

Recent insights into the radiocarbon dating of Arctic Ocean sediments

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Radiocarbon dating of planktic and benthic foraminifera forms the backbone of most late Quaternary paleoclimate reconstructions. In the Arctic Ocean, radiocarbon dates become particularly important because of the limited usefulness of oxygen isotope stratigraphy caused by strong fresh water overprint on the isotope signal, as well as the scarcity of calcareous micro- and nannofossils. However, recent studies have high-lighted several problems with the commonly accepted radiocarbon dated chronostratigraphies from the central Arctic Ocean. In particular, Wollenburg et al. (2023) demonstrated that authigenic calcite overgrowth can make radiocarbon ages several thousand or even tens of thousands of years older, and they argue that this bias can offer an alternative explanation for the apparent widespread hiatus observed in many Arctic cores for the MIS 2 interval. However, the study overlooks the effect of deep-reaching bioturbation. The producers of trace fossils such as *Zoophycos* have been shown to pipe surface material deep down into the sediment, resulting in age errors of several thousands of years (Leuschner et al., 2002; Löwemark and Werner, 2001).

In fact, the depth interval where Wollenburg et al. (2023) finds the largest discrepancies in the radiocarbon ages coincides with an interval rich in *Zoophycos*. It is therefore likely that at least some of the offset in age between radiocarbon ages influenced by authigenic calcite and the presumed true age of the sediment can be explained by downwards piping of younger foraminifera from the (paleo)sea floor. This would mean that while radiocarbon ages of the MIS 2 interval likely are too old, the offset might not be as large as postulated by Wollenburg et al. (2023).

Another, maybe more important implication from their study is that it is not enough to select the best preserved foraminifera when radiocarbon dating sediment. These pristine foraminifera may actually represent “fresh” specimens piped down by *Zoophycos*, providing an alluring source of foraminifera for dating and proxy measurements in a sediment else dominated by heavily altered tests. Consequently, before sampling of foraminifera for radiocarbon dating, it must be established that the sediment interval is free of deep reaching burrows. This is best done by consulting X-ray radiographs.

References

- Leuschner, D.C., Sirocko, F., Grootes, P.M., Erlenkeuser, H., 2002. Possible influence of *Zoophycos* bioturbation on radiocarbon dating and environmental interpretation. *Mar. Micropaleontol.* 46, 111-126.
- Löwemark, L., Werner, F., 2001. Dating errors in high-resolution stratigraphy: a detailed X-ray radiograph and AMS-¹⁴C study of *Zoophycos* burrows. *Mar. Geo.* 177, 191-198.
- Wollenburg, J.E., Matthiessen, J., Vogt, C., Nehrke, G., Grotheer, H., Wilhelms-Dick, D., Geibert, W., Mollenhauer, G., 2023. Omnipresent authigenic calcite distorts Arctic radiocarbon chronology. *Communications Earth & Environment* 4, 136.