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Hysteresis response of thermohaline circulation to fresh-water forcing revealed by an unmixed grain-size record from the North Atlantic

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Numerous studies have indicated that late Quaternary variability of surface and deep-ocean circulation in the North-Atlantic may be inferred from grain-size characteristics of terrigenous deep-sea sediments. Grain-size data of the silt fraction are widely used to reconstruct bottom-current vigour and the terrigenous sand fraction of North-Atlantic sediments is often regarded as ice-rafted detritus (IRD). However, in cases where the silt fraction is not exclusively transported and deposited by bottom currents, silt-based proxies for bottom-current vigour lead to erroneous reconstructions. Unmixing of the grain-size record of core DS97-2P from Reykjanes Ridge with the end-member modelling algorithm EMMA allows quantification of the ice-rafted contribution to the silt fraction, and therefore a realistic reconstruction of variations in ice-rafting and bottom-current vigour. The modelling results contradict the silt-based reconstruction, but are in line with earlier studies indicating that deep-water convection is inversely correlated with IRD flux. The interpretation of the end members has been confirmed by analysis of the trace-elemental composition of the terrigenous silt fraction.

We present an extended, detailed grain-size record of core DS97-2P, spanning Marine Isotope Stages 2 and 3 (˜11-52 ka BP). Our results show millennial-scale ice-rafting

events occurring simultaneously with decreasing bottom-current vigour. The unmixed grain-size record of MIS 3 also reveals repeated hysteresis response of thermohaline ocean circulation (THC) to fresh-water forcing, showing that threshold values of the THC to perturbation by fresh water were high. During the colder MIS 2, bottom-current vigour was more reduced, sensitivity of the THC to fresh-water forcing was greater, and surprisingly, direction of the hysteresis loops was opposite compared to MIS 3. Although hysteresis response of ocean circulation to fresh-water forcing has emerged as a robust feature of numerical ocean circulation models, it is now for the first time confirmed by geological data.