Cyclostratigraphy in the Hauterivian-Barremian Frielingen core (Lower Saxony Basin, Germany)

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Astrochronology in the Hauterivian

Astrochronology has proven to be a powerful method to constrain the duration of geological periods. However in some geological periods cyclostratigraphic studies give diverging results. For instance the **duration of the Hauterivian Stage** was estimated as **3.5 Myr** in central Italy, and **5.9 ± 0.4 myr** in South-Eastern France and South-Eastern Spain (Fig. 1; Martinez et al. 2015; Sprovieri et al. 2006).

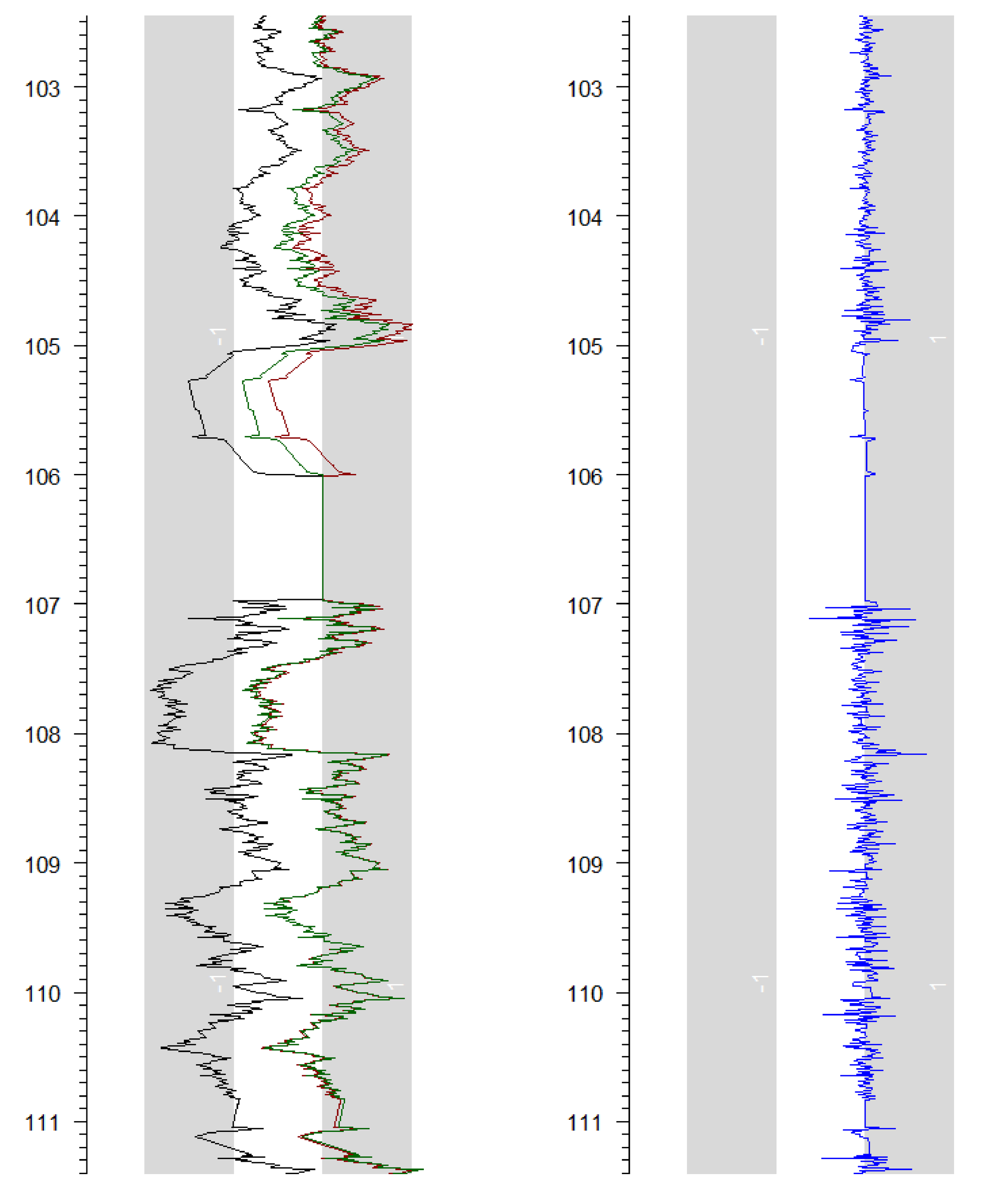
Cycles in the Lower Saxony Basin

In the Lower Saxony Basin, pale marl-dark shales cycles are accompanied by changes in clay mineralogy, floral and faunal communities and geochemistry (variations in Ba, Si, Ca, Rb, Fe and Zr), which point to **orbitally-forced climatic cycles** (Mutterlose et Ruffell 1999). High-resolution (1 cm) scanning XRF results have been recently acquired on the mid-basinal Frielingen core (Fig. 3) which is situated next to Hannover (Germany). This new data set should give fresh insights on the **Hauterivian** duration.

Preliminary results

This preliminary work allowed the observation of a prominent **1.25–1.3 metres period cycle** around 100 metres depth (Fig. 2), even in prewhitened signals where this cycle becomes harder to assess visually (Fig. 1). The first analyses do not allow a straightforward interpretation of these cycles (i.e. find its period and origin; precession, obliquity or eccentricity). Our efforts will be directed towards studying the Si/Ti signal, closing the gaps in the data and using other time-series analysis techniques to decipher the influence of orbital forcing on these clearly climatically-controlled cycles.

Fig.1 Close-up view of the K/Ca log ratio between 103 and 111 metres depth. The original signal is in black, the ones detrended with the LOWESS and captive method in red and green respectively, and the prewhitened signal is in blue.



