High Resolution Record of Ice Rafted Detritus in Central North Atlantic Deep-Sea Sediment Core V30-100

Erin Fyfe* and James Cullen, Department of Geological Sciences, Salem State University, Salem, MA,
Alyson Churchill, Korie DeBellis, and Jerry McManus, Lamont Doherty Earth Observatory, Columbia University, Palisades, NY. * e_fyfe@salemstate.edu

Introduction

High-resolution deep-sea sediment records from the North Atlantic have convincingly documented millennial-scale climate oscillations over the last glacial interval (Marine Isotope Stages 4-2; MIS 4-2). At least six (6) separate short term episodes of elevated amounts of lithic fragments have been deposited that are attributed to the delivery of Ice Rafted Detritus (IRD) into the central North Atlantic during times of increased iceberg calving from continental ice sheets. These intervals, called Heinrich Events, are easily identified by their abundance of coarse-grained (>150 microns) lithic grains and low concentrations of planktic foraminifer specimens (Heinrich, 1988).

We have analyzed 149 closely spaced samples from the top 2 meters of central North Atlantic piston core V30-100 (44°06.5'N, 32°30'W; see figure 1 and 2). The upper 100cm was analyzed at 4cm intervals and the 100-200cm interval at 1cm intervals. We have used these samples to generate a high-resolution record of changes in IRD input and foraminiferal abundance. Specifically, we have:

1. used three proxies to document changes in IRD input and foraminiferal abundance.
2. used the proxies, along with magnetic susceptibility measurements, to identify Heinrich Events in core V30-100.
3. compared our records of IRD input to core V23-14, a nearby core with a set of previously identified and well-dated Heinrich Events (Hemming, 2003).

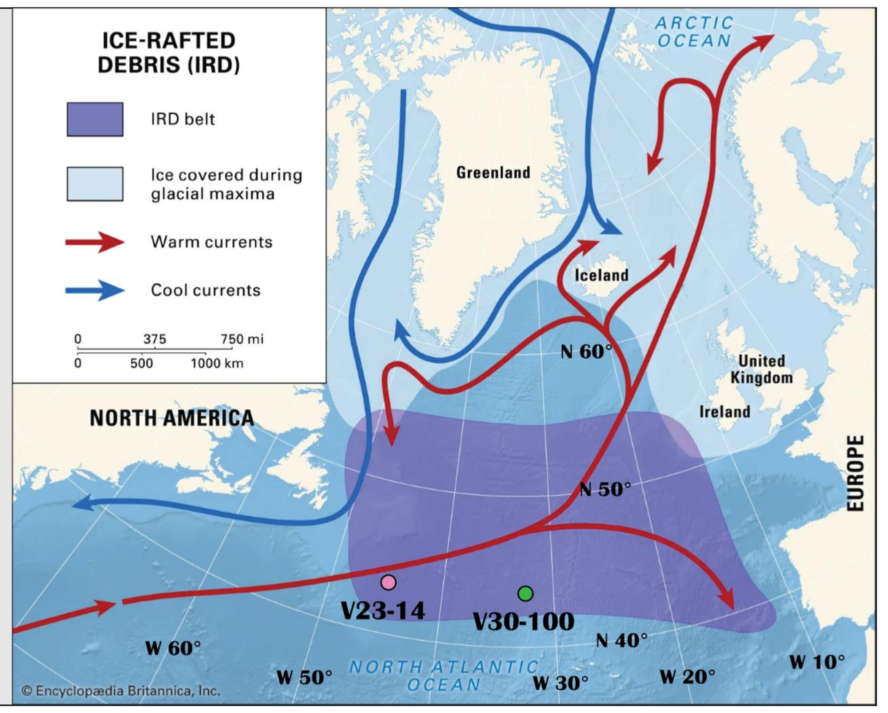

Figure 1: Locus map displaying the locations of deep-sea sediment cores V30-100 at (44°06.5'N, 32°30'W) and V23-14 at (43.4°N, 45.25°W) in the Central North Atlantic Ocean.

