Tephra-based time-markers from the Last Glacial Period recorded in the North Atlantic: an emerging tool for an east-west synchronization of paleoclimate records

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Ancient volcanic eruptions are valuable time markers

Tephra (volcanic ash) shards ejected from volcanoes are deposited over large geographical areas in different geological environments and can act as regional time-parallel marker horizons. The geochemical distinct signature of tephra shards, often distinct, allows for identification of the source volcano system and, in some cases, the specific eruption from which the shards originate. Geochemically distinct tephra shards embedded in marine sediment sequences have a proven potential to be utilized as a key correlational tool the synchronization of paleoclimatic events within the marine realm, but also across different climate archives. Here, we utilize the identification of the instantly deposited and wide-spread tephra marker NAAZ II (II-RHY-1) deposited during Greenland Interstadial 15 to synchronize paleorecords across the North Atlantic Basin. The study focuses on ocean temperature and salinity changes and therefore, we use already available $\delta^{18}O$ & $\delta^{13}C$ data coupled with new Mg/Ca records, from benthic and planktic foraminifera.

Fig. 1: Volcanic eruption.

Study Area

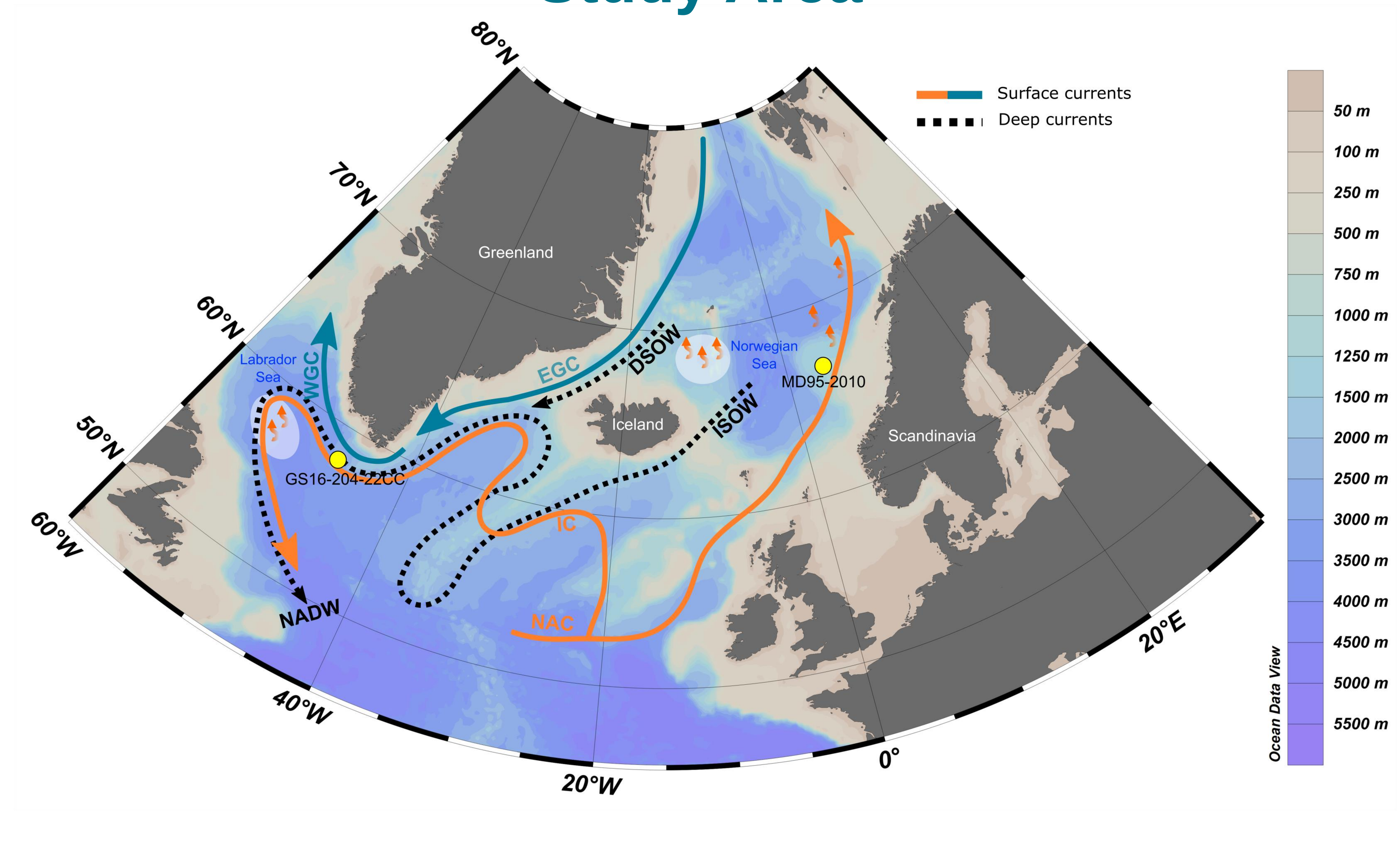

Fig. 2: Map of study area. Study sites are marked by yellow dots. Solid lines represent main surface currents and dotted line main deep currents. Deep-water formation sites in the Labrador Sea and Nordic Seas are also marked.

