

LIST OF ABSTRACTS

What can be learned from a Northwest Pacific Geotraces Transect

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An international marine biogeochemistry program, GEOTRACES, is being planned to study the distribution and biogeochemical behavior of trace elements and radionuclides in seawater. A major advantage of such coordinated international research effort is that insight on a wide range of oceanic processes can be obtained at the global scale based on strategically placed ocean sections. Recent *in situ* Fe addition experiments in sub-arctic Pacific have demonstrated that dramatic potential of this high nutrient low chlorophyll (HNLC) region to draw down atmospheric CO₂. In addition, the northwest Pacific is down-wind of the Asian dust source. A shift in dust deposition from mid-latitude oligotrophic Pacific gyre to high-latitude HNLC region can fundamentally alter the biogeochemistry of this region and will influence global carbon budget.

The low salinity surface water and stratification prevent deepwater formation in the North Pacific region. This stratification is due to an excess of precipitation over evaporation north of the polar front. Any future climate change, in particular, changes in moisture supplied to the far north Pacific, is very likely to perturb the North Pacific deep water formation process. As a result, it may enhance or reduce the amount of carbon that is currently stored in the North Pacific deep water. Perturbation of northwest Pacific can even influence the dynamics of biogeochemistry of the eastern Pacific by changing the composition of the water that ventilates the North Pacific Intermediate Water.

A GEOTRACES transect in the northwest Pacific can take advantage of the existing hydrography gradient and contrast the sub-arctic North Pacific HNLC, Fe-depleted region with the mid-latitude oligotrophic, not Fe-limited region influenced by dust. Such understanding is crucial in our ability to predict ocean carbon cycle with future climate changes.

Trace element biogeochemistry: biological aspects

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It has been well established that the geochemical behavior of trace elements in the ocean is closely controlled by the biological activity, such as the uptake, regeneration, decomposition, and sinking. Marine plankton actively participate in the cycling of trace elements in surface waters. I will briefly discuss some research activities conducted in my laboratory, including 1) uptake of trace elements by marine phytoplankton and its relationship with growth; 2) transfer of trace elements to marine zooplankton by the grazing activity; and 3) the recycling and regeneration of these elements by biological processes.

Radiocarbon as a geochemical tracer for paleoceanographic and ocean carbon cycle studies

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Since the discovery of radiocarbon (^{14}C) dating in early 50's, there have been many, many interesting applications of radiocarbon dating in a variety of different fields in which ^{14}C played a central role. In recent years, a growing number of studies in paleoclimatology and paleoceanography have used ^{14}C as a sensitive geochemical tracer. Paleoclimatic and paleoceanographic studies require accurate and precise time scales. Ages less than 40,000 years are usually based on radiocarbon dating. In this presentation, some recent applications of ^{14}C as a geochemical tracer used in paleoceanographic, ocean carbon cycle and environmental change studies are briefly reviewed.

Introduction to COMRA environmental studies program Na VaBa

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In order to assess the potential environmental impacts caused by deep sea mining of polymetallic nodules in future and to help to set up the baseline of the environment, a program called as “Natural Variability of Baseline” (NaVaBa) is initiated by China Ocean Mineral Resources R & D Association (COMRA) in Chinese pioneer/contract area of polymetallic nodule area in East Pacific since 1996. Objectives, frame and preliminary results of this program will be introduced in this presentation.

Applications of transition metal isotopes in paeleocyanography

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The transition metals Cu, Zn and Fe are present as trace elements in seawater, but are biologically utilised. It is anticipated that the isotope compositions of these elements in seawater will be a function of several factors including their source input, ocean circulation and biological processing. Isotopic variations of these elements may in turn be used to reconstruct details of these processes, particularly in relations to climate changes.

Samples selected for this study are Fe-Mn crusts from world-wide oceans. Hydrogenous Fe-Mn crusts has proved to provide excellent records of isotope compositions of dissolved metals in deep seawater (O'Nions et al., 1997; Zhu et al., 2000a). The investigation on transition metal isotopes was performed on surface samples and as depth-profiles (time series). Fe, Cu and Zn isotopes were measured using a Nu Instruments MC-ICPMS after chemical purification (Zhu et al, 2000b, 2002). Results are expressed in ϵ units which are deviations in parts per 10^4 from the isotope reference materials.

