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The Nd-isotopic composition of late Cretaceous bathyal–abyssal seawater from fossil fish skeletal debris

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There is currently very little proxy data available for determining the inter-ocean mixing of deep-water masses during the Cretaceous, and thus uncertainty remains as to the importance of deep-water circulation in latitudinal heat transport and bottom-water oxygenation for that time. A solution lies in exploiting a geochemical water-mass tracer, such as the neodymium (Nd) isotopic composition of seawater. It has been shown that the distinct differences in the Nd-isotopic composition observed in modern deep and intermediate waters have persisted since the early Cenozoic, but currently our knowledge of the Cretaceous oceans is poor. Most of the existing Nd-isotope data for the Cretaceous are from shallow-water masses on the continental shelves of the Tethyan and Atlantic Oceans.

It has previously been shown that biogenic apatites record the Nd-isotopic composition of bottom-waters during an early diagenetic reaction at the sediment–water interface. We present Nd-isotope data from fish-teeth and skeletal debris picked from deep-ocean sediments recovered by DSDP and ODP drilling in the North and South Atlantic, Indian and Pacific Oceans. The sites chosen for this study were all deposited at bathyal–abyssal water depths. In conjunction with other recent studies, our data establish that the Pacific Ocean has likely maintained a constant range of Nd-isotopic values between ≈5 and -3 since at least 135 Ma. The data from the North Atlantic, South Atlantic and proto-Indian Ocean show that bottom-waters in these basins had relatively radiogenic Nd-isotopic compositions for much of the mid-Cretaceous (≈8 to ≈5), before shifting to less radiogenic values (<-9) between 85 and 75 Ma. A recently published study from Demerara Rise (MacLeod et al. 2008) revealed the existence there of a large positive Nd-isotope excursion during OAE2, which we see no evidence for elsewhere suggesting that the excursion most likely resulted from mixing of locally-sourced bottom-waters with bottom-waters from the rest of the deep North Atlantic. We interpret the Late Cretaceous shift in our data as reflecting either a decrease in the influence of Pacific waters via circum-equatorial surface currents, or as an increase in the contribution of a deep-water mass with a highly radiogenic value. The values attained by this shift suggest a Late Cretaceous age for the establishment of the Cenozoic Nd-isotope pattern. However, this shift did not occur at the transition in the Turonian to more oxygenated sedimentation in the North Atlantic, thereby leaving unanswered the question of whether ocean circulation changes and shifting tectonic gateways were responsible for the oxygenation event.

MacLeod, K.G., et al., 2008, Nd isotopic excursion across Cretaceous ocean anoxic event 2 (Cenomanian-Turonian) in the tropical North Atlantic, Geology, 36, 811–814.