Methods

- Sieve sample to >150 microns and split it to 300-500 forams
- Count the # lithic grains in that sample
- Generate 3 proxies using the following equations:

$$\bullet\text{% Lithics} = \frac{(\#lithic\ grains > 150\ microns)}{(\#lithic\ grains > 150\ microns + \#foraminifers > 150\ microns)} * 100$$

$$\bullet\text{Lithics / gram} = \frac{(\#lithic\ grains > 150\ microns)/(split)}{Dry\ weight\ of\ sample\ (g)}$$

$$\bullet\text{Forams / gram} = \frac{(\#foraminifers > 150\ microns)/(split)}{Dry\ weight\ of\ sample\ (g)}$$

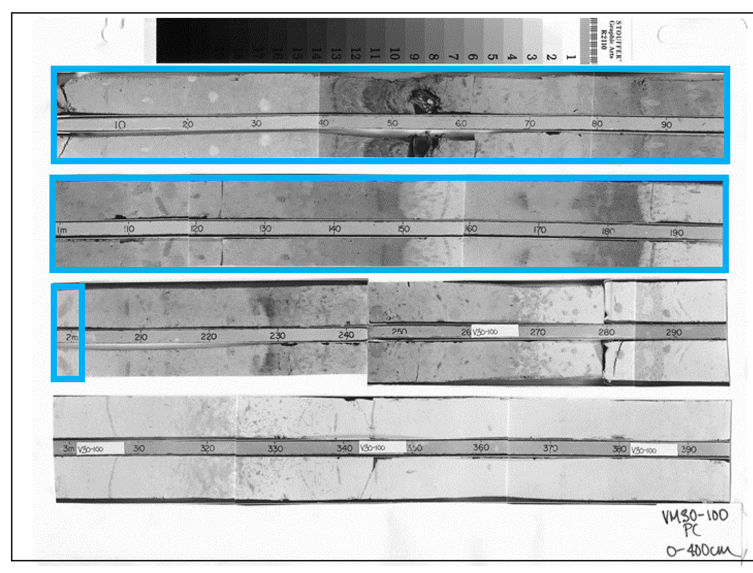

Figure 2: A scanned image of the upper 400 cm of the V30-100 core. The segment analyzed in this study (0-200cm) is highlighted in blue.

