Obliquity-dominated glacio-eustatic sea level change in the early Oligocene: Evidence from the shallow marine siliciclastic Rupelian stratotype (Boom Formation, Belgium)

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Recent drilling substantially lengthened the known record of the shallow marine Rupelian stratotype. High-resolution proxy records for lithology were used to re-examine the astronomical origin of the sedimentary cyclicity. The results clearly reveal variations of glacio-eustatic sea level at astronomical periodicities during the early Oligocene.

Lithology and interpretation

The Boom Clay consists of a rhythmic alternation of shallow marine silt and clay layers (Vandenberghe, 1978; Figure 1). The lateral persistence of the individual silt-clay sequences (Vandenberghe et al., 2001) requires a forcing mechanism that exerts a simultaneous influence over the entire basin. Sea level variations influencing the amount of sorting by varying the wave base is the most plausible process that can account for this (Vandenberghe et al., 1997) implying that the succession is an archive of early Oligocene glacio-eustatic sea level.

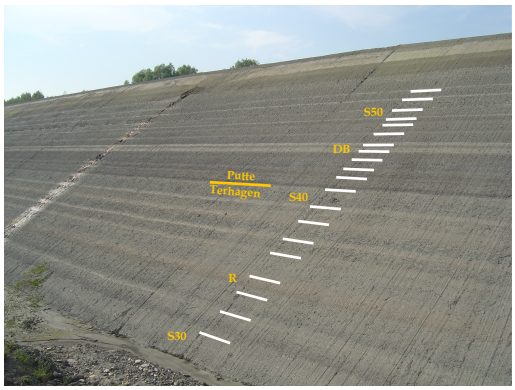

Figure 1. The Boom Clay outcrop in Rumst, Belgium. Light (dark) horizons represent silt (clay) beds. The white lines represent the top of successive clay - silt couplets. Location of Septaria horizons, the Double Band (DB), and the Red layer (R) are indicated.

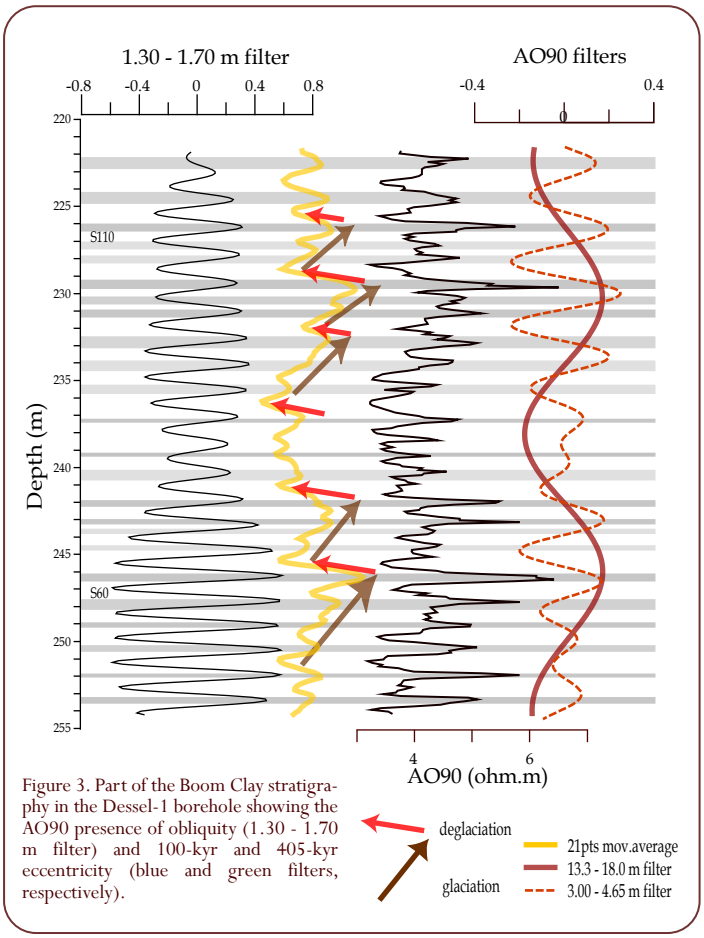

Figure 3. Part of the Boom Clay stratigraphy in the Dessel-1 borehole showing the AO90 presence of obliquity (1.30 - 1.70 m filter) and 100-kyr and 405-kyr eccentricity (blue and green filters, respectively).

Spectral Analysis

Blackman-Tuckey spectral analysis has been performed on the AO90 resistivity depth records of extended Boom Clay successions in the Dessel-1 borehole (see Figure 4) in order to detect cyclic variability. The analysis reveals spectral power at around 1.45 metre which is related to the basic silt – clay sequence (Figure 2). Additionally, 3.65 and 14 metre peaks are found.

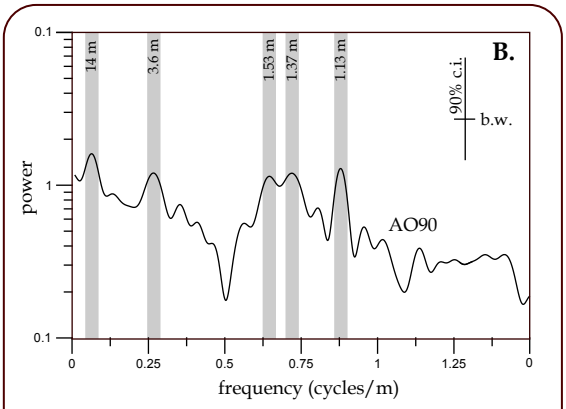

Figure 2. Blackman - Tuckey power spectrum of AO90 resistivity record in the depth domain. Grey shades indicate prominent spectral peak periods.

CONCLUSIONS

Existing age control indicates that the laterally persistent metre-scale silt-clay couplets are related to obliquity forcing. This implies that glacio-eustatic sea level oscillations in the early Oligocene were dominantly obliquity controlled. Additional influence of the ~100- and 405-kyr eccentricity cycles was present. Gradual sea-level lowering is followed by rapid deglaciations at 100-kyr timescales (arrows in Figure 3), similar to glaciations in the late Pleistocene.

References
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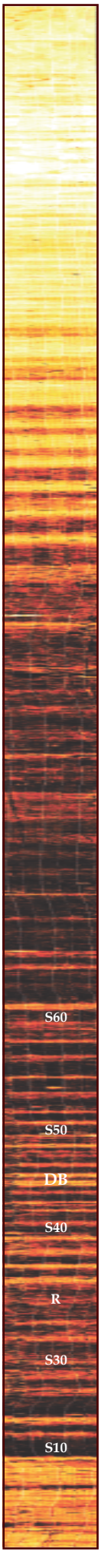

>> Figure 4. FMI-log of the Boom succession in the Dessel-1 borehole. Septaria horizons, the Red layer (R), and the Double Basin (DB) reference levels are situated in the Dessel stratigraphy by bed-to-bed correlation with outcrop successions.