Orbitally forced sequences and climate reconstruction around the Devonian–Carboniferous boundary, and the Hangenberg Extinction Event

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In Belgium (Namur–Dinant Basin), the late uppermost Famennian ("Strunian") and Tournaisian deposits are controlled by orbitally forced sequences corresponding to precession cycles of short duration (18.6 Ka as average) and eccentricity cycles of longer duration ("third-order" sequences, 2.4 Ma). No other cycles were recognized.

The late "Strunian" precession cycles are typically alternations of shale and limestone. They are well exposed in the Anseremme railway section where at least 25 cycles were recognized in the upper part of the Comblain-au-Pont/Etrœungt Formation. They are included in the transgressive system tract (TST) of the third-order sequence 1 defined by Hance *et al.* (2001, 2002).

The Lower Tournaisian precession cycles vary from alternations of shale and calcareous shale to alternations of calcshale and limestone, and to limestone bed dominated, depending on their position in the third-order sequences. One hundred fifty-five precession cycles were recognized in the Hastarian Substage (Lower Tournaisian), distributing in the uppermost part of the third-order sequence 1, in the sequence 2, and in the TST of the sequence 3.

Nature and evolution of the precession cycles along the eccentricity cycles suggest relatively low eustatic variations but wet–dry climate variations.

In contrast, the lateral and vertical evolution of the eccentricity cycles and their boundaries show that they recorded high-amplitude eustatic variation corresponding to ice age–warm climate alternations.

Two ice ages corresponding to the falling stage system tract (FSST) and to the sequence boundaries are recognized in the Hastarian. The first is stratigraphically situated in the upper part of the MFZ1 foraminifer Zone (FSST of the sequence 1 and sequence 1–sequence 2 boundary), and the second one in the MF3 Zone (FSST of the sequence 2 and sequence 2–3 boundary).

In the Namur–Dinant Basin, the Hangenberg Black Shale is not really marked because its anoxic facies did not spread into the shallow-water environments, or perhaps only as shally intercalations into the cycles, and carbonate facies rich in benthic fossils continued to develop here during its development in other areas. Nevertheless, the following Hangenberg Sandstone, which reflects a strong sea-level drop, is easily recognizable in the Aachen area (Germany), and its lateral variation from sandy limestone to limestone facies is traceable to the Dinant area (Mottequin & Poty, 2014). The levels corresponding to that episode sharply overlie beds rich in "Strunian" brachiopods, rugose corals, stromatoporoids and foraminifera. There is no gap at their base which rests directly on the shales of the last Strunian precession cycle, but they can include some reworked "Strunian" fossils.

Therefore, the extinction event is very sharp and the levels correlated laterally to the Hangenberg Sandstone event do not fit into the succession of the deposits that are controlled by the precession cycles. Moreover, the event does not correspond to a third-order sequence boundary, being included in the upper part of the sequence 1.

References

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