Results & Discussion

Step 1. Identification of NAAZ II (55 380 ± 1184 b2k*)

GS16-204-22CC (Labrador Sea)

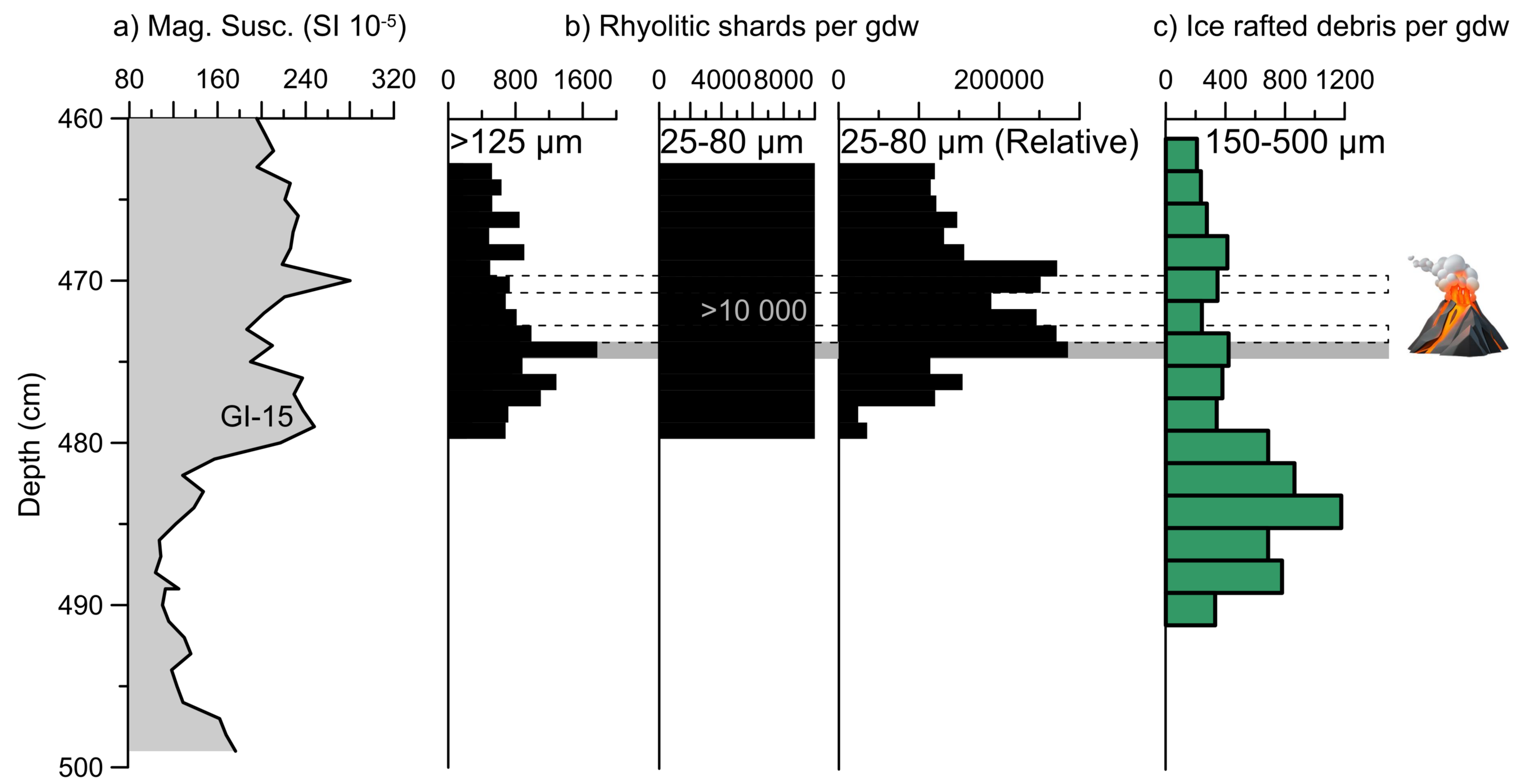

Fig. 3: Tephra shard concentration profile from Labrador Sea core GS16-204-22CC (Rutledal et al., 2020).

