A high-resolution ostracod-derived $\delta^{18}O$ record of early Holocene abrupt climatic change from N. Scotland.

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This is 'work in progress' as part of my PhD. Results and figures are incomplete and will change in the future. Please do not reuse them.

Aim:

To produce a ostracod-derived $\delta^{18}O$ record of the early Holocene from Crudale Meadow, Orkney and compare to other palaeoenvironmental evidence in order to reconstruct early Holocene abrupt climate events.

Why?:

There are many abrupt climatic events in the early Holocene recorded in NW Europe. This is a *potentially* sub-centennial scale record & adds to the existing transect of $\delta^{18}O$ records from W. Ireland[1], W. England[2], & Scandinavia [3].

How?:

$\delta^{18}O$ from winter calcifying *Candona* ostracods.
Tephrochronology.
Chironomid-Inferred Temperature record.
Pollen record.

Where is Crudale Meadow?

Crudale is on the west of Orkney Mainland, Scotland (Figure 1). It is a palaeolake site that has a sediment sequence that spans the Last Glacial to Interglacial Transition, including the earliest Holocene.

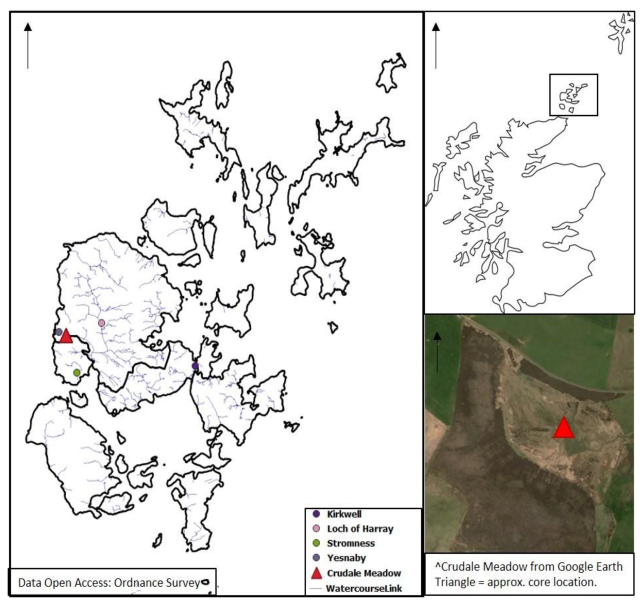

Figure 1: Location of Crudale Meadow taken from Google Earth[4] and Ordnance Survey[5] data.

The Ostracod Method:

Multi-shell samples of winter-calcifying ostracod *Candona* spp. (Figure 3) are analysed for ^{18}O:^{16}O. Using winter species limits the influence of evaporation on the produced $\delta^{18}O$ record. The ostracods are hand-cleaned, with methanol.

Figure 2: *Candona ostracods from Crudale Meadow. Photo by: J. Tindall.*

$\delta^{18}O$ records can be used to infer palaeoclimatic change (temperature, precipitation & atmospheric circulation). A bulk carbonate $\delta^{18}O$ record exists for Crudale but at low resolution [6]. Here, a high-resolution ostracod-derived $\delta^{18}O$ record is presented offering both a greater resolution to the palaeoclimatic reconstruction and more certainty of the provenance of the carbonate.

