Press Releases

December 5, 2014
JAMSTEC
Kyoto University

Revealed Isotopic Distribution of Cu in Ocean with High Accuracy ~Isotopic Distribution of Trace Elements May Give Clue to Ocean General Circulation~

1. Overview

In collaboration with Kyoto University, Shotaro Takano, Research Student at Kochi Institute for Core Sample Research, Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) and Doctoral Student at Kyoto University, and Dr. Masaharu Tanimizu, Chief Scientist at Kochi Institute for Core Sample Research, JAMSTEC succeeded in precise measurement and comparison of copper isotopic ratio ($^{65}Cu/^{63}Cu$) in seawater around the world by developing a new method using solid phase extraction. The analytical procedures used were NOBIAS Chelate PA-1 resin for pre-concentration of copper and Multicollector-Inductively Coupled Plasma Mass Spectrometer (MC-ICPMS) for measurement of copper isotopic ratio.

A positive correlation between vertical profiles of isotopic composition of Cu and apparent oxygen utilization (AOU), the age of deep seawater, was recognized. It suggests that trace metal elements and their isotopes can be an important tracer for clarifying the oceanic circulation mechanism. The research has been carried out as part of the international GEOTRACES[*1] project, which aims to elucidate biogeochemical cycles based on distribution of trace elements and their isotopes in the marine environment.

Deep ocean circulation is considered to take 2,000 years to complete circulation, playing an important role to transfer Earth's heat from equator to the poles. Radiocarbon dating method is commonly used to determine pathway and flow rate of deep water circulation. However, because the half-life of carbon-14 is 5,700 years, it is not possible to date back over several million years, which is limiting our knowledge of paleo-ocean circulation. Therefore, this scientific result will lead to open a new path for the further research.

Cu and other trace mental elements such as Zn and Ni are necessary for phytoplankton. This kind of isotopic method will be effective in examining more closely how metal elements have been affecting the marine environments and organisms since the industrial revolution, which brought drastic increase of anthropogenic sources of metallic elements in the environment. It is also expected to be utilized in various research fields in earth science.

These study results have been posted on the online *Nature Communications* on December 5, 10:00 am (JST:19:00).

Title: Isotopic Constrains on Biogeochemical Cycling of Copper in the Ocean

Authors: Shotaro Takano[1], Masaharu Tanimizu[2], Takafumi Hirata[3],Yoshiki Sohrin[1]
Affiliation: 1 Institute for Chemical Research, Kyoto University
2 Kochi Institute for Core Sample Research, Japan Agency for Marine-Earth Science and Technology 3 Laboratory for Planetary Sciences, Division of Earth and Planetary Sciences, Kyoto University

*1 GEOTRACES: An International Study of the Marine Biogeochemical Cycles of Trace Elements and Their Isotopes. The GEOTRACES Science Plan was formulated by researchers from more than 30 countries and then adopted in 2005 after discussion by SCOR (Scientific Committee on Oceanic Research) at ISU (International Council for Science). It aims to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions. Research and study on a global scale has been carried out using ocean research vessels.
**GEOTRACES Japan: http://www.jodc.go.jp/geotraces/index_j.htm

*2 Isotope: Atoms of elements with different numbers of neutrons. For instance, there are three stable isotopes of oxygen (^{16}O, ^{17}O, and ^{18}O). Copper used for this research has two stable isotopes, ^{63}Cu and ^{65}Cu. Study of copper isotope ratio helps us closely understand sources of copper in the marine environment and its circulation process.