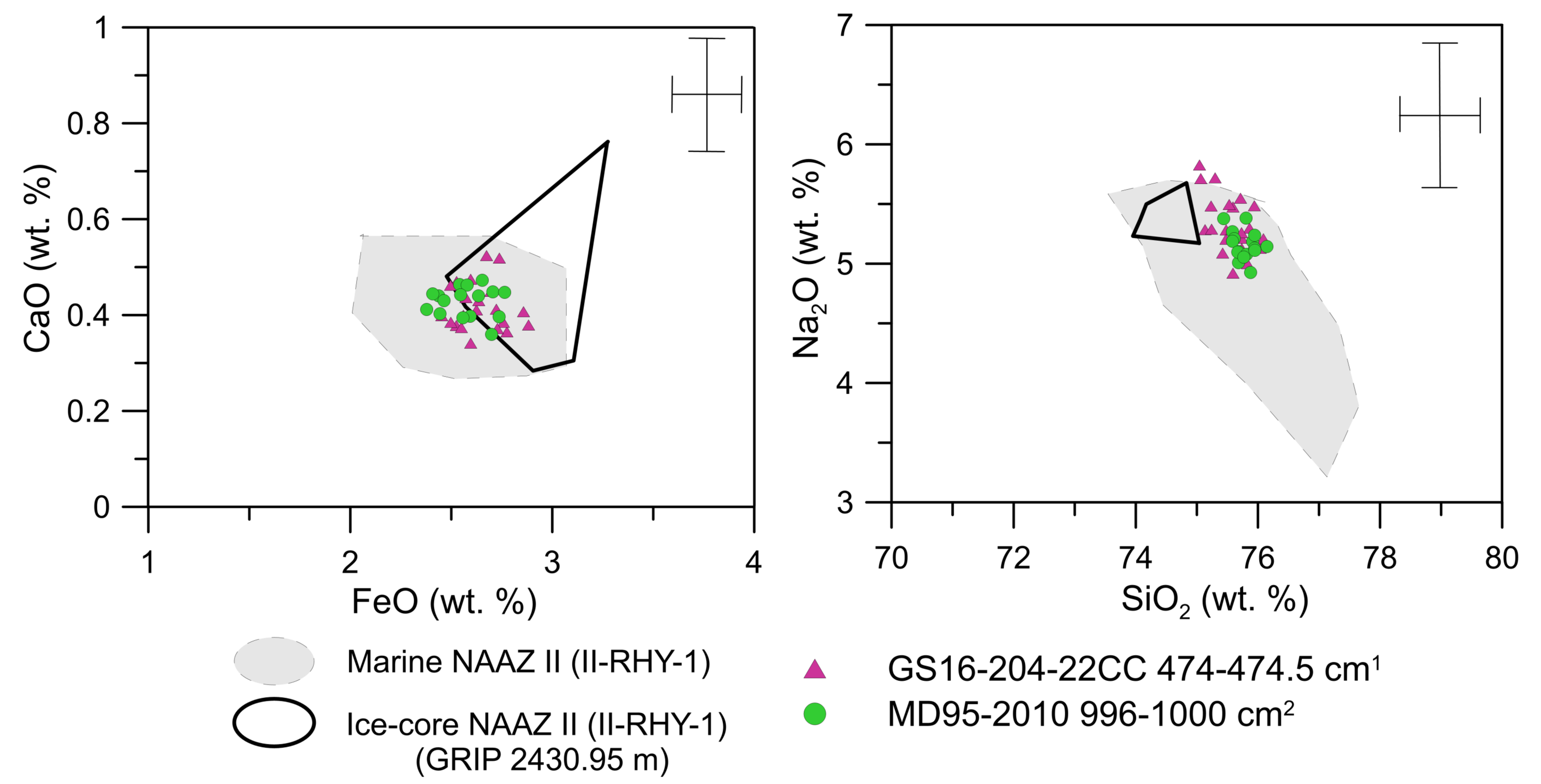

Fig. 4: Biplot comparison of tephra shard analyses (major element oxides) from marine sediment cores GS16-204-22CC and MD95-2010 to the NAAZ II (II-RHY-1) geochemical data from the North Atlantic marine tephra framework (grey shaded area) (Austin et al., 2004; Wastegård et al., 2006: Brendryen et al., 2011; Abbott et al., 2016, 2018) and from the Greenland ice core GRIP (black line) (Grönvold et al., 1995). Error bars represent 2 standard deviations of replicate analyses of Lipari Obsidian reference glass. [1]Rutledal et al. (2020), [2]Abbott et al. (2018).

NAAZ II (II-RHY-1) was successfully identified in core GS16-204-22CC from the Labrador Sea (Rutledal et al., 2020) and in core MD95-2010 from the Norwegian sea (Abbott et al., 2018). The tephra layers are interpreted to be near-instantaneously deposited and is thus useful as correlational time-markers in future studies.

