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Terrestrial Impact of Abrupt Changes in the North Atlantic Thermohaline Circulation; Early Holocene, UK.

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Methods and Chronology:

Supplementary information from the GSA Data Repository

Stratigraphy and isotopic analysis –

Additional details of the stratigraphy and the isotopic systematics of the modern lake at Hawes water are given in Jones et al., 2004, and Fisher et al, 2005.

The >8m cored Holocene intervals in the early to mid Holocene cores HWLC1 and HWLC2 start, at their base, in a clay that represents deposition during the latest part of the Younger Dryas stadial, and the cored intervals consist of very pure, fine grained authigenic carbonate (>96% calcite, typically 2% organics 2% clay). Carbonate accumulation at the cored sites, on the shore of the modern lake, ceased in the mid-Holocene due largely to lake-level fall. Samples for isotopic analysis of the carbonates were taken at 1cm intervals. The fine fraction carbonate was separated by sieving though a 125µm sieve and bulk samples of the micrite were analysed using conventional methods at the University of Liverpool. Values are reported relative to the Vienna Pee Dee Belemnite (VPDB) international standard and are reproducible to ± 0.1 ‰. The isotopic records of 778 analyses from HWLC1 (Fig 1a) and replicate record of the early Holocene interval from HWLC2 with 201 analyses (Fig. 2) are based on data from overlapping 1m cores taken from two adjacent holes at each site. Individual cores were correlated using lithological markers, and magnetic properties, together with the carbon and oxygen stable isotope values. On a sample-to-sample basis the isotopic records are highly coherent.

Chronology – see Table DR 1

Individual U-series dates from HWLC1 were obtained on bulk carbonate sediment samples and corrected for the effects of detrital clay contamination using U isotope values from clays from the same catchment. Samples were dated at the Open University Uranium Series Facility, Open University, Milton Keynes, UK. The age model uses a Gaussian interpolation program to fit a smooth curve through fourteen U-series dates that a) has no depth reversals and b) passes within error of the two dates near 5.4 m or about 8000 yr BP. One outlying point (7,793 yr ±471 at 1.695m), perhaps reflecting contamination, was excluded from the interpolation. The age model was confirmed using the accepted ages for five pollen biostratigraphic events previously dated at sites in NW England using ^{14}C (Birks, 1989). The HWLC2 record was provisionally dated by using the common $\delta^{18}O$ events (Fig. 2) as tie points. The resulting age-model agrees with the position of pollen biostratigraphic markers identified in HWLC2. The sediments do not contain material suitable for ^{14}C dating.

Table DR 1 – Dated horizons. The age model in the paper is based on the U-Series dates alone – the pollen dates confirm the validity of the results.

Composite Depth (m)	Age yrBP	Calculated Uncertainty yr (2 sigma)	Source*	Comments -
0.675	5287	158	U	
0.685	5135	177	U	contiguous 1cm sample
1.005	6000		P	*Elm decline* ~5900 -6700 cal. yr. BP (calendar years before present)
1.195	6189	169	U	
1.695	7793	471	U	Outlier -the uncertainty in 230/232 is twice normal- possible contamination - not used in age model
1.705	6222	197	U	
2.085	7144	208	U	
2.355	6500		P	Tilia Rise~6400-6700 cal. yr.BP (calendar years before present)-2.35 m
3.045	7284	197	U	
4.115	8059	229	U	
5.195	8192	233	U	
5.205	8291	218	U	
5.205	8290	222	U	Replicate U-Series analysis - age agrees to within 1 year
5.255	8100		P	Alnus rise~7800-8500 cal yr BP (calendar years before present)
6.175	9143	308	U	
6.705	9760	259	U	
6.705	9600		P	
7.205	9712	243	U	
7.575	10821	334	U	
7.585	10248	426	U	
8.055	11500	50	P	End of Loch Lomond Stadial 11500+/-50 cal.yr.BP (J.Lowe - Royal Holloway University of London)

- Source – U- series TIMS dates; Pollen horizons recognised in HWLC1– isochrones dated by ^{14}C in other archives in NW England. Birks 1989.

Chironomid Temperature Analysis

The broad scale geographic distribution and abundance of chironomid taxa is primarily regulated by temperature (Walker, 2001). Detrended Correspondence Analysis (DCA) axis 1 accounted for 31.4% of the variance in the chironomid assemblage and the sample scores showed similar trends to the reconstructed temperature. Chironomid-inferred temperatures were calculated using Brooks and Birks' transfer function (Brooks and Birks, 2001) and unpubl. The chironomid-temperature inference model has a root mean squared error of prediction of ± 1°C. Previous work at Hawes Water demonstrates that the transfer function is applicable at the site (Bedford et al., 2004).

References Cited

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