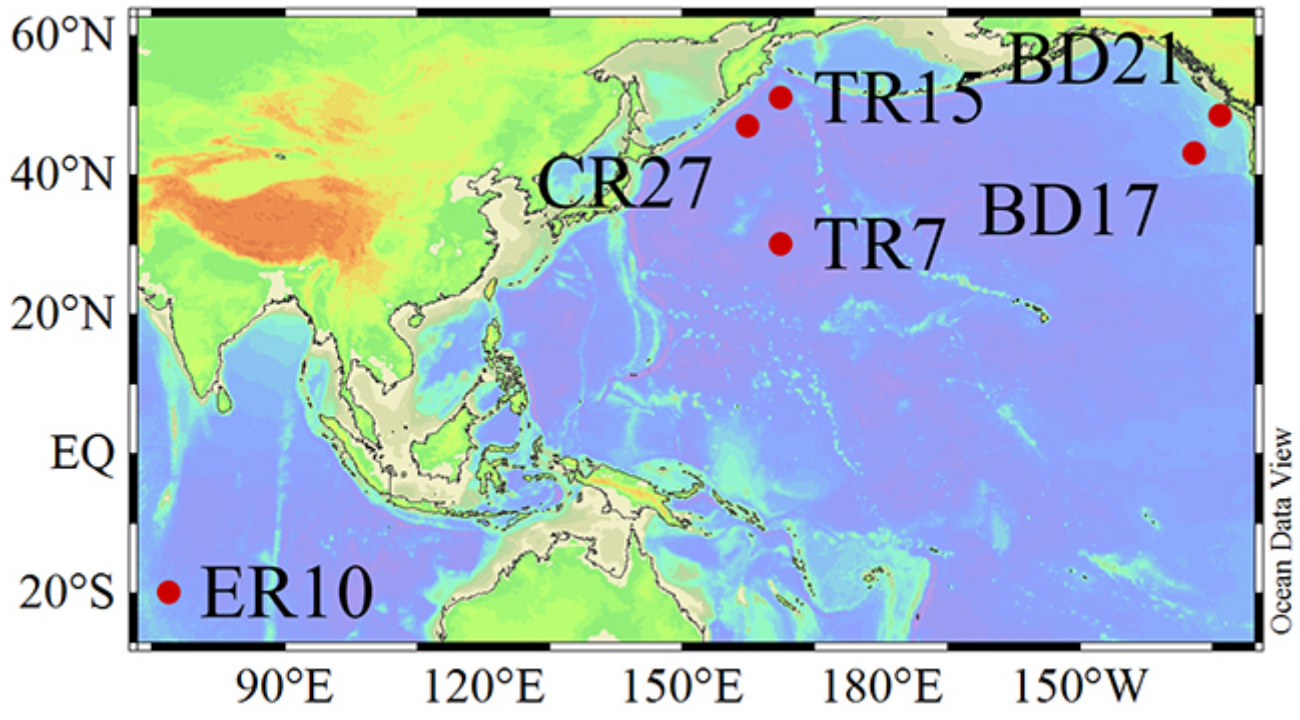
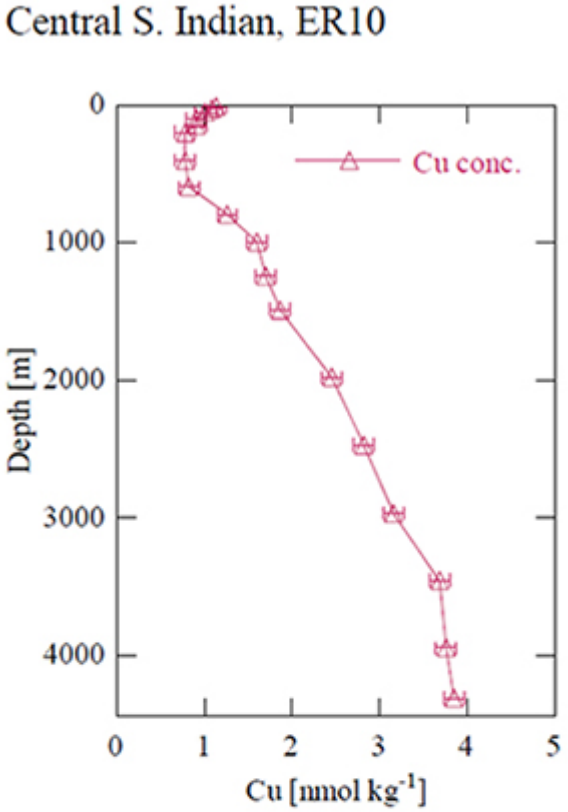
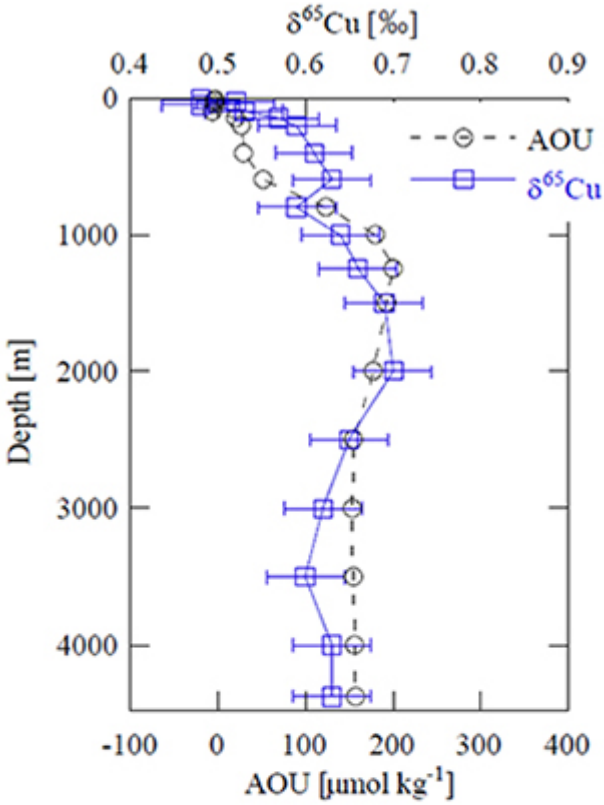


