

Deep-sea coral evidence found for enhanced subglacial discharge from Antarctica during meltwater pulse 1A

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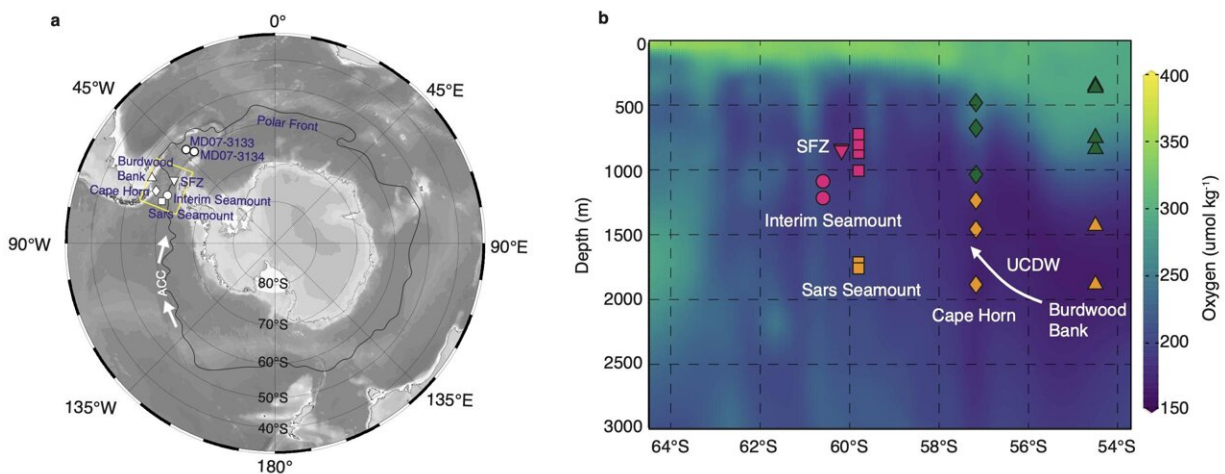


Fig. 1 Locations of deep-sea coral samples. Credit: NIGPAS

Subglacial discharge from the Antarctic Ice Sheet (AIS) likely played a crucial role in the loss of ice sheet and the subsequent rise in sea level during the last deglaciation. However, no direct proxy is currently available to document subglacial discharge from the AIS, which leaves significant gaps in our understanding of the complex interactions between subglacial discharge and ice sheet stability.

Recently, Assoc. Prof. Li Tao from the Nanjing Institute of Geology and

Paleontology of the Chinese Academy of Sciences (NIGPAS), in collaboration with researchers from University of Bristol, University of St Andrews, and Nanjing University, carried out a high-resolution deep-sea coral $^{234}\text{U}/^{238}\text{U}$ records from the Drake Passage in the Southern Ocean to track subglacial discharge from the AIS. The findings provide an important reference for predicting possible future changes in the Antarctic ice sheet.

The study was published in [*Nature Communications*](#) on Nov. 13.

The uranium isotopic composition of seawater is a potential tracer for subglacial discharge and thus ice-sheet stability in the past. Due to the relatively mobile nature of ^{234}U induced by α -recoil effects, ^{234}U is preferentially released and transported to the ocean via riverine input, resulting in an enrichment of ^{234}U relative to ^{238}U in modern seawater. Within debris-laden basal ice and subglacial sediments, however, recoil rejection of ^{234}U is maintained in either basal ice or subglacial waters, thus leading to a ^{234}U -enriched reservoir beneath the ice sheets.

