An evaluation for mixing and biological processes based on oxygen isotopic ratios of dissolved oxygen.

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The delta-^{18}O of O_2 is a useful tracer for chemical and biological processes not linearly related to oxygen utilization. The variations of delta-^{18}O, therefore, will give us information of processes occurring in the interior ocean independently from dissolved oxygen itself.

The Japan Sea has several deep basins over 3000 meters in depth, connected to the outside seas with four shallow straits. Thus, the oceanography of the Japan Sea is specific. For example, the water is vertically well mixed with a time scale of order 100 years, but the deep water stays in the Sea with a residence time of 1000 years [1]. The ranges of variation in temperature and salinity are much smaller in the Japan Sea than in the Pacific Ocean, by one order of magnitude in temperature or even two orders of magnitude in salinity, but the relative changes in temperature versus salinity in the Japan Sea are similar to those of the Pacific Ocean.

We measured the $^{18}O/^{16}O$ ratios of oxygen dissolved in seawater of the Eastern Japan Sea collected in March 2005 and the central north Pacific during August to September 2005, along 160˚W. Samples were drawn from Niskin bottles mounted CTD rosette. For the isotope measurements, approximately 150 mL of water were collected in 300 mL preevacuated bottles that have been poisoned with 45µl of saturated $HgCl_2$ solution. These samples were prepared and analyzed by Finnigan^{TM}-DELTA^{plus}XP according to the modified procedure described by E Barkan and B. Luz, [2].

This is the first study reporting the isotopic ratios of dissolved oxygen in Japan Sea. The mean delta-^{18}O observed in the mixed layer was +22.86‰, which was depleted more than the atmospheric saturation level at 10˚C by about 1.4‰. It is clear that the relative depletion of delta-^{18}O is caused by the addition of photosynthetic “light” oxygen. We apply a simple mixing model to the water below the mixed layer of the Japan Sea, the Japan Sea Proper Water (JSPW), to obtain the oxidation fractionation factor. The isotopic fractionation factor during the respiration process (α_r) was determined to be 0.982 from the vertical profile of the O_2 concentration and the delta-^{18}O values of the JSPW. The obtained α_r value of the JSPW is somewhat higher values but similar to that of the central north Pacific.

References

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