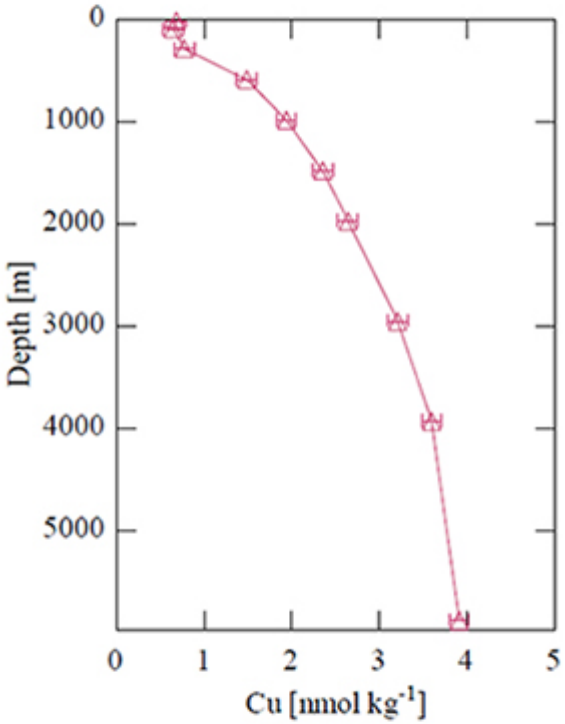
Figure 1: Location of six seawater samples analyzed in this study (two points at Eastern Pacific, three points at the western North Pacific, and one location at the central Indian Ocean). Two additional samples were analyzed from the North Atlantic Ocean and South Atlantic Ocean.