Results

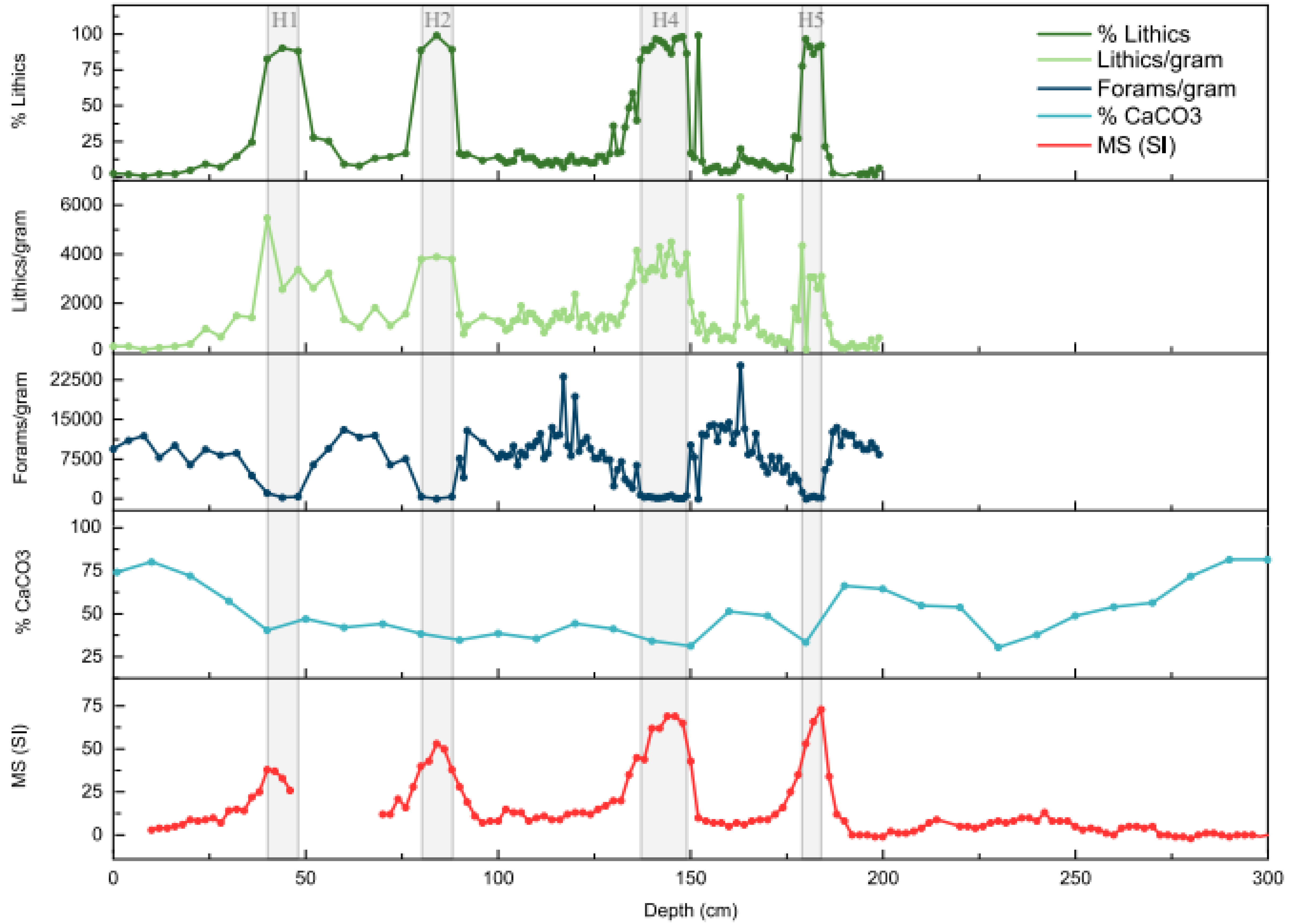

Figure 3: Comparison plots of %lithics, lithics/gram, forams/gram, %carbonate, and magnetic susceptibility for the upper 300cm of the V30-100 core. The %lithics plot reveals 4 distinct intervals of >80% lithics coupled with consistently very low forams per gram at 40-48cm, 80-88cm, 137-149cm, and 179-184cm separated by long intervals of significantly lower lithics (<20%). The lithics per gram plot is consistently above 3000 lithics per gram during the intervals of high %lithics but show more variability. Where the %lithics is the highest, lithics/gram typically shows drastic increases. The opposite occurs for forams/gram as it decreases, %lithics increases. Based on the %carbonate plot, it can be interpreted that the upper 200cm of the core are representative of the last glacial interval (MIS 4-2). Magnetic susceptibility data also shows 4 drastic increases. There are no increases in magnetic susceptibility further down the core meaning the spike in %lithics centered around 180cm is the lowest.

Discussion

Analysis of our high-resolution IRD records with the low-resolution carbonate record and magnetic susceptibility data from V30-100 as well as our detailed comparison to other IRD records from the Central North Atlantic (Hemming, 2003) suggests that the 4 intervals of high %IRD in V30-100 correspond to well documented Heinrich events that occurred in the North Atlantic during the last glacial interval (MIS 4-2). The deepest high %lithics interval, centered around 180cm, was interpreted as H5 because there are no deeper spikes of increased magnetic susceptibility meaning few lithic grains. The interval centered around 145cm has been correlated to H4. The IRD events centered around 85cm and 45cm have been correlated to H2 and H1, respectively (figure 3). If these correlations are correct, H3 has not been recorded in V30-100. H3 is considered an 'atypical' Heinrich event. During this event, the North Atlantic received relatively less IRD input from the Laurentide ice sheet than during more typical Heinrich events like H4 (Snoeckx et al., 1999).

A comparison of the V30-100 core to a well-dated core nearby shows a striking similarity. The %lithics plot for the V23-14 core (43.4°N, 45.25°W) also shows 4 distinct intervals of increased IRD representing H1, H2, H4, and H5 as well as a small spike that is indicative of H3 (figure 4). The intervals of high %lithics in the V23-14 core occur slightly closer to the top. This is likely due to the upper portion of the piston core being lost as the core was taken.