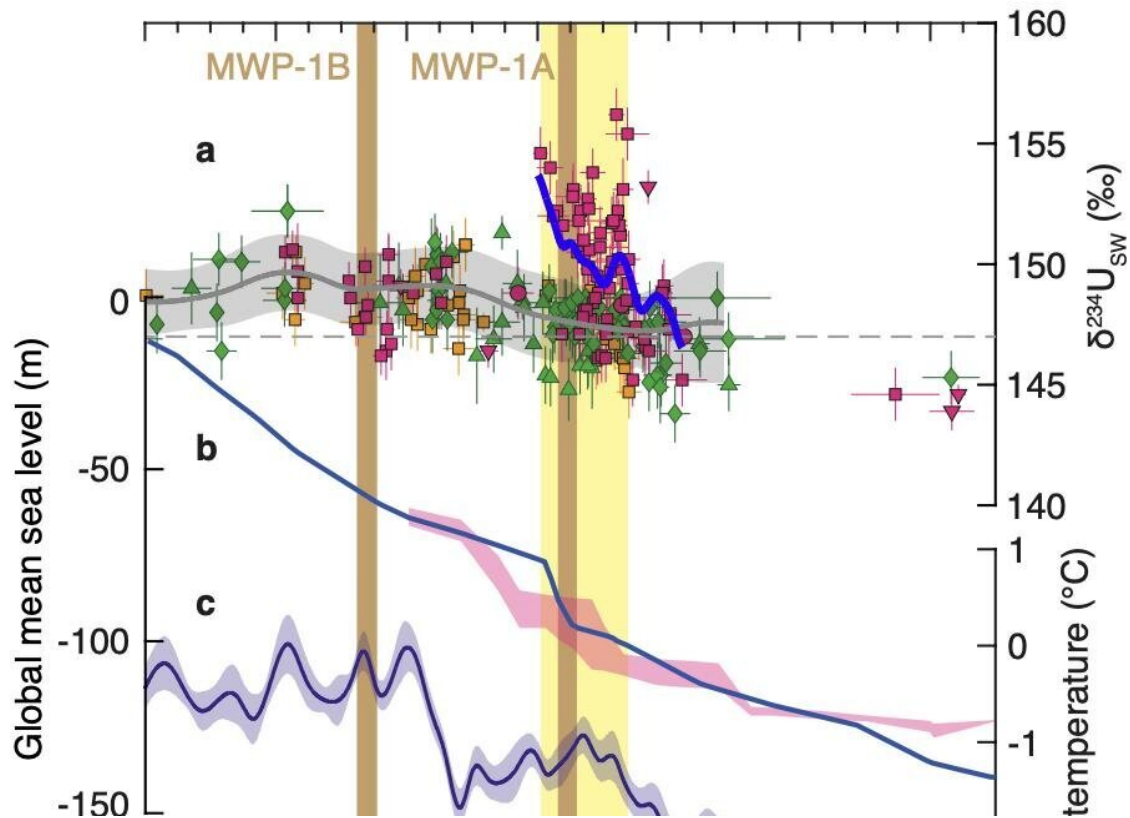


Fig. 2 Comparison of Southern Ocean seawater $\delta^{234}\text{U}$ record with other paleoclimatic records. Credit: NIGPAS

Given the widespread presence of subglacial lakes beneath AIS, the pool of excess ^{234}U is expected to be considerable, and may have significantly impacted local seawater $\delta^{234}\text{U}$ if it was released into the Southern Ocean during episodes of AIS retreat during the last deglaciation.

In the study, the researchers recovered deep-sea coral samples from seamounts in the Drake Passage, including two sites to the north of the Polar front (PF) (Cape Horn and Burdwood Bank), one site aligning with PF (Sars Seamount), and two sites to the south of the PF (Interim Seamount and Shackleton Fracture Zone). These samples were precisely dated by isotope dilution U-Th disequilibrium. This comprehensive

geographic coverage allowed the researchers to investigate a range of oceanographic conditions and potential sources of $\delta^{234}\text{U}$ anomalies.

The findings revealed distinctively higher seawater $^{234}\text{U}/^{238}\text{U}$ values from 15,400 to 14,000 years ago, corresponding to the period of the highest iceberg-rafted debris flux and the occurrence of the meltwater pulse 1A event. This correlation suggests a [causal link](#) between enhanced subglacial discharge, synchronous retreat of the AIS, and the rapid rise in sea levels. "We further demonstrated that the enhanced subglacial discharge and subsequent AIS retreat appear to have been preconditioned by a stronger and warmer Circumpolar Deep Water," said Li.

By analyzing 38 new samples from Sars Seamount 695 to 981 m and integrating these data with 335 existing U-Th measurements, the researchers investigated the presence of $\delta^{234}\text{U}$ anomalies in the Southern Ocean at the highest possible temporal resolution. The results revealed a general increase in Southern Ocean seawater $\delta^{234}\text{U}$ from the last glacial period to the early Holocene, with a glacial low of $\sim 144.0\text{‰}$ (~ 20 ka) to a value of $\sim 148.9\text{‰}$ during the early Holocene (~ 10 ka), followed by a gradual decreasing trend towards a modern value of 146.8‰ .