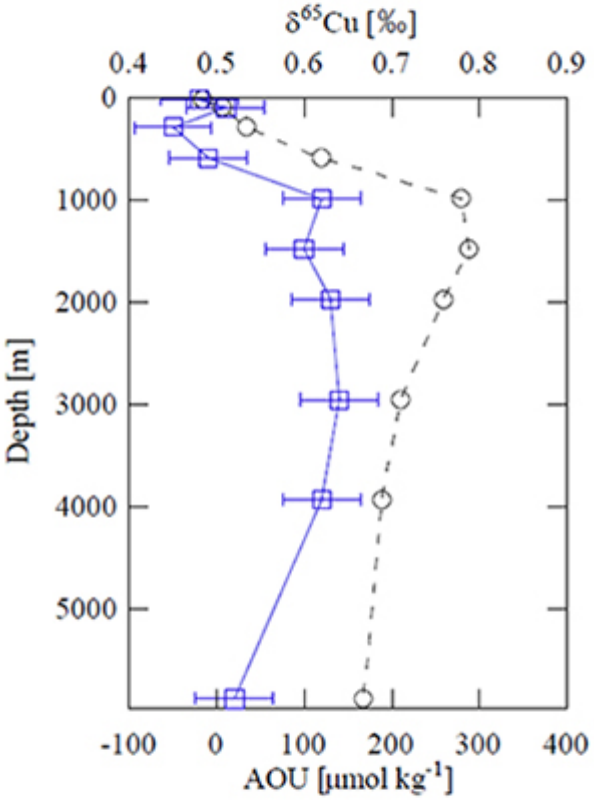
Central S. Indian, ER10



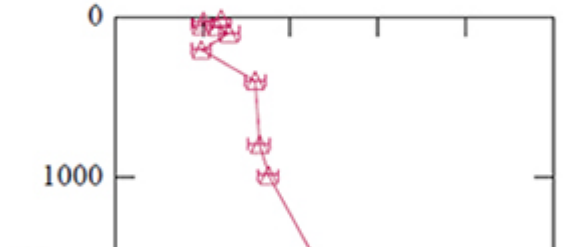


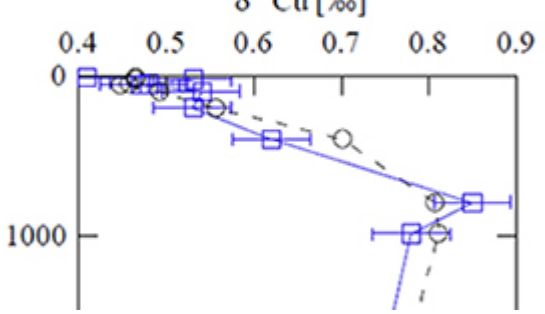
Western N. Pacific, TR7





Eastern N. Pacific, BD17





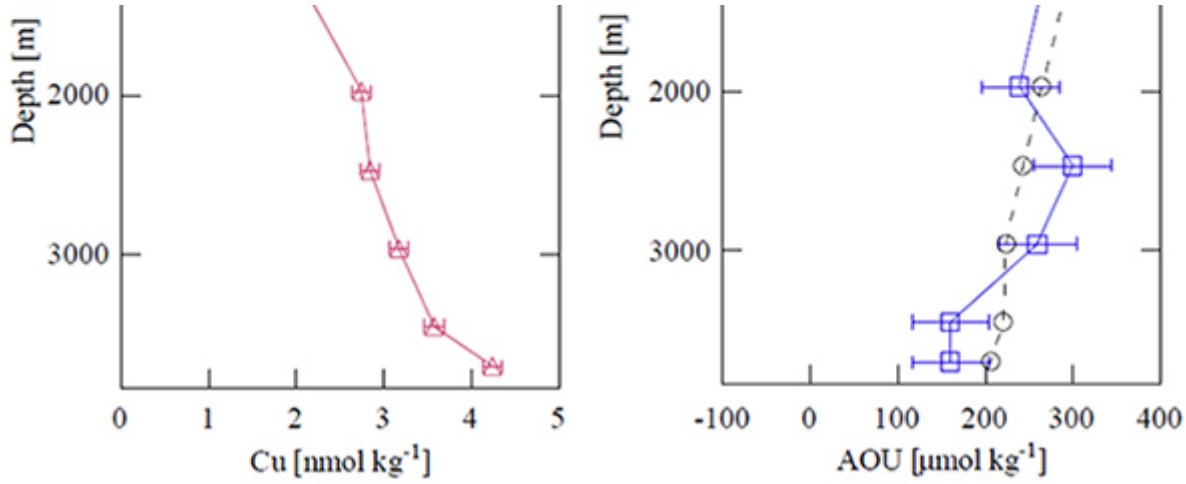


Figure 2: Representative vertical profiles of Cu concentration, δ^{65}Cu and apparent oxygen utilisation (AOU) in the ocean. Magenta triangles indicate Cu concentration. Blue squares and black circles