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Early Late Cretaceous (Cenomanian–Turonian) sequence stratigraphy and correlations around the Mid-European Island: Plänerkalk, Elbtal and Danubian Cretaceous groups, Germany

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Detailed Cenomanian–Turonian sequence stratigraphic investigations have been conducted in different sedimentary basins, situated around the emergent Mid-European Island (MEI). The North German (i.e., Münsterland and Lower Saxony), the Saxonian and the Danubian Cretaceous with their respective deposits, combined in the Plänerkalk, Elbtal and Danubian Cretaceous groups, serve as the key localities of this study (Fig. 1). For the sequence stratigraphic correlations between costal, shallow marine and hemipelagic settings, high-resolution integrated stratigraphic approaches such as macrofossil biostratigraphy based on ammonite and inoceramid zones, chemo-, cyclo- and event stratigraphy have been used. An extremely careful data interpretation was strongly required, considering the correlation of carbonate- and siliciclastic-dominated sedimentary systems within this research project (see Janetschke et al. subm. for a synopsis).

As a result of the detailed investigations (Wilmsen et al. 2010, Niebuhr et al. 2011, 2012, Richardt & Wilmsen 2012, Richardt et al. 2013, Janetschke & Wilmsen 2014), a corresponding number of altogether ten depositional sequences (DSs) has been recognized for the investigated time interval in all three study areas. These depositional sequences are defined by ten sequence boundaries (SBs); five of those are observed in both stages, the Cenomanian (SBs Ce 1–5) and the Turonian and (SBs Tu 1–5). The sequence boundaries have been identified in basin margin (unconformities forming stratigraphic gaps or major erosion surfaces) as well as in offshore positions (correlative conformities), occuring in identical stratigraphic positions, meaning that they are in fact strictly time-equivalent. A comparison with the recently published eustatic charts of Haq (2014) generally shows a broad accordance. In particular, some discrepancies occur in the Turonian, concerning SB Tu 3 and 4 or KTu1, KTu2 and KTu4 of Haq (2014), respectively. These might result from divergent interpretations of the hierarchy of sequences or sea-level cycles.

Consequently, these observations provide firm evidence that eustatic sea-level changes governed the sedimentation and stratigraphic architecture of the lower Upper Cretaceous around the MEI. The major onlap phase was the Late Cenomanian–Early Turonian, finally culminating in a late Middle Turonian maximum flooding. Albeit tectonic activity, starting in the Middle Turonian, led to increased subsidence of marginal troughs in front of uplifted zones, as especially exemplified by the thickness development of the Elbtal and Danubian Cretaceous groups, this inversion movements could not overprint or mask the eustatic signal.

In addition, the reconstructions of sea-level changes presented herein indicate large-scale variations of up to 50 m within a time span of much less than a hundred thousand years. These high rates implicate glacio-eustasy as driving factor for the early Late Cretaceous sea-level fluctuations. All other so far known geological processes are either too long-term or of too low amplitude.

Moreover, the periodical patterns, underlying the sea-level changes, refer to an orbital forcing mechanism. Cyclostratigraphical calibration methods revealed the recurrence of sea-level falls every 1.2 myr, regularly amplified in a 2.4 myr mode. This strongly suggests the formation of Cenomanian–Turonian third-order sea-level falls due to Antarctic ice build-up during short-term cooling events (“cold snaps”), triggered by low-