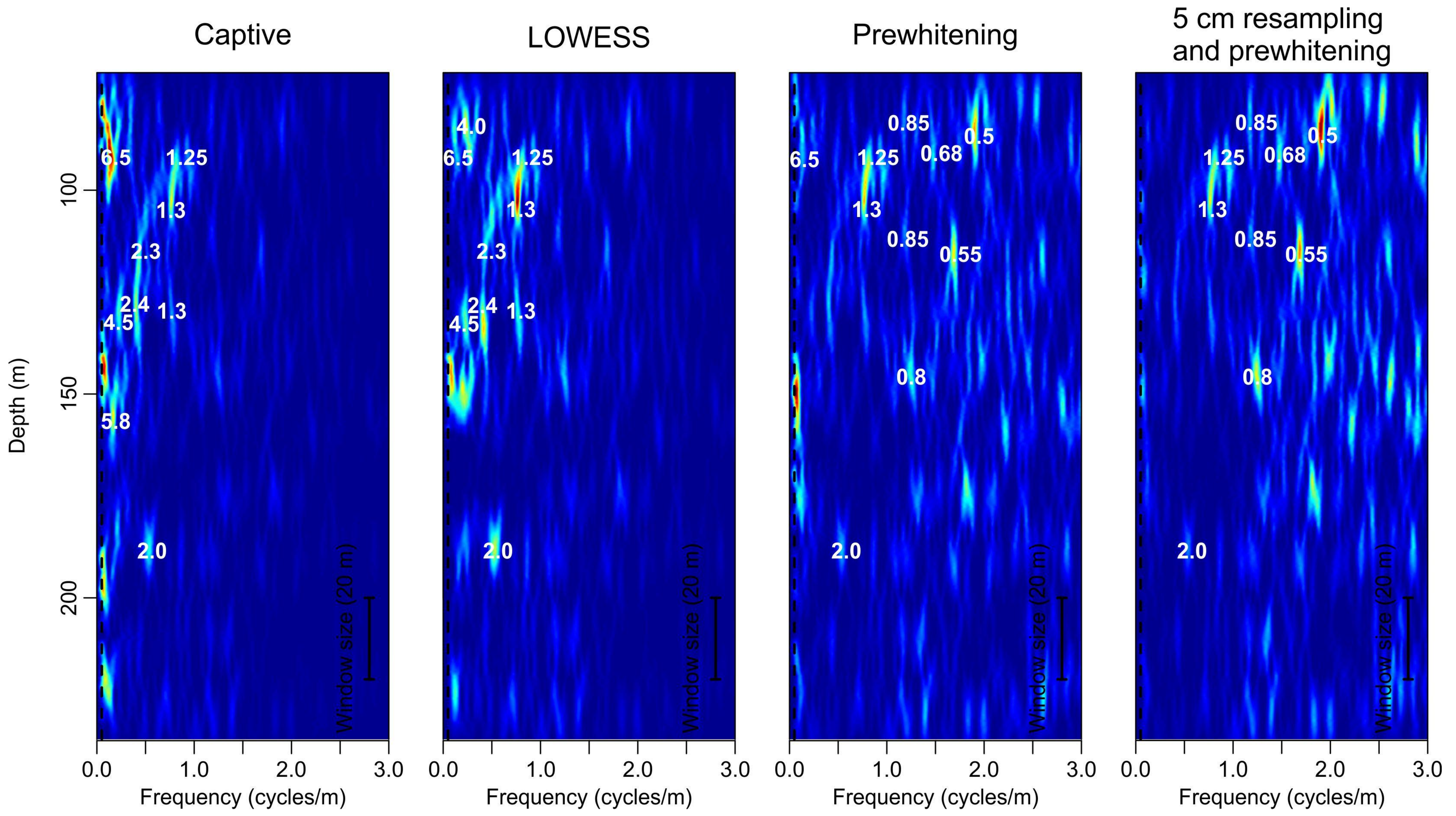