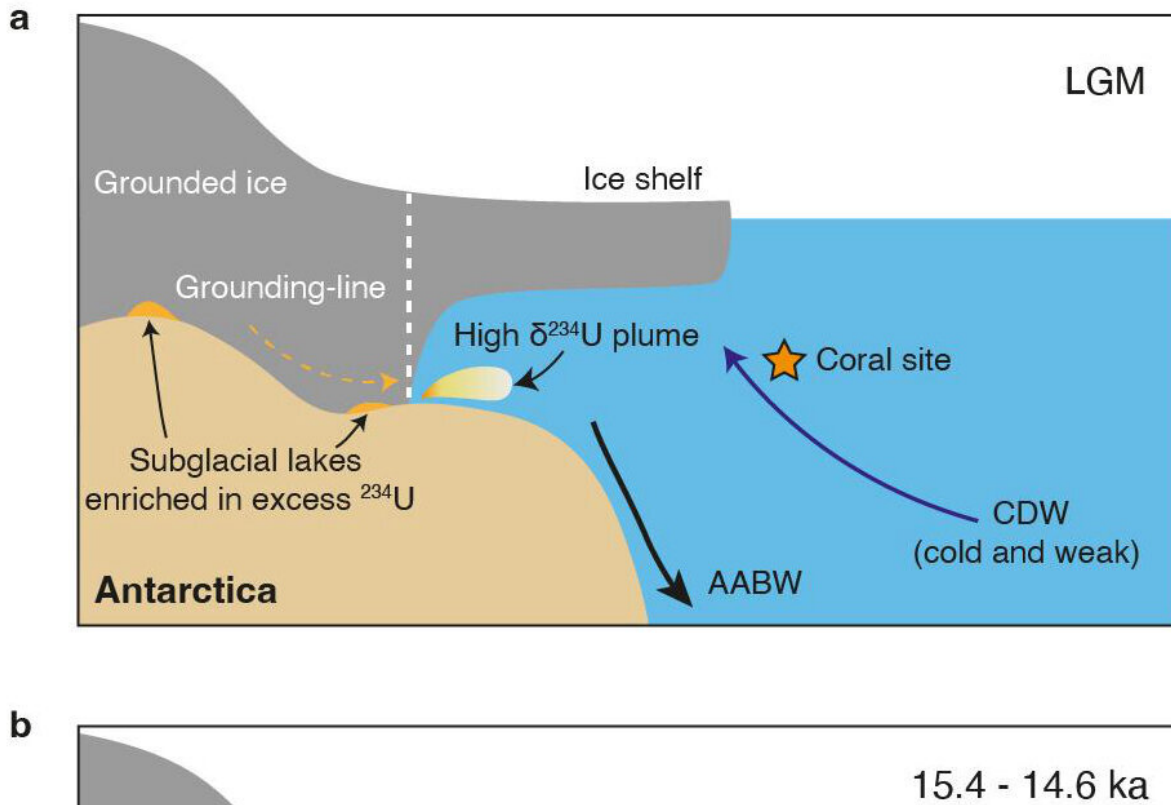


Fig. 3 Schematic of changes in ocean circulation, subglacial meltwater plume, and AIS. Credit: NIGPAS

This deglacial increase of seawater $\delta^{234}\text{U}$ reflected the input of excess ^{234}U relative to ^{238}U to the global ocean, which has been linked to the intensified physical weathering resulting from the rapid retreat of ice sheets during the last deglaciation. Superimposed on the general deglacial trend is a remarkable spike in $\delta^{234}\text{U}$ reaching up to $\sim 155\text{‰}$ from ~ 15.4 to 14 ka.

"We argued that this high $\delta^{234}\text{U}$ signal cannot be fully explained by the advection of ^{234}U -enriched water from other ocean basins for several reasons and is most likely caused by enhanced subglacial discharge from the AIS during this time period," said Li.

The researchers further demonstrated that this [discharge](#) occurred synchronously with the peak in iceberg-rafted debris originating from the Weddell Sea sector of the AIS and meltwater pulse 1A (MWP-1A, ~14.65 to 14.3 ka), which provides direct evidence supporting Antarctic contribution to MWP-1A during the last deglaciation.

By comparing the deep-sea coral $\delta^{234}\text{U}$ record with several climate proxies, they underscored that a stronger and warmer Circumpolar Deep Water may have preconditioned this rapid AIS retreat and the release of meltwater, and thus highlighting the critical role of oceanic heat in driving major ice sheet retreat.

More information: Tao Li et al, Enhanced subglacial discharge from Antarctica during meltwater pulse 1A, *Nature Communications* (2023). [DOI: 10.1038/s41467-023-42974-0](https://doi.org/10.1038/s41467-023-42974-0)

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