The Fe, Cu and Zn isotopes of deep seawater deduced from the Fe-Mn crusts show both spatial and temporal variations. For Fe isotopes, an overall variation of ca. 20 $\epsilon^{57}\text{Fe}$ units has been observed from the surface samples. Whereas relatively large intra-ocean variation has been observed (e.g. Atlantic: $-13.9 \leq \epsilon^{57}\text{Fe}_{\text{IRMM14}} \leq 6.6$), the average Fe isotopes composition for each Ocean are remarkably similar. But they are significantly enriched in light isotopes relative to both the continental and oceanic crusts. Comparing with Fe isotopes, aariations for Cu and Zn isotopes are much smaller. Like Fe isotopes, no inter-Ocean differences in Cu and Zn isotopes have been observed.

Besides the surfaces samples, a high resolution time-series of Fe, Cu and Zn isotopes has been obtained from a North Atlantic Fe-Mn crust, which demonstrates that the Fe, Cu and Zn isotope compositions in North Atlantic Deep Water have changed substantially over the last 6 Ma. Moreover, it has been observed that the Fe-isotope variations in the crust are closely correlated to those of Pb-isotopes, which indicates that the observed Fe-isotope variations predominantly reflect those of Fe input from terrigenous sources. But the profiles of Cu- and Zn-isotopes contrast greatly to those of Fe-and Pb-isotopes, whereas Cu- and Zn-isotopes themselves show remarkably similarity. This suggests that the recorded Cu and Zn isotope variations result predominantly from processing within Oceans themselves.

References

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The role of submarine groundwater discharge in GEOTRACES

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The input and distribution of material, including Trace Elements and Isotopes (TEIs), to the marine environment by means of riverine inflow, atmospheric precipitation or geothermal input due to the eruption of submarine volcanoes on mid-oceanic ridges have been considered and discussed. However, the discharge of freshwater from the seafloor of the continental shelf is recognized as an important, direct transport pathway both for water and other materials between the land groundwater system and the marine environment. This submarine groundwater discharge (SGD) is possibly more important than its contribution to the water balance alone would suggest, because the concentration of dissolved material is greater than that of river water, and much of the riverine dissolved material is removed by colloids and/or up taken by phytoplankton in the estuary region.

Today, SGD has been recognized as a general phenomenon caught by the rapid advance of observational techniques. Classes of SGD include fresh water linked with the groundwater system of the land, brackish water near the fresh- saline boundary, and recirculating water between sea water and sediment pumped by tides. However, because the discipline of SGD is still very young, we are still very far from making the global SGD data base that would be comparable to similar river and precipitation system data bases. Recently, within an international framework, interdisciplinary research is beginning, though it typically is still separated between oceanography and limnology, e.g., the joint IAPSO/IAHS Groundwater-Seawater Interactions committee under the IUGG, and the working group "Effect of submarine groundwater discharge on the coastal environment" of SOCR/LOICZ, UNESCO/IHP, IAEA, LOICZ(IGBP)-Phase II. As SGD has been taken up as one of the research subjects in GEOTRACES, SGD research is now developing on the world wide scale, reflecting its importance as a source of fresh water and material for the ocean.

Here, recent SGD research based on case studies around Japan done in last few years will be introduced, such as elucidation and origin identification of SGD by geochemistry, estimation of SGD flow rate, evaluation of fresh water and nutrient fluxes using box models, and the impacts on coastal geochemical ecosystems. These processes may contribute to an estimate of the global impacts of SGDs in the future.

Biogeochemical process of settling particles in the South China Sea and its significance for paleoenvironment studies

