RECORDS OF THE LATE GLACIAL INFLUX OF ICE-RAFTED DETRITUS ON THE ORPHAN KNOLL, NORTHWEST ATLANTIC OCEAN

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Introduction & Background

Detrital layers found in sediments from the Orphan Knoll, Northwest Atlantic Ocean, are analogous to Heinrich layers found in Atlantic Ocean deep-sea sediments that were deposited during the last glacial cycle. Abrupt increases in ice-rafted detritus (IRD) are expected to occur with sharp increases in the Ca/Sr ratio.

Heinrich Events are exhibited in the sediment record as Heinrich layers and are notably abundant in lightly-colored, detrital carbonate grains (Bond et al., 1992). This may suggest a strong influence by the Laurentide Ice Sheet launching "armadas" of icebergs from Canada through the Hudson Strait (Broecker et al., 1992) which may or may not be entirely driven by climate variability. These Heinrich layers are in sync with fluctuations of the sediment's Ca/Sr ratio because an overall lowering in the abundance of strontium in the record indicates a lack of foraminifera present or an influx of detrital carbonate, particularly dolomite. This suggests Canada and the Hudson Strait as the main source area.

In 2017, RRS Discovery Cruise DY081 (Figure 1) recovered sediment cores (GVY001 and GVY002) for two locations on the Orphan Knoll at depths of 3,721 meters and 1,170 meters, respectively. The Ca/Sr records for both cores are very high resolution and indicate a series of peaks in Ca/Sr, which can be a proxy for some of the previously identified Heinrich events in the North Atlantic Ocean. Heinrich events H0-H4 have been tentatively correlated by Hendry, et al. (2019) to the shallowest peaks in the Ca/Sr ratio for GVY001.

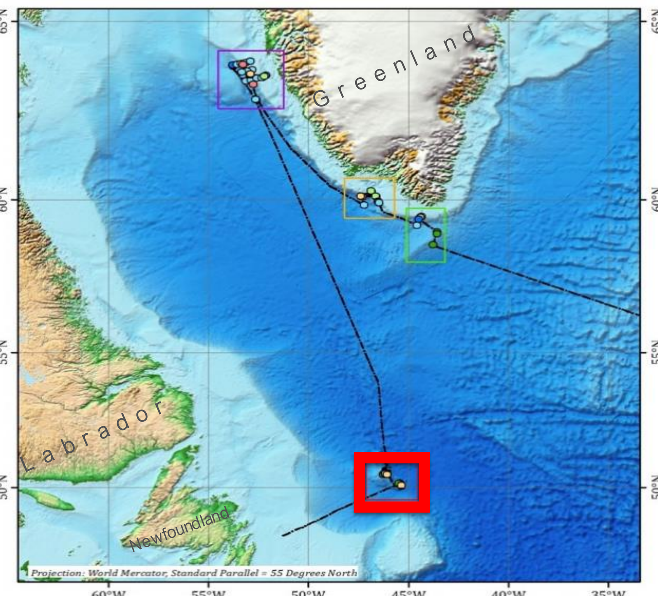

Figure 1. Overview map of RRS Discovery Cruise DY081 ship route (2017), produced in Mercator projection with a standard parallel of 55°N. Note that the area outline in red is the Orphan Knoll, which is a topographic high sitting off the continental margin of Labrador.

Purpose

The purpose of this study is to:

I. Document changes in two proxies of ice-rafted detritus (IRD (>150 µm)/gram and % IRD (>150 µm)) at the Orphan Knoll.
II. Evaluate core GVY002 by comparing its IRD record with the Ca/Sr ratio previously generated for this core.
III. Compare this information to core GVY001 to correlate the two cores.
IV. Interpret the results within the context of North American Heinrich Events.

Methods

- Two 5-meter cores (DVY081-GVY001 and DVY081-GVY002, found at water depths of 3,721 meters and 1,170 meters respectively) were recovered from the Orphan Knoll during cruise: RRS Discovery Cruise ICY-LAB (2017).
- Detailed Ca/Sr XRF count ratios have been generated for both cores. Both cores have been sampled at 2-centimeter intervals to generate two proxies for the input of IRD:
  1) *Lithics/gram or IRD/gram: (number of lithic fragments >150µm per gram sediment)*
  2) *% lithics or % IRD: (number of lithics >150µm/ (number of lithic grains >150µm + number of whole planktic foraminifers (forams) >150µm))*

