea-level and is considered as corresponding to the development of an ice-cap and to a heralding change to the Carboniferous climate with glaciations. This low sea-level persisted during the earliest Viséan, and the third-order sequence 5 of Hance *et al.* (2002) never reached the shallow marine platforms previously covered by the latest Tournaisian sea. It is from the base of this third-order sequence 5 that a marked fourth (obliquity) and/or fifth-order (eccentricity) cyclicity developed. These latter sequences are the same than the ones recorded in the Middle (Livian substage) and the Upper Viséan (Warnantian substage). The transition between the Tournaisian monsoon climate and the Viséan climate with glaciations is well documented in sections in the Dinant vicinity where the Tournaisian precession cycles passe to eustatic obliquity-excentricity cycles.

Therefore, it can be concluded that the onset of the Carboniferous glaciations is as early as the Early Viséan and not in the Late Viséan as usually considered.

References

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