Step 2. Synchronization of paleorecords

Preliminary results and ongoing work. Do not reuse

The identification of the NAAZ (II-RHY-1) ash in both sediment cores allows for a robust correlation of paleo-proxy records from both sites across the Greenland Interstadial (GI) 15 transition. During GI-15, overall the data indicates similar surface water conditions at the two sites, apart from a slight freshening of the surface waters in the Norwegian Sea relative to the Labrador Sea (likely related to increased Ice Rafted Debris input). Contrarily the Mg/Ca temperature record from benthic foraminifera indicates a cooling in the Norwegian Sea deep waters relative to the Labrador Sea. Unfortunately, benthic stable isotope data is not yet ready from the Labrador Sea site.

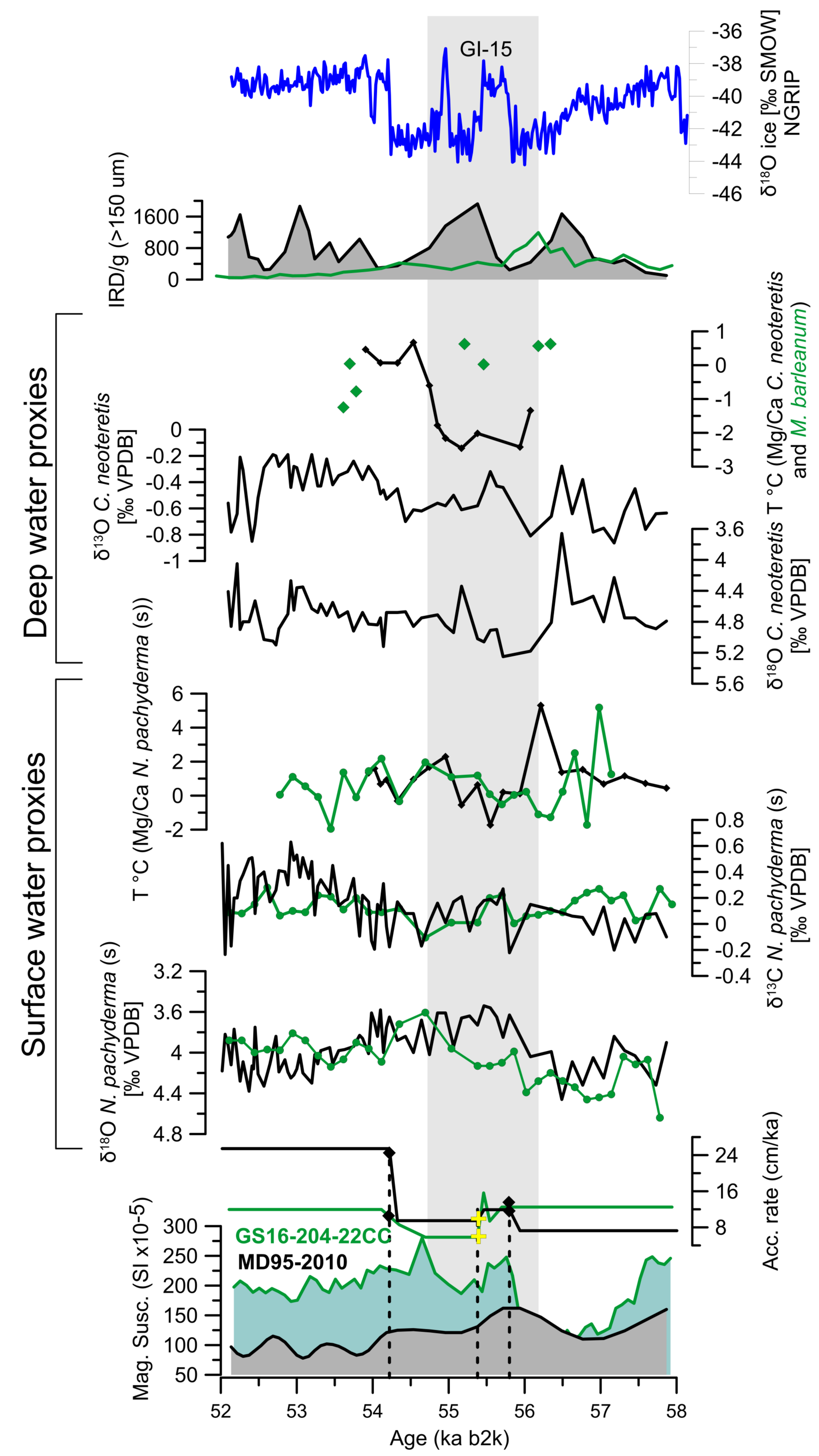

Fig. 5: Proxy data from cores MD95-2010 and GS16-204-22CC. IRD and Stable isotopes GS16-204-22CC (Griem et al., 2019) and MD95-2010 (Dokken and Jansen 1999). Mg/Ca data (this study). NAAZ II (II-RHY-1) marked by yellow cross.

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