indicate δ^{65}Cu and AOU, respectively. The error bars are 2-sd of ±0.045‰ for δ^{65}Cu and ±0.11 nmol kg^{-1} for Cu concentration, as described in the Method.

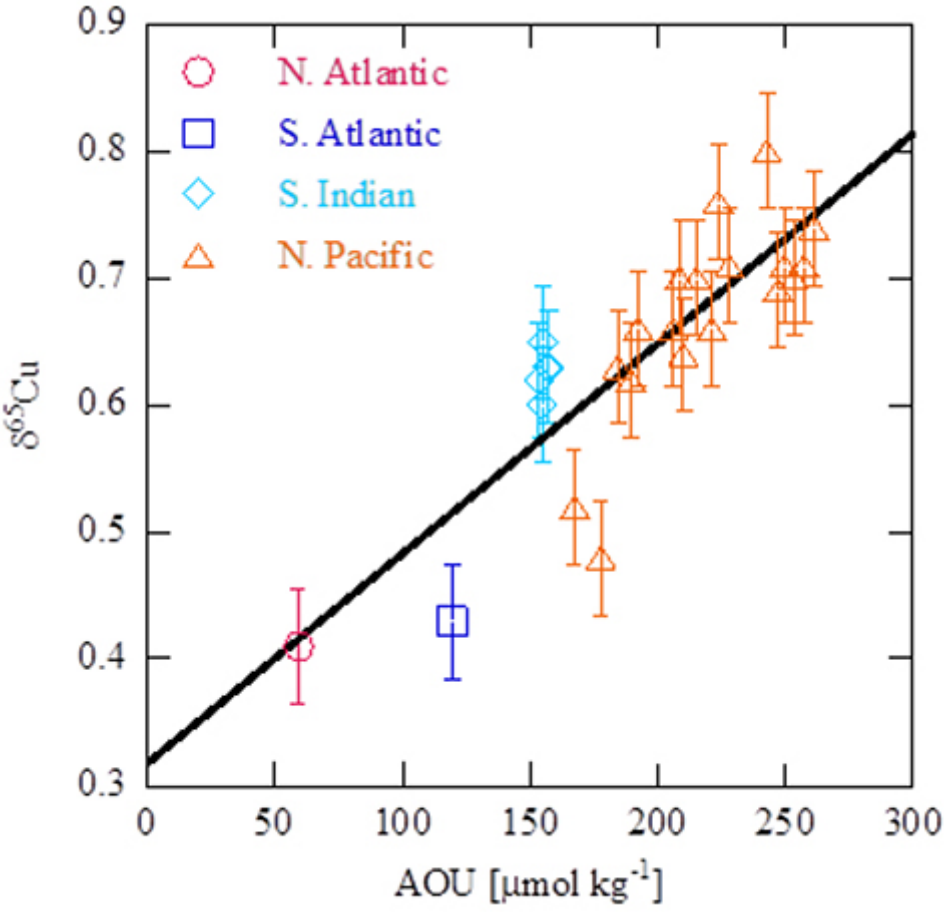


Figure 3: δ^{65}Cu vs. AOU for deep seawater. Isotopic ratios shown as δ^{65}Cu values become higher in order of that from the North Atlantic to the South Indian Ocean and then the North Pacific, which shows a stronger correlation with AOU.

