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Neodymium isotopic evolution of Boreal-Tethyan upper ocean waters during the Campanian

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The role of oceanography in long-term climatic cooling during the Late Cretaceous is poorly understood. During the Campanian, the Atlantic Ocean was gradually opening and sea level was higher than at present, with large parts of north-western Europe covered by shallow epicontinental chalk seas. Reconstructed upper-ocean circulation patterns are based on scarce records that have often been assembled from multiple localities. Here we present a high-resolution continuous record of neodymium-isotope ratios (ε_{Nd}) of bulk carbonate and fish debris from the Trunch borehole of Norfolk, England, to reconstruct the evolution of upper ocean waters of the Boreal-Tethyan epicontinental shelf during the Late Cretaceous (87.6-72.8 Ma). We observe a slight offset in Nd-isotope values obtained by leaching ferromanganese oxide coatings from those obtained from fish debris, although rare earth element profiles support a sea-water origin for both records. Overall, average Campanian ε_{Nd} values of -12 from the Trunch borehole are more unradiogenic than mid-Cretaceous (Cenomanian–Turonian) records from the European chalk sea, consistent with a gradual restriction of low-latitude Pacific–Tethyan gateways and a decline in the influence of the equatorial Tethyan Circumglobal Current.

We compare our ε_{Nd} values to detailed carbon-isotope stratigraphy, to reconstructed sea-level curves and to lithological indicators of local sea-level variations. Our results indicate that local sea-level change is the main driver of short-term ε_{Nd} variability, by modifying the input of relatively unradiogenic Nd from nearby continents. This finding contrasts earlier interpretations of Campanian shallow-water Nd-isotope values from the European chalk sea, which have mainly attributed ε_{Nd} variation to circulation changes. Instead, the observed strong spatial variability in ε_{Nd} across the European shelf during the Campanian may highlight the importance of local processes, such as continental inputs of Nd and boundary exchange, in modifying water-mass chemistry. The overall stability of ε_{Nd} values throughout the Campanian suggests that circulation patterns in the Boreal realm were relatively stable and likely did not contribute to the long-term global cooling trend.