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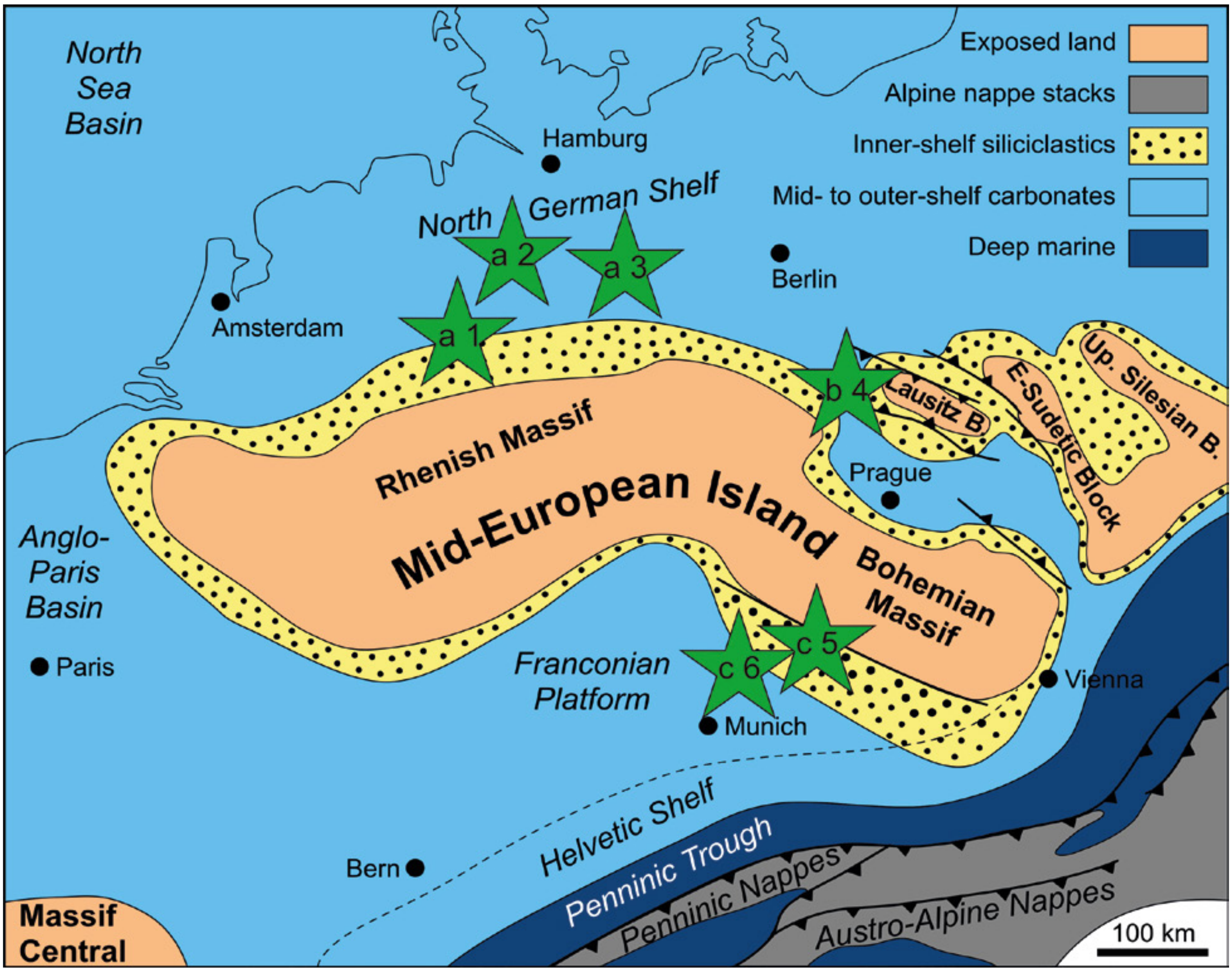

Fig. 1. Key localities of detailed Cenomanian–Turonian sequence stratigraphic investigations conducted in different sedimentary basins, situated around the Mid-European Island (MEI): a 1, North German Cretaceous, southern Münsterland (Anröchte and Werl); a 2, North German Cretaceous, central Münsterland (Halle/Westf.); a 3, North German Cretaceous, Lower Saxony (Konrad core 101); b 4, Saxonian Cretaceous (HG 7006 Krietzschwitz); c 5, Danubian Cretaceous, Bodenwöhrer Senke; c 6, Danubian Cretaceous, Regensburg–Kelheim area (modified after Janetschke et al. subm.).

frequency modulations of the Milankovitch oscillations (cf. Flögel et al. 2011, Hinnov & Hilgen in Gradstein et al. 2012).

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