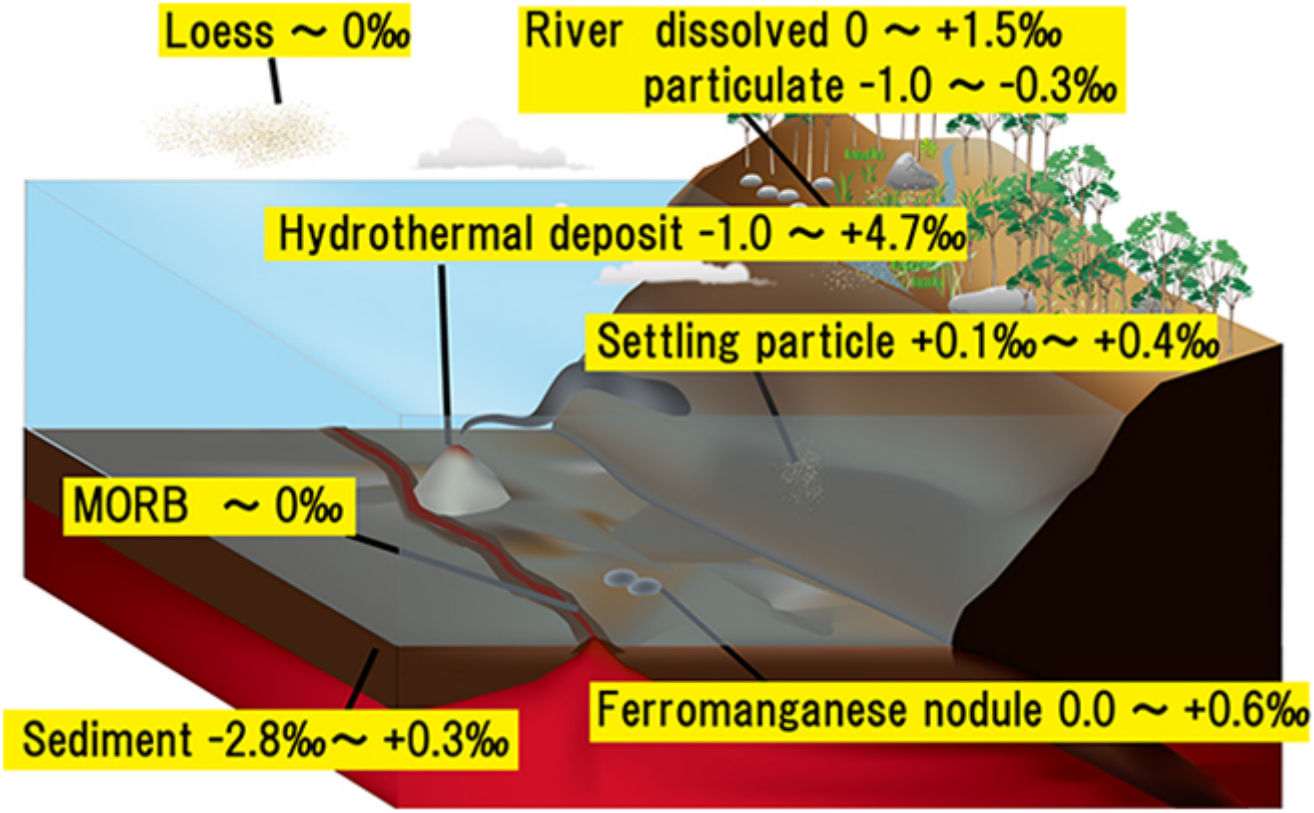


Figure 4: δ^{65}Cu values of several geological components which controls Cu isotope budget of the modern ocean.

Contacts:
(For this study)
Mr. Shotaro Takano, Doctoral Student, Kyoto University
Research Student, Kochi Institute for Core Sample Research, JAMSTEC

Masaharu Tanimizu, Chief Scientist
Kochi Institute for Core Sample Research, JAMSTEC

(For “GEOTRACES”)
Yoshiki Sohrin, Professor
Institute for Chemical Research, Kyoto University

(For press release)
Kazushige Kikuchi, Manager, Press Division, Public Relations Department