Results

IRD/GRAM, %IRD AND CA/SR RATIOS FOR GVY002

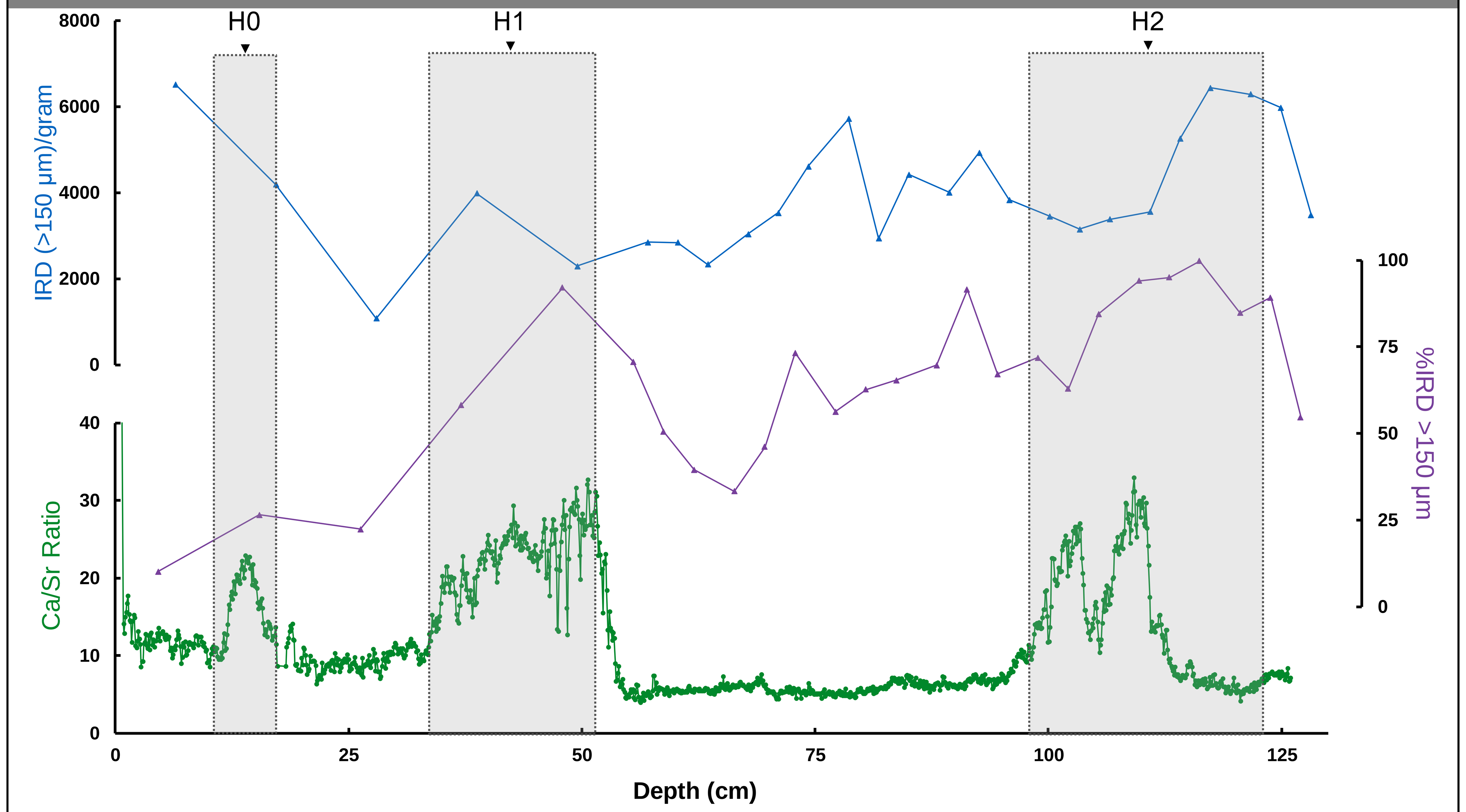

Figure 2. Comparison of IRD/gram, % IRD (>150 µm) and the Ca/Sr count ratio for the upper 126 cm of GVY002. Heinrich Events H0, H1 and H2 have been identified, marked by peaks in IRD/gram, % IRD and Ca/Sr count ratio. This method is based on Hendry, et al. (2019), who tentatively correlated the shallowest peaks in Ca/Sr ratios in GVY001 with Heinrich Events H0-H4 by correlating the Ca/Sr ratio records in GVY001 to the δ18O records of N. pachyderma (s.). Notice two distinct maxima in both IRD/gram and % IRD between H1 and H2, which occur during an interval of notedly low Ca/Sr ratios, indicative of a dolomite-poor IRD influx at that time.

