Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.14263

Severe changes in the marine environment across the Cretaceous—Paleogene boundary in the Danish Basin: Constraints from the combined Cd-Cr isotope system

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Cadmium (Cd) isotope signatures ($\delta^{114}Cd$) deduced from seawaters, and from modern and ancient marine deposits are often used as a proxy for bioproductivity and for micronutrient cycling. Chromium (Cr) isotope signatures ($\delta^{53}Cr$) deduced from seawaters and from modern and ancient marine deposits have been proposed as a useful tracer for ocean redox conditions and oxygenation. The Cretaceous—Paleogene (K/Pg) boundary is characterized by one of the Earth's five big mass extinctions, a meteor impact (Chicxulub), large igneous eruptions (Deccan Traps), and abrupt sea level changes. This study contributes the first combined Cd-Cr tracer applied to marine carbonates from three stratigraphic sections in the Danish Basin across the K/Pg boundary, and we link the tracer to palaeobioproductivity and ocean redox conditions. The measured $\delta^{114}Cd$ values range between -0.28‰ and +0.27‰ with an average of +0.05‰ ± 0.24 (2σ, n=87). The $\delta^{53}Cr_{raw}$ values range between -0.03‰ and +0.94‰ with an average of +0.51‰ ± 0.50 (2σ, n=81). An only moderate positive relationship between $\delta^{114}Cd$ values and $\delta^{53}Cr$ values (R^2=0.33) reveals that these two isotope systems are controlled by different processes. Nutrients and bioproductivity control the $\delta^{114}Cd$ values, and redox processes control the $\delta^{53}Cr$ values in the marine realm. The Late Maastrichtian White Chalks from the Danish Basin reveal relatively consistent positively fractionated Cd and Cr isotope signatures, which indicate a period with high bioproductivity and enhanced oxygenation. The isotopic signatures of Cd and Cr show a negative shift in the end-Maastrichtian, which corresponds to severe changes in the marine environment. Across the K/Pg boundary and in the transition layer (Fish Clay), $\delta^{114}Cd$ and $\delta^{53}Cr$ consistently exhibit values close to the values of continental crust, which indicate a period of reduced bioproductivity, if any, and/or strong detrital influence on the carbonate inventory. In the Early Danian, the marine carbonates reveal $\delta^{114}Cd$ values primarily negative or near zero, which supports previous studies showing a slow recovery of bioproductivity after the K/Pg mass extinction. The combined Cd-Cr isotope system is proposed as a useful reconstruction tool for bioproductivity and ocean oxygenation preserved in ancient marine carbonates.