Oceanographic Change in the Late Cretaceous Chalk Sea (Denmark): Clues from Chromium Isotopes

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Exposures of the Danish Basin have long been recognized as important archives for global events across the Cretaceous-Paleogene (K-Pg) transition. On the Stevns Peninsula (Denmark), the Maastrichtian upper Sigerslev Member comprises white coccolith chalk mudstone intercalated with sub-parallel flint bands. The transition between the Sigerslev and the overlying Højerup Member is marked by a series of incipient hardgrounds and a facies change to grey wackestone containing benthic fossils (bryozoan, bivalves, echinoderms) in a coccolith mud matrix intercalated with wavy, meter-high, asymmetrical flint bands. The flint bands mimic sea-bed topography and their geometry suggests the development of bottom currents in the latest Maastrichtian. The top of the Højerup Member is marked by the K-Pg boundary Fish clay, above which lies bryozoan-rich limestone mounds of Danian age. Although these sedimentological features have been well-documented, the significance of the Sigerslev-Højerup facies transition and its calibration against K-Pg events remains unclear in terms of Chalk Sea dynamics and chemistry. Here we present new geochemical data from the Maastrichtian to early Danian of the Stevns Peninsula, as well as data from a new section near Hunstrup, northern Jutland (Denmark). Our analyses include C, O, and Sr isotopes, rare-earth elements, and Cr-isotope data that have the potential to record ancient redox and oceanographic conditions. Data from the Stevns Peninsula record a major shift in Cr-isotopes from +0.7 ‰ to ~0 ‰ across the Sigerslev-Højerup transition, followed by an increasing trend to +0.4 ‰ and a subsequent decline to ~0 ‰ coincident with the K-Pg boundary. Although the Cr-isotope system is sensitive to changes in redox conditions and hydrothermal input, a consistently negative Ce-anomaly and a relatively stable Sr-isotope signal argue against either of these hypotheses to explain Cr-isotope trends in the Maastrichtian. Instead, we propose that observed trends are associated with regional mixing of water masses with distinct Cr-isotope signatures. These results imply that dynamic oceanographic changes occurred in the Chalk Sea prior to the K-Pg event.