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Cretaceous (Cenomanian-Coniacian) shallow-water pelagic Red Beds from NW Germany

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Introduction. Red pelagic carbonates, partly highly fossiliferous (inoceramids, brachiopods), occur widespread but stratigraphically and geographically discontinuous in the lower Upper Cretaceous (Upper Cenomanian to Lower Coniacian) of northern Germany (Rotpläner: Red Pläner Limestones). They represent classic oceanic red beds, however their depositional environment differs from that of numerous other pelagic red beds: sedimentology suggest open oceanic shelf setting (nearest coast ca. 300 km distant) but at water depths at least periodically around storm wave base.

Stratigraphy. Stratigraphically, the so-called Facies Change (*geslinianum* Zone, Upper Cenomanian) marks the sudden and almost isochronous turnover from white pelagic coccolithic limestones to pelagic red marls and limestones in the area. The youngest occurrences are recorded from some large Middle Coniacian slumps with Rotpläner olistoliths of an early Coniacian age. Chronostratigraphically, this red bed period lasted ca. 4-5 my.

Sedimentology and Depositional Framework. The Rotpläner are typically developed on intra-shelf swells, while time-equivalent rocks in intra-shelf depressions are white/grey limestones (Weisspläner: White Pläner Limestone) and – in the case of the Upper Cenomanian to lowermost Turonian - Black Shales of the OAE II. Vertically, periods of widespread white limestones are intercalated, giving the regional and stratigraphic red bed distribution some patchiness. Laterally, both facies types can interfinger at distances of only several 100 m. Sedimentary structures in the Rotpläner (gutter casts, small channels, storm-infilled *Thalassinoides* burrows, rare hummocky cross stratification) suggest deposition above storm wave base at least for parts of the successions. Simply speaking, microfacies shows two end members of rock types: (marly) bioclastic calcisphere packstones (shallowest setting) to weakly bioclastic mudstones

(deeper setting). In areas not influenced by synsedimentary movements along faults or on/near diapirs, cyclic bedding (at dm to m-scale) is developed, showing a peculiar but in the area widespread vertical succession of lithofacies: shallowing-up cycles start with a marl, grading into (pink to white) massive limestones which develop into nodular limestones and later into (red) lithoclast/bioclast-bearing marls. The associated decrease of bed thickness (shallowing/thinning up development) resulted from progressively reduced accommodation space. These cycles are interpreted to reflect small-scale relative sea-level fluctuations. Bentonites as independent isochronous marker demonstrate that – in a swell-basin transect – the facies types observed in a cycle grade laterally into another as in the sense of facies law of Walther.

Dating of Red Coloration. Both Rot and Weisspläner have comparable Fe-contents but vary in the oxidation state. Early diagenetically cemented green-stained gutter casts, white limestone lithoclasts floating in dark red marls and limestone phacoids with a white core and progressively red coloration towards its less lithified margins suggest the genesis of the red coloration to postdate early diagenesis occurring in diagenetic hot spots such as infilled burrow systems and gutter casts, and the red coloration is not genuine. Triggering mechanisms are yet unclear, and it remains explicable why the diagenetic colour change effected mainly swell setting. Irrespective of this problem, the gross discrimination between white and red likewise marks an easy distinction between more (depression) and less subsident (swell) areas.

Significance in the Context of the CTBE. The north German red beds show no relation to the CTBE, as their duration pre- and postdates this event significantly. Within this context it must be also emphasized that Albian marine red beds are known from England and northern Germany, and triggering mechanisms of a possibly global scale still need to de demonstrated for those rocks.