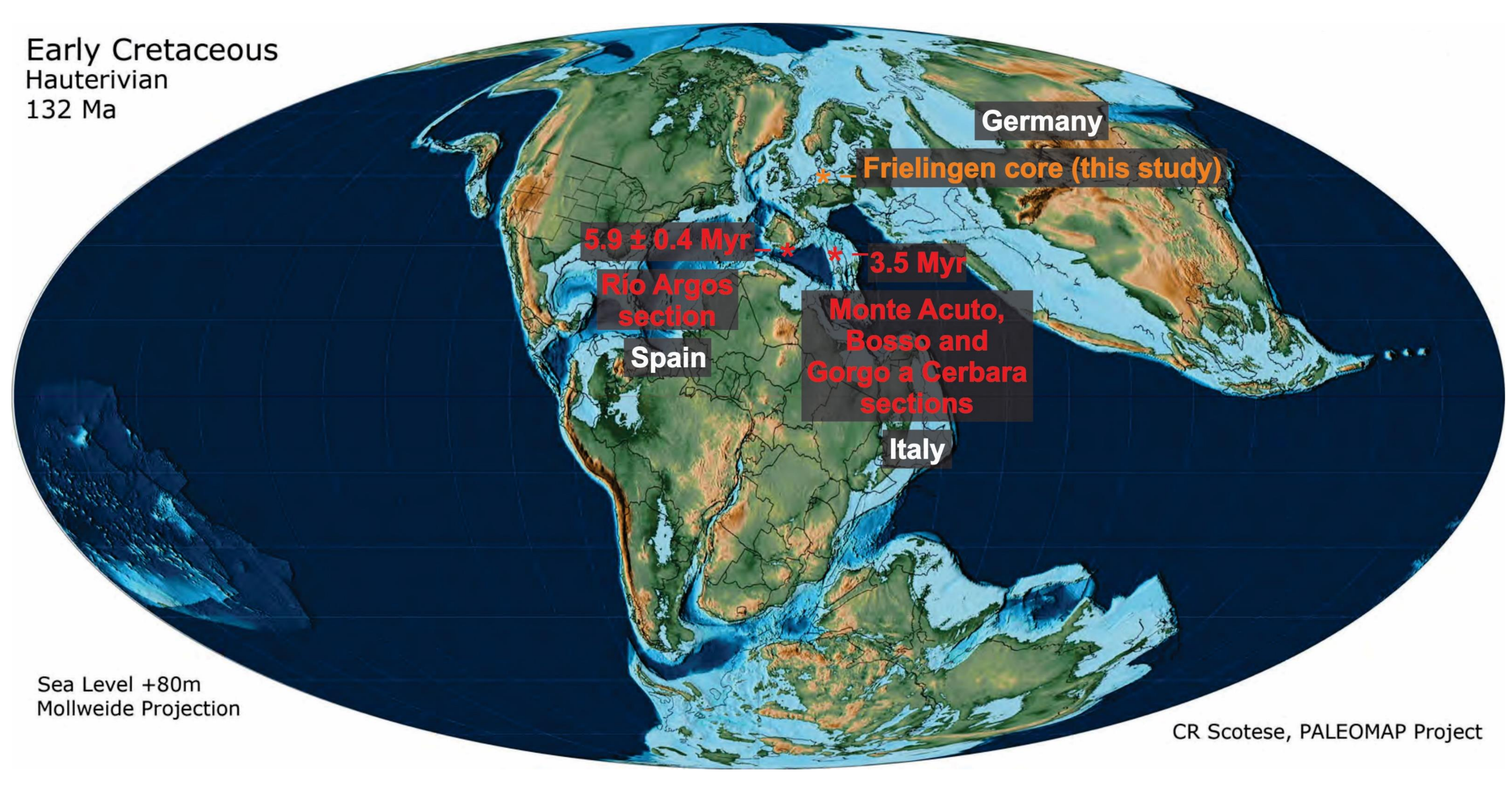


