Development of automatic analysis apparatus for triple oxygen isotopes of dissolved oxygen

*Masanori Ito[1], Hiroki Sakuma[1], Daisuke Komatsu[2], Fumiko Nakagawa[1], Urumu Tsunogai[1], Toyoho Ishimura[3]

1.Graduate School of Environmental Studies,Nagoya University , 2.Department of Marine and Earth Science,School of Marine Science and Technology,Tokai University, 3.National Institute of Technology,Ibaraki College

Oxygen molecules (O_2) consists of triple oxygen isotopes (mass numbers 16, 17 and 18) providing additional unique information such as triple oxygen isotopic compositions ($\Delta^{17}O = \ln(\delta^{17}O + 1) - 0.518\ln(\delta^{17}O + 1)$). In most of the terrestrial processes (e.g. photosynthesis and respiration) fractionate O isotopes in a mass-dependent way, such that ^{17}O enrichment is about half of the ^{18}O enrichment relative to ^{16}O. As a result, $\delta^{17}O$ and $\delta^{18}O$ in terrestrial materials plot along a single line with a mass-dependent slope of about 0.52. In contrast to these mass-dependent processes, ultraviolet-induced interactions among O_2, O_3, and CO_2 in the stratosphere cause mass-independent fractionation with equal lowering of $\delta^{17}O$ and $\delta^{18}O$ in atmospheric O_2. Therefore, $\Delta^{17}O$ of photosynthetically-produced O_2 in the hydrosphere shows higher values of about +150 - 250 per meg compared to atmospheric O_2. Since the $\delta^{17}O$ and $\delta^{18}O$ of O_2 fractionated by respiration vary along a line with a mass-dependent slope, which means the $\Delta^{17}O$ will not change, we can estimate a mixing ratio of O_2 produced from photosynthesis in the hydrosphere ($\Delta^{17}O$ = ca. +150 ~ 250 per meg) and atmospheric O_2 ($\Delta^{17}O$ = ca. +150 ~ 250 per meg) dissolved in water. This will make it possible to estimate gross primary production in the lake and ocean or the air-water gas exchange coefficient by measuring the $\Delta^{17}O$ of dissolved O_2. In this study, we constructed the new purge and trap system to measure $\Delta^{17}O$ of dissolved O_2. The system is fully automated, extracting dissolved gases from the water samples, separate O_2 from all the other gases including Ar, and collecting pure O_2 using a cryogenic temperature cooling sampling device (ca. 10K). We will report $\Delta^{17}O$ values of dissolved O_2 in Lake Biwa where remarkable eutrophication and hypoxia have been observed in recent years.

Keywords: dissolved oxygen, triple oxygen isotopes, vertical profile

