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A direct link between the erosion of continental crust and the Hf isotopic composition of seawater

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Hafnium isotopic records from deep-sea ferromanganese crusts have been proposed as a proxy for the rate of continental weathering through time, but the link between ocean Hf isotopes and silicate weathering is still missing. In a recent study (Bayon, Vigier, Burton et al., in preparation), we have reported ^{176}Hf/^{177}Hf ratios for various rivers, rocks, soils and granitoid acid leachates from the Moselle Basin (Vosges mountains, France), showing that the Hf isotopic composition of river waters is controlled by the dissolution of specific mineral phases and linked directly to the intensity of silicate weathering. Our estimate for the global isotopic composition of riverine hafnium was similar to seawater values (from ε_{Hf} $\sim$ –3 to $\sim$ +9), suggesting that the ocean Hf budget may be dominated by river inputs and, hence, directly connected to changes in silicate weathering rates.

Here, we test this hypothesis by reporting new Hf and Nd isotope ratios for sediments collected off the Congo River. Core KZAI-01 has been recovered from the Congo deep-sea fan, at 800 m water depth, and provides a continuous record of the Congo sediment discharge for the last 40,000 years. An age model for this core has been derived from ^{14}C ages. High-resolution profiles for major elements have been obtained with a Cortex XRF Core Scanner (NIOZ). Variations of Al/K along this core provide an index for the intensity of chemical weathering within the Congo drainage basin through time (Schneider et al., 1997). Hf and Nd isotopic ratios have been analysed on both detrital and Fe-Mn oxide fractions of sediments. It is assumed here that Fe-Mn oxides leached from such rapidly-accumulating sediments have precipitated initially on-land, from the dissolved constituents leached from soils, or, alternatively, from

river-waters. Our aim is to infer and quantify changes in silicate weathering processes in Central Africa, during the Late Quaternary, and assess whether those changes may have affected the global Hf isotopic composition of the ocean.

In core KZAI-01, ^{143}Nd/^{144}Nd ratios measured for both detrital and Fe-Mn oxide fractions are similar and do not vary throughout the whole core ($\varepsilon_{Nd} \sim$ -16). This suggests that the source of terrigenous material delivered by the Congo River has remained unchanged through time. By contrast, the Hf isotopic composition of detrital fractions fluctuates down-core (from $\varepsilon_{Hf} \sim$ -8 to $\sim$ -12) and correlates strongly with Al/K ratios. The Fe-Mn oxide fractions are characterised by more radiogenic values (from $\varepsilon_{Hf} \sim$ -1 to $\sim$ +1). All these data suggest that ^{176}Hf/^{177}Hf ratios within Congo fan sediments have recorded changes in silicate weathering processes during the Late Quaternary.

We consider a steady-state erosion model, which confirms that down-core ^{176}Hf/^{177}Hf fluctuations are in agreement with changes in the chemical weathering intensity. Results are used to discuss the global link between continental erosion and the Hf isotopic composition of the ocean. In particular, we show that the ε_{Nd} vs. ε_{Hf} seawater array can be reproduced using a simple erosion model, adding further support that ocean Hf isotopes have been directly connected to changes in silicate weathering rates through time.