Fig.2 Evolutive FFT analysis of the K/Ca log ratio signal in the Hauterivian (colour scaling for the power). Different signal treatments were used : the captive and LOWESS detrending in the two first panels, and prewhitening in the two last. The most prominent feature is a 1.25–1.3 metres period cycle around 100 meters depth, observed whatever the treatment. The frequency at the moving window size is indicated by the dashed line.

Fig.3 Palaeogeographical reconstruction of the world during the Hauterivian Stage. The –sections and cores studied by Martinez et al. (2015), by Sprovieri et al. (2006) and in this study are situated, with indication of existing durations assessments.



Geochemical interpretation of the Frielingen XRF data

The work presented here is a preliminary study of the Frielingen core to assess the feasibility of time-series analysis. The XRF data are treated in log ratio. **The K/Ca log ratio was chosen to be studied: it is a proxy of terrigenous input against biogenic input, and is coherent with the pale marl-dark shales cycles** studied by Mutterlose and Ruffell (1999). Moreover we observed that the Si/Ti log ratio follows trends opposite to those of the K/Ca log ratio. This link is interpreted as reflecting a **climatic control of the Si/Ti** log ratio. It can be explained by **climatically-controlled differential behaviour of the terrigenous minerals brought into the basin**: heavy Ti-bearing oxides being brought preferentially in comparison with silicates (mainly clays) during times of higher detrital input.

Time-series analysis in the case of incomplete data

Some gaps affect the data, which were widened by the exclusion of suspicious data points (to remove possible surface contamination of the core for instance). Some of the gaps were closed by interpolation, but the wider ones were treated with different methods; all intervals between the wider gaps were detrended either by the LOWESS method, which can be thought of as a moving average, by what we call the "captive method", where the detrending allows the first and last value of the interval to be zero, and by prewhitening (with samples every cm or after 5 cm resampling), in our case by a first difference filter. All wider gaps were filled with zero values to allow the use of the evolutive Fast Fourier Transform (FFT).

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References

Martinez, Mathieu, Jean-François Deconinck, Pierre Pellenard, Laurent Riquier, Miguel Company, Stéphane Reboulet, et Mathieu Moiroud. 2015. « Astrochronology of the Valanginian–Hauterivian stages (Early Cretaceous): Chronological relationships between the Paraná–Etendeka large igneous province and the Weissert and the Faraoni events ». *Global and Planetary Change* 131: 158-73. doi:10.1016/j.gloplacha.2015.06.001.

Mutterlose, Jörg, et Alastair Ruffell. 1999. « Milankovitch-scale palaeoclimate changes in pale–dark bedding rhythms from the Early Cretaceous (Hauterivian and Barremian) of eastern England and northern Germany ». *Palaeogeography, Palaeoclimatology, Palaeoecology* 154 (3): 133-60. doi:10.1016/S0031-0182(99)00107-8.

Sprovieri, Mario, Rodolfo Coccioni, Fabrizio Lirer, Nicola Pelosi, et Francesca Lozar. 2006. « Orbital Tuning of a Lower Cretaceous Composite Record (Maiolica Formation, Central Italy) ». *Paleoceanography* 21 (4): PA4212. doi:10.1029/2005PA001224.