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The provenance of ice-rafted debris in the glacial NE Atlantic: Ice sheet dynamics and global sea-level change during Heinrich event 4

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The growth of the last British and Irish ice sheet (BIIS) through Marine Isotope Stage (MIS) 3 and its expansion onto and across the continental shelf of NW Scotland provides an excellent opportunity to test the relative contribution of BIIS ice-rafted debris (IRD) into Heinrich layers (HL) adjacent to the European margin. Radiogenic isotope measurements of the sediments and quantification of the IRD components enable us to differentiate between geological source regions and provide a critical test of rapid, non-destructive mineral magnetic measurements which have been used to model sediment provenance through this interval. Within Greenland stadial (GS) 9 (approximately 40,120 – 38,360 yr ago) we recognize HL4 as a prominent, short-lived (ca. 200 yr) IRD event, characterized by a marked increase in the concentration of detrital carbonate grains with a diagnostic LIS δ18O fingerprint and decrease in the 206Pb/204Pb ratio and εNd(0) values of bulk sediments. A magnetic un-mixing model confirms that a Laurentide ice sheet (LIS)-sourced component dominates HL4 and that a BIIS-sourced component characterizes the latter part of GS9, increasing in relative abundance until the abrupt warming that marks the GS9 – Greenland interstadial (GI) 8 transition. The observed LIS-BIIS sequence, which we have replicated from cores MD95-2006 and MD04-2822, located 83 km apart in the northeastern North Atlantic, does not provide evidence of European “precursor” IRD events prior to HL4. Our results suggest that an extensive lobe of the BIIS extended onto the continental shelf of NW Europe during GS9 (ca. 38.5 kyr) and that an abrupt sea-level rise associated with the LIS-sourced component of HL4 triggered regional BIIS instability and collapse, with important implications for the relative timing of global sea-level change at this time.