COMPARISON OF GVY002 WITH GVY001

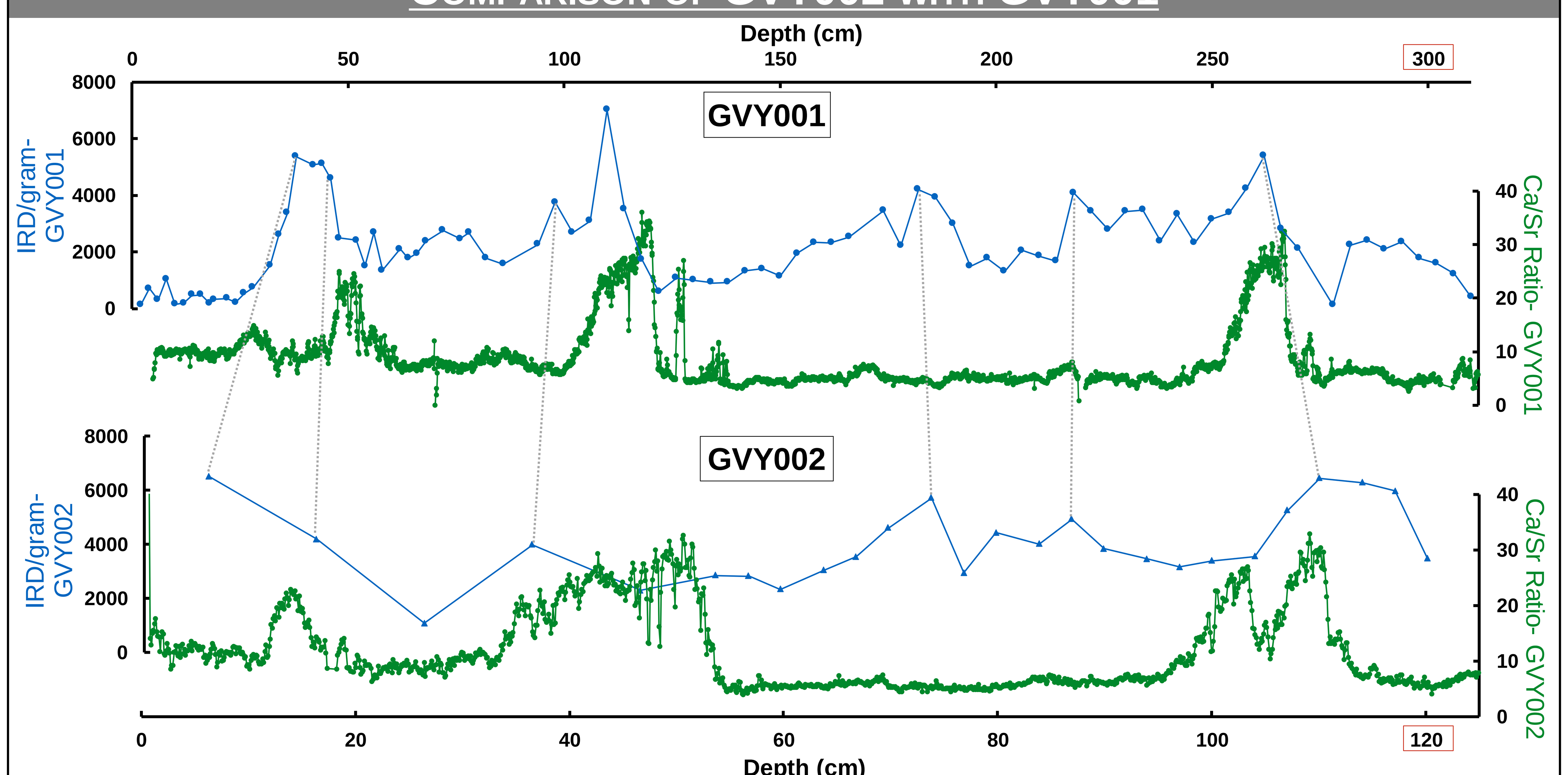

Figure 3. Comparison of the IRD/gram and Ca/Sr ratios for the upper ~120 cm of core GVY002 (bottom) with the upper 300 cm of GVY001 (top). Maxima in Ca/Sr ratios at the same core depth as influxes of IRD indicates a Heinrich Event for that time interval. Core GVY002 was analyzed every 10 cm for the first half meter and every 3 cm from then on. GVY001 was analyzed every 2 cm throughout its entire core depth. The IRD record produced for core GVY002 shows evidence of strong IRD influxes which coincide with Heinrich events H0, H1, and H2 (see Figure 2). Both cores display an interval of exceedingly low Ca/Sr, which was used to align them with one another, coupled with influxes of IRD/gram which can indicate an alternate source area for this IRD that is low in dolomite. Dashed lines indicate a comparison of IRD influx for both cores.

Discussion & Conclusion

- The top 126 centimeters of the IRD record for GVY002 reveals ***five distinct peaks in IRD input***, each between 4,000-6,500 lithics/gram (Figures 2 and 3).
- ***Three of these peaks coincide with three peaks in the Ca/Sr ratios*** in the upper meter indicative of dolomite rich IRD from the Canadian margin (Figure 2).
- The IRD record and Ca/Sr ratio record generated with this study, when compared to the previously generated similar records in GVY001, reveals a ***similar pattern but over a shorter downcore interval*** (the upper 1.8 meters in GVY002 versus the upper 4.5 meters in GVY001). ***This is due to the higher sedimentation rate in GVY001*** (Figure 3).
- GVY002 and GVY001 both display ***two additional IRD peaks of at least 4000 lithics/gram between H1 and H2 over intervals of very low Ca/Sr ratios*** (Figures 2 and 3). Peaks in IRD coupled with low Ca/Sr ratios could represent a lack of calcium as well as an abundance of strontium in the system. This is indicative of dolomite-poor sediment.
- An IRD peak in GVY001 corresponds to each of the Heinrich Events identified in Hendry, et al. (2019). Subsequent comparison of GVY002 IRD records with those of GVY001 suggest that ***Heinrich Events H0, H1, and H2 can be identified over the upper meter*** (Figure 2).

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