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The Re-Os record embracing the Cretaceous-Paleogene boundary at Stevns Klint, eastern Denmark

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Continuous cliffs of white chalk on the east coast of Denmark contain accessible and spectacular exposures of Maastrichtian-Danian carbonates and the intervening boundary layer (Fish Clay) marking the Cretaceous-Paleogene (K-Pg) mass extinction [1]. At Stevens Klint, the Fish Clay ranges from 0 to 8 cm thick, with an irregular pyrite-rich layer at its base. It constitutes a debris-rich, reworked ash-pyrite-sedimentary layer and holds the characteristic PGE enrichment and Ir anomaly recognized as the K-Pg boundary on the global scale. Far more spectacular than the thinly undulating Fish Clay boundary bed, however, are the continuous beds of nodular black chert, both above and below the K-Pg boundary layer, and their striking contrast against the background of white fossil-packed marine chalks.

Our aim in this study was to test the Re-Os chronometer for dating cherts which, if successful, would give us another sedimentary media for acquiring direct radiometric ages and enhancing the geologic time scale. The beauty of the study is that we already precisely know the age of the Fish Clay [2,3], so we were putting nature to the test, not our analytical tools. We analyzed the top and bottom layers of the Fish Clay, acquiring same stratigraphic samples by digging laterally into the cliff face. These data build on a previously acquired, but limited data set for the Fish Clay [4]. To examine the Os isotope record over a longer time interval and larger stratigraphic interval, we systematically sampled three meters of section – two meters above and one meter below the Fish Clay K-Pg boundary layer. Ultimately, we analyzed not only black cherts but also intervals of chalk.

The Osi record held in Maastrichtian chalks below the K-Pg boundary shows a relatively smooth trend matching well with open ocean Osi records [5]. However, a more chaotic post-K-Pg Osi trend in the Danian is the likely consequence of a mixture of reworked crustal and cosmogenic materials. Os concentrations in chalks are higher near the K-Pg boundary, reflecting seawater doped with cosmogenic debris. Re concentrations for flint nodules, chalks and Fish Clay spanning the late Maastrichtian and early Danian are similar (0.01-0.3 ng/g). Higher Re concentrations have been found in a few flint nodules in the Danian Bryozoan Limestone (0.25-2.7 ng/g). A Re-Os isochron for one flint nodule from the Bryozoan Limestone yields a Model 3 depositional age of 66.4 $\pm$ 3.7 Ma, showing that flint nodules can provide ages for deposition or early diagenesis. The large uncertainty on the age may reflect either (1) variable Osi during void-filling, or (2) time required for transformation of flint-forming silica gel to cryptocrystalline quartz and closure of the isotopic system.
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