

Radiocarbon and Deepwater Mass Changes in the Western North Atlantic During the Past 2000 Years: A Late Holocene Deepwater Study

Lloyd Keigwin, Geology & Geophysics

Final Report

Radiocarbon makes a powerful tracer for ventilation of the modern and the paleo ocean. Most paleo studies have used the ^{14}C proxy for ventilation studies of the ocean when it went through some of its most profound changes during the time interval 20,000 to 10,000 years ago. In general there is a remarkable concordance between ^{14}C ventilation results and results using other tracers such as Pa/Th, $\delta^{13}\text{C}$, Cd/Ca, grain size, etc., but ^{14}C excels because it is subject to fewer ambiguities than most other tracers. The large D^{14}C variations observed during the aforementioned deglacial interval (20-10 ka) are consistent with the very large changes that accompanied Earth's transition from glacial to interglacial climate.

Climate variability within the present interglacial epoch (the Holocene) is much less than it was during the glacial epoch in the North Atlantic region, and many of our paleo tracers are challenged to give a reliable indication of the ocean's role in the climate change. My preliminary data that led to the OCCI proposal showed that the sense of D^{14}C change during the late Holocene was actually opposite to that observed during glaciation. Prior to 10,000 yrs ago cold events in climate were associated with ^{14}C ventilation ages in the North Atlantic that were much older than today, but within the last few millennia the available data showed better ventilation. With OCCI support from the Comer Foundation I have greatly expanded this set of data and now I can show with confidence that two locations in the deep western North Atlantic were better ventilated than today during the Little Ice Age of a few hundred years ago and during another cold phase about a thousand years before that. This surprising result suggests that when the northern North Atlantic cools a little, say 1-2 degrees, more deep water is produced, but when cooling is much greater less deep water is produced. Most likely during the latter situation, sea ice is produced and that prevents ventilation. A dozen more ^{14}C measurements are pending at this moment, and when those results are in hand a paper will be written. An abstract of this research was presented by Keigwin et al. at the 2007 European Geosciences Union assembly in Vienna.

During the course of this project an opportunity arose to make some ^{14}C ventilation measurements of the glacial Pacific ocean at unusually deep sites. Funds from the Atlantic project were diverted to this Pacific objective, but most of the analytical costs were covered by my colleague Scott Lehman at U. Colorado. Our results in two cores have identified for the first time the extremely old bottom waters during the last glacial maximum (~15-23 ka) that were hypothesized by Broecker to account for dramatic atmospheric ^{14}C changes as Earth left the glacial state and deep ocean ventilation resumed. These results were presented by Keigwin et al. at the Fall 2006 AGU in San Francisco. A manuscript will be prepared in the coming months.