

Relic Water in the Deep Arctic Ocean

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Radiocarbon measured in the deep Canadian Basin during the 1990s and more recently in 2015 from the US Arctic GEOTRACES cruise, revealed a nearly homogenous distribution below 2500 m with a mean $\Delta 14C$ of about -110 o/oo, which corresponds to a mean age of about 450 years. Two ways to explain this age are: 1) the age is in steady state with a renewal time of 450 years or 2) the water is not being renewed or being renewed slowly and the $\Delta 14C$ age is getting older. CFC-11 and CFC-12 measurements from the US GEOTRACES cruise revealed an essentially homogeneous distribution below 2700 m with average concentrations of about 0.024 and 0.009 pmol/kg for CFC-11 and CFC-12. There were also locations where the CFC concentrations increased at the bottom by up to a factor 5 above the mean deep water concentration revealing the inflow of recently formed bottom water, presumably from the continental shelf seas. The deep water renewal time calculated from the CFC data was about 7000 years. This suggests either that the deep water is essentially relic with an age of 450 years or that the rate of formation decreased from a renewal time of 450 years to a renewal time of 7000 years prior to the input of CFCs, which began around 1950. In the Eurasian Basin water below about 3500 m is homogeneous. The mean $\Delta 14C$ below 3500 m measured in the 1990s is about -75 o/oo and the mean CFC-11 and CFC-12 concentrations from measurements on the 2015 German GEOTRACES cruise are about 0.128 and 0.059 pmol/kg. The higher $\Delta 14C$ and CFC concentrations are the result of more rapid ventilation of the deep Eurasian Basin. The $\Delta 14C$ age and renewal time is about 180 years and the renewal time based on the CFC data is about 1250 years. This indicates that the deep water is a mixture of relic water that formed more rapidly in the past and recent water forming at a slower rate.