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Linking of upper ocean and bottom response largely determines the possibility and credibility of utilizing geochemical or microfossil indicators as paleo-proxies. In this presentation, the topic of "Biogeochemical process of particle settlement in the water column and its significance for paleoenvironment studies" was discussed based on surface sediments analysis and time-series sediment trap results in South China Sea, which were carried out jointly between the Second Institute of Oceanography, SOA and the University of Hamburg, Germany. The scientific questions are focused on how modern processes affect geochemical paleo-proxies such Corg, opal and chlorin as paleo-production (PP), UK37 as paleo-SST and $\delta^{13}\text{C}_{\text{org}}$ as source of organic matter. Comparisons between sedimentary organic carbon, chlorine and opal, and the upwelling area and upper layer PP indicate that organic carbon is relatively a good paleo-PP, but chlorine and opal are not because sedimentary biogenic component is strongly affected by carbonate dissolution and lithogenic dilution in this oligotrophic, low PP marginal sea. In most cases, sea surface temperature (SST) measured by UK37 in settling particulate matter differs from the upper layer remote sensing data, and there was also decoupling of particulate matter UK37 signals between upper and deep traps during the same periods, all attributable to the advection of particles. On the other hand, the variation of coccolith bloom season as well as their living depth fluctuation in the euphotic layer could have also accounted for this phenomenon. There was no significant change of UK37 index during particle settling in the water column. Although UK37 temperature derived from settling particles disagrees with remote sensing SST, a good correlation between the sediment UK37 temperature and the annual average temperature from the upper layer (30m) in the SCS confirms the empirical linear curve of UK37 and SST, and suggests that a long term sediment record (decadal to millennial) may smooth the short term fluctuations of environment signals. The increasing of C/N ratio from water column particles to sediment can be attributed to selective decomposition. The distribution of $\delta^{13}\text{C}_{\text{org}}$ in surface sediments, which indicates more organic matter in the shallow area than in the deep sea basin, was affected by terrigenous input, especially in areas near the Pearl River Estuary, north-east corner of the SCS, the Mekong River Delta and Sunda shelf. The abnormally light $\delta^{13}\text{C}_{\text{org}}$ in these areas likely resulted from rapidly increasing pCO₂ due to recent human activities.

Trace Elements in Marine Carbonate Minerals: Tracers & Proxies

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Carbonate minerals (e.g., calcite and aragonite) are ubiquitous in the ocean. When they form, biotically or abiotically, they coprecipitate a variety of trace elements and their isotopes (TEIS) from seawater into their crystal structures. The coprecipitation processes were usually controlled or influenced by a number of oceanographic parameters (e.g., seawater temperature, seawater trace element activity, salinity, etc.) and therefore, various important paleoceanographic information may have been encoded in carbonate minerals by these TEIS. If quantitative knowledge of how these TEIS were partitioned between the carbonate minerals and the seawater solutions and how various oceanographic parameters influenced the partitioning was obtained, we would obtain paleo information of the various oceanographic parameters from marine carbonate minerals preserved in the sediments. Laboratory experimentation has been proven effective in obtaining such knowledge. In this talk, I will describe the methodology applied and present some of the results of our ongoing project on the experimental determination of the partition coefficients of a group of important TEIS (As, Cd, Cu, Pb, REEs, U, Zn, etc.) between calcite or aragonite and seawater solutions and of the quantitative influences of seawater temperature, solution saturation state, mineral precipitation rate, trace element solution concentrations, solution redox, salinity, and carbon dioxide partial pressure on the partitioning. If time permits, I will also report to you our success in the determination of seawater trace element concentrations using ion chromatograph and ICP-MS.

Marine Geochemistry of Actinides (Neptunium and Plutonium)

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Two key actinides, ^{237}Np and $^{239/240}\text{Pu}$ have been introduced to marine environment mainly by atmospheric nuclear weapons testing in the 1950s and early 1960s. $^{239/240}\text{Pu}$ along with ^{137}Cs and ^{90}Sr was among priority elements in GEOSECS program because of their importance with respect to environmental toxicity and because of their usefulness as geo-tracer. However, their analysis using conventional radiometric method required not only large volume sample, but lengthy time for sample processing and measurements, rendering it as main hurdle for studying them. Inductively coupled plasma mass spectrometry was introduced in mid 1980s and is becoming a method of choice for long lived radionuclides like ^{237}Np and $^{239/240}\text{Pu}$. It is sensitive, fast and yet allows separate isotope measurements. In our laboratory a method has been developed for simultaneous determination of ^{237}Np and $^{239/240}\text{Pu}$ using small amount of sample, typically 200 ml sea water and 0.2 g sediment. This ICPMS method involves multiple precipitation and ion exchange steps for isolation / pre-concentration of analytes from sample matrix, and subsequent ICPMS measurements. Using this method, a suite of ocean waters and sediments collected from North Pacific, North Atlantic, Black Sea and East Sea (Sea of Japan) have been successfully analyzed. It appeared that the two nuclides are contrasting; $^{239/240}\text{Pu}$ being particle reactive while ^{237}Np being conservative. Their data details and potential usefulness as geo-tracer will be discussed.