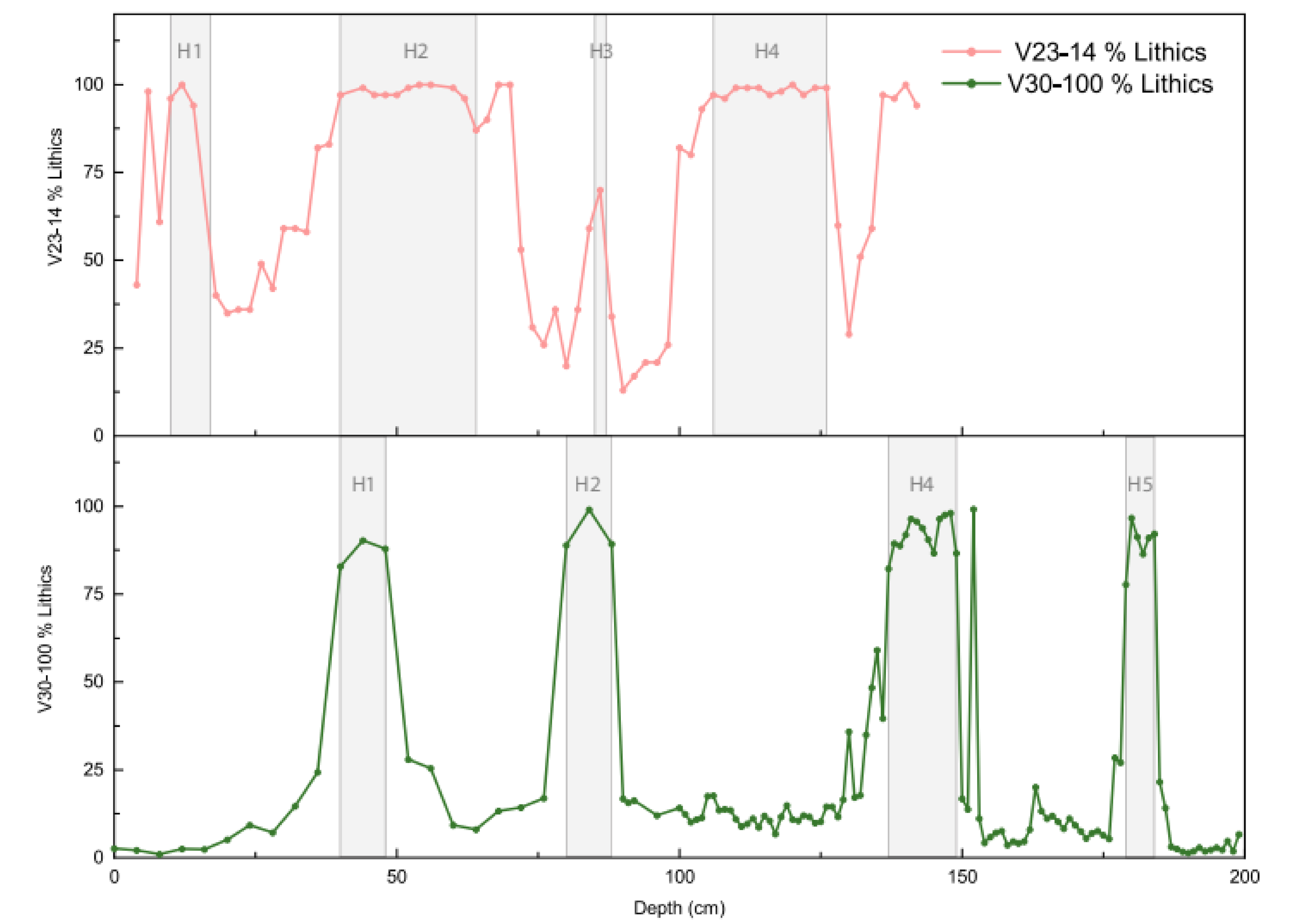

Figure 4: Comparison of %lithics from the radiocarbon dated V23-14 core (pink) (Hemming, 2003) to the V30-100 core (green). Identified Heinrich events in V23-14 are similar to the intervals of high %lithics in V30-100.

Table 1: Table shows 14C ages and Heinrich layer identifications from core V23-14 compared to intervals of high IRD input in core V30-100. Modified from Hemming, 2003.

Heinrich Event	^{14}C age (yr) from V23-14	Interval (cm) of V23-14	Correlated interval (cm) of V30-100
H1	14,000	10-17	40-48
H2	20,500	40-64	80-88
H3	27,000	~85-87	
H4	35,000	106-126	137-149
H5	43,000	136-end	179-184

Conclusions

- The high-resolution record for the V30-100 core shows four large spikes in lithics
- Heinrich events 1, 2, 4, and 5 have been identified in the V30-100 core
- Evidence of Heinrich event 3 was not captured in the V30-100 record

References

Heinrich, H., 1988, Origin and consequences of cyclic ice rafting in the northeast Atlantic Ocean during the past 130,000 years: Quaternary Research, v. 29, p. 142–152, doi: 10.1016/0033-5894(88)90057-9.

Hemming, S.R., and Hajdas, I., 2003, Ice-rafted detritus evidence from 40ar/39ar ages of individual hornblende grains for evolution of the eastern margin of the Laurentide Ice Sheet since 43 14cky: Quaternary International, v. 99-100, p. 29–43, doi: 10.1016/s1040-6182(02)00110-6.

Snoeckx, H., Grousset, F., Revel, M., and Boelaert, A., 1999, European contribution of ice-rafted sand to Heinrich Layers H3 and H4: Marine Geology, v. 158, p. 197–208, doi: 10.1016/s0025-3227(98)00168-6.