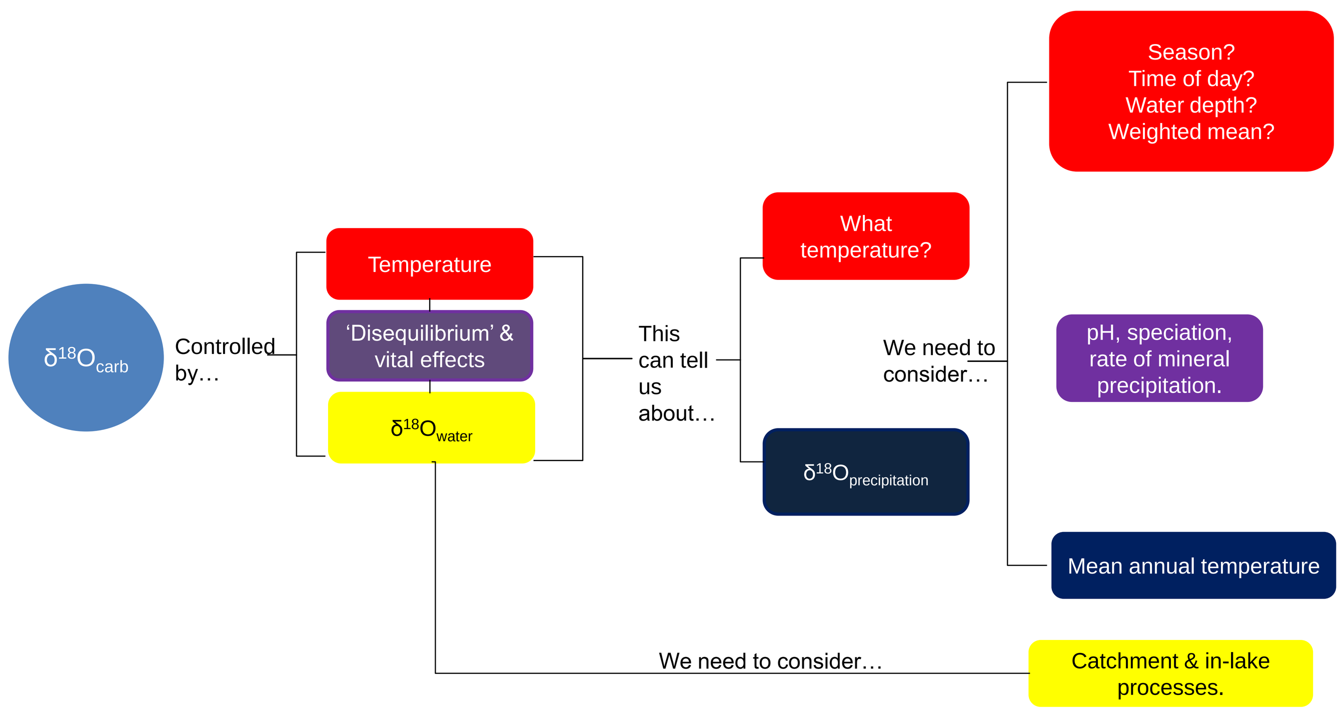

Figure 3: *Adapted from Leng and Marshall (2004)* [7]

Results:

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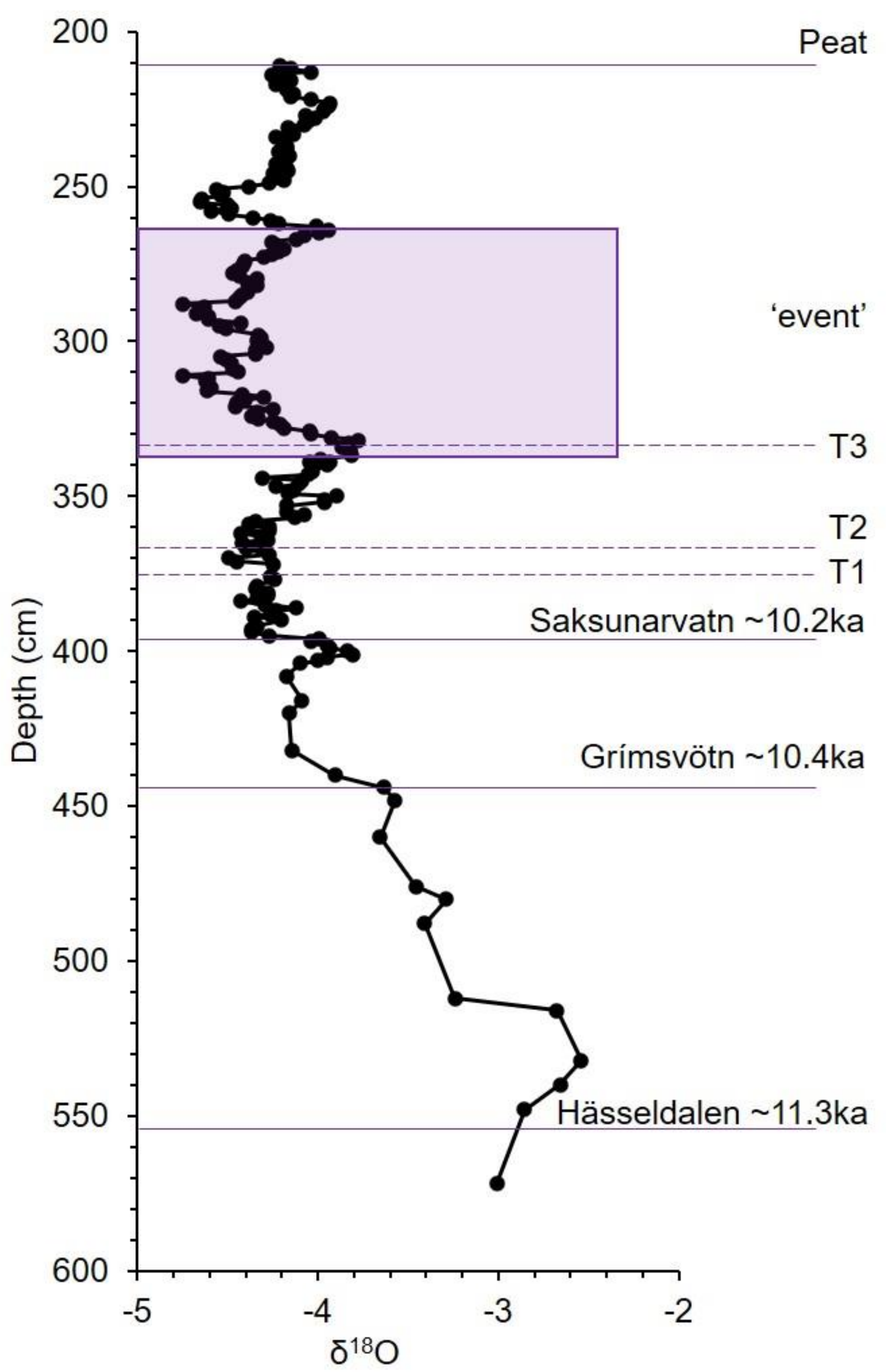

Figure 4: *Oxygen isotope record from Candona species at Crudale Meadow. Values are corrected for the vital offset (+2.2‰[8]). Data presented are a six-point moving average. The total uncertainty on isotope values is 0.17. Tephra layers approximated from Timms et al. (2018)[9]. Depths are raw core depths and have not yet been corrected for overlaps. T1, T2, T3, refer to layers where a cryptotephra peak has been found but is yet to go under geochemical analysis. These are at depths of 331cm, 368cm and 374cm.*

Key Findings:

- At ~520cm there is a peak in $\delta^{18}O$ values. Similar peaks are seen in other early Holocene isotopic records.
- This record suggests the decline from this peak is constrained to around ~10.2ka. Often, early Holocene sites have limited chronologies and identifying the timing of this excursion is not possible
- Post ~10.2ka, between 255-330cm there is a negative excursion in the isotopic record. The high sampling resolution identifies complexity in this excursion.
- The position of this event makes it likely to be the 9.3ka event subject to chronology confirmation.
- The evolution of this event, tentatively, appears similar to that of Greenland, presented in Rasmussen *et al.* (2007)[10].
- A pollen record produced by Daniel Petts (not shown here) closely matches that of Whittington *et al.* (2015)[6] who produced an earliest Holocene record for Crudale. It shows a decline in tree species & increased shrub and herbaceous type species at the time of the 'event'.
- The pre 10.2ka isotope peak in this record, is also identifiable in Whittington *et al.* (2015)[6] $\delta^{18}O_{marl}$ record.
- Initial chironomid-inferred summer temperature work by Chris Francis indicates complexity in their response, with changes in C-IT sometimes asynchronous with the $\delta^{18}O$ trend.

Next Steps:

- Complete the tephrochronology. There are another 3 tephra layers that require geochemical identification post ~10.2ka.
- Correct the core depths and properly integrate with the Timms *et al.* (2018) record from Crudale Meadow.
- Properly explore the pollen and chironomid records that have been produced and understand what they can tell us about early Holocene climatic change at Crudale Meadow.

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References:
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