ICE AGE OCEAN TEMPERATURES INFERRED FROM ODP PORE WATERS

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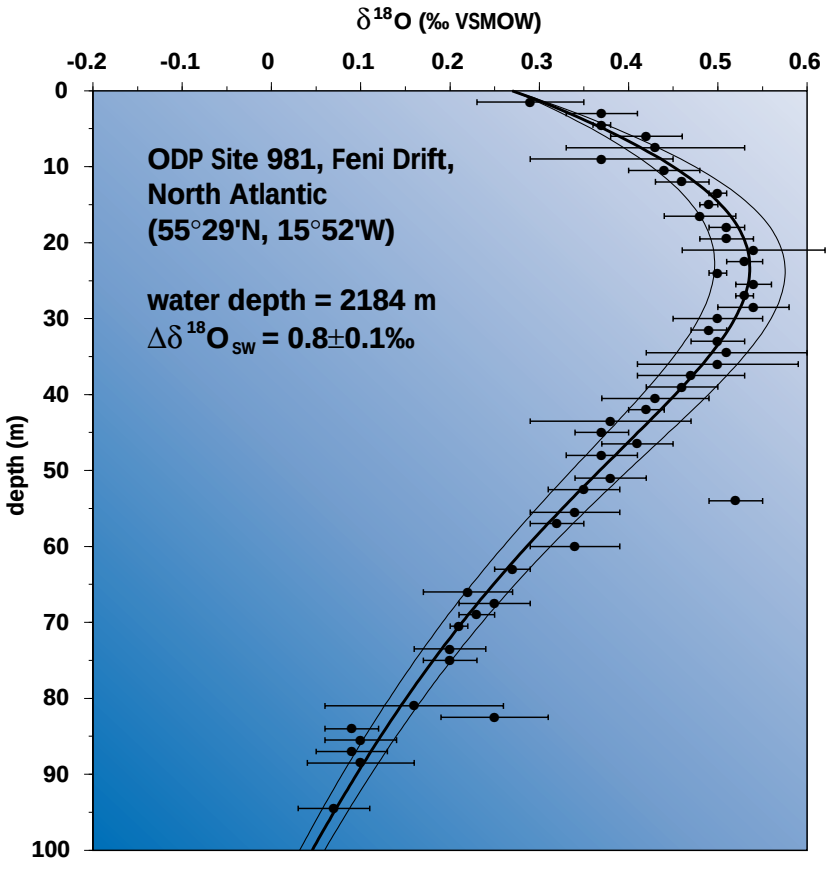
To reconstruct past climates and to improve our understanding of climate dynamics, paleoceanographers have focused on key climatic parameters such as ocean temperature and the size of continental ice sheets. To estimate temporal fluctuations in these two, scientists have historically relied upon downcore measurements of the ratio of oxygen isotopes ^{16}O and ^{18}O (i.e., $\delta^{18}O$) in calcareous foraminiferal microfossils. The difficulty of this approach is that foraminiferal $\delta^{18}O$ monitors changes in both temperature and seawater $\delta^{18}O$, the latter of which is primarily due to variations in ice sheet size. Up to now, the challenge has been to disentangle the two signals from the one foraminiferal data set. A new approach — measuring the $\delta^{18}O$ of pore waters squeezed from ODP sediment cores — may resolve the degree to which each parameter contributes to the total change in foraminiferal $\delta^{18}O$. The approach is straightforward. Seawater diffuses into the seafloor leaving a profile of $\delta^{18}O$ versus depth in the sediment column that records the $\delta^{18}O$ history of the overlying seawater, independent of temperature [*Schrag and DePaolo,* 1993]. The depth to which the signal penetrates is determined by the diffusivity of water through the pore spaces. Detailed measurements of pore water $\delta^{18}O$ from the upper 50 m of ODP Site 925 (Leg 154 in 1994), in the tropical Atlantic, enabled us to reconstruct seawater $\delta^{18}O$ during the last ice age [*Schrag et al.,* 1996]. These data suggest that continental ice growth increased the mean $\delta^{18}O$ of seawater by only 1.0‰, 0.3‰ less than previous estimates. New data on North Atlantic samples from Leg 162 (in collaboration with D. Hodell and K. MacIntyre) yield a similar change of 0.9±0.1‰ (see figure). By subtracting these pore water values from the larger foraminiferal values we are able to isolate the temperature component of the isotopic signal. Our data suggest that the deep ocean was ~3°C colder during the ice age and the tropical surface ocean was 2-5°C colder. These results support the argument that the ice age world was colder than some paleoclimatologists previously thought. Detailed sampling of pore waters on future drilling legs will tell us how seawater temperature and $\delta^{18}O$ in the deep ocean varied within and between ocean basins.



References:
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