MIS023-01 Room:303 Time:May 22 09:00-09:15

Development of the field of biogeochemistry in the world as well as in Japan

Keiichiro Fuwa[1]*

[1]none

The field of biogeochemistry was developed, first, by the great Russian scientist V.I. Vernadsky with the relationships to his philosophical discussion on the biosphere.

This interesting field, which is closely related nowadays environmental chemistry, has been succeeded by many geochemists in the world including Japanese scientists such as Profs J. Takahashi, Y. Shibata, Y. Miyake et al..

MIS023-02 Room:303 Time:May 22 09:15-09:45

Biogeochemical studies of today and tomorrow: Roles of the SI method to integrate field observation and modeling

eitaro wada[1]*

[1]JAMSTEC

The ideas such as Earth System Science Partnership (ESSP) and Global Earth Observation System of Systems (GEOSS) are now well established under the global environmental issues. The rapid developments in the field of satellite remote sensing, computer sciences and automatic field observation systems make it possible to promote these kinds of international programs. At present tentative goal of the global environmental studies is to provide clear cut scientific scenarios to solve various kinds of environmental problems. Along this line, integrative studies of the observation, modeling and simulation are highly required.

In this context, we can consider that SI studies provide possible roles to contribute above mentioned integration. Biogenic substances in nature contain significant amounts of less abundant stable isotopes (SI) of light elements such as carbon and nitrogen. Although the SIs of a particular element have rather similar chemical behaviors, their specific thermodynamic properties and rate constant in chemical and biological reactions differ. The SIs of biogenic substances vary depending on the isotopic compositions of the reactants, the pathways and kinetic modes of the reaction dynamics, and the physical, chemical, and biological conditions. Thus, every biogenic material has its own unique isotopic composition, known as the ”dynamic stable isotope finger print”, which is determined by its function and position in the material flow of an ecosystem or metabolic map.

Because of these characteristics SI methods can be useful for studies of material cycling occurring in natural ecosystems at levels from molecule to ecosystem..

The following topics will be reported and discussed.

i) Roles of the SI method in collaborative studies to create a new paradigm .

ii) Structure of biogeochemical systems and food chains.

Trophic fractionation of C/N isotopes at a level of metabolic maps with emphasis on amino acid metabolisms.

iii)Possible validation of ecosystem models

Keywords: Stable Isotope Ratio, Nitrogen, Carbon, Food Chain

MIS023-03 Room:303 Time:May 22 09:45-10:15

Unveil the Depth of Methanogenesis in Deep Subsurface and Microbial Ecology

KATO Kenji[1]*

[1] Faculty of Science, Shizuoka University

Bubbles of methane in the ground water coming up from deep subsurface in a sedimentary rock area of Hokkaido, North Island of Japan were shown biological contribution to their origin from stable isotope signature of delta-^{13}C-CH_4. Gene sequence of archaeal small subunit rRNA derived from 500 m water showed an existence of various methanogenesis archaeal Genus there. Incubation experiments carried out for the subsample of 500 m ground water revealed that these archaeal community exhibited methanogenesis activity under the in situ or somewhat higher temperature of 30 to 40/45 C with anoxic condition, but not at neither 20 C nor 50 C. Similar incubation applied to the ground water of 140 m deep did not show any methanogenesis under even absolute anoxic condition so far examined for 90 days at both in situ and higher temperature as 16 C and 30 C, respectively, though the stable isotope signature of delta-^{13}C-CH_4 in the bubbles obtained from this depth was as low as -57 per mil suggesting methane was biogenic and methanogenesis archaeal genes were found.

Keywords: Subsurface, Methanogenesis, Microbial Ecology

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

MIS023-04 Room:303 Time:May 22 10:45-11:15

Quantifying nitrate dynamics in hydrosphere using the triple oxygen isotopes as tracers

Urumu Tsunogai[1]*, Daisuke Komatsu[1], Fumiko Nakagawa[1]

[1]Faculty of Science, Hokkaido University

In most studies that have been conducted to date, the gross uptake rate of nitrate has been estimated by incubation experiments using ^{15}N tracer techniques. In this conventional approach, ^{15}N labeled NO_3^- is added into bottles or mesocosms that simulate in situ conditions, which leads to the production of particulate organic-^{15}N (PO^{15}N) through assimilation over a known incubation period of several hours to several days. This PO^{15}N is then gathered and quantified by mass spectrometry. However, these experimental procedures are generally costly, complicated, and time consuming, especially those that employ mesocosms.

Furthermore, the ^{15}N tracer method has several problems with determining accurate nitrate uptake rates. For example, the usual ^{15}N tracer method does not include assimilated nitrogen released to dissolved organic-^{15}N (DO^{15}N) during incubation within the estimated uptake rates, which results in the rates being underestimated. Additionally, incubation itself could also result in the production of artifacts by changing the physical/chemical environments. Finally, it is difficult to simulate nitrate uptake by periphyton or microbes on the lake floor through typical incubation in bottles.

The gross nitrate uptake rate estimated using the triple oxygen isotopic compositions of NO_3^- overcomes the aforementioned problems inherent in the conventional ^{15}N-labelled tracer methods. Accordingly, the triple oxygen isotope method can be an alternative to standard techniques for the determination of accurate gross nitrate uptake rates in hydrosphere that contain detectable quantities of atmospheric nitrate within the total nitrate.

In this study, we applied this the triple oxygen isotope method in the water column of Lake Mashu, Japan, which is a crater lake with a depth of 211 m. To quantify the geochemical dynamics of nitrate in the oligotrophic environment, the stable isotopic compositions of nitrate, including the ^{17}O anomalies, were determined twice in one year (June and August 2007) in the lake.

While the total inventory of nitrate in the lake water decreased from 4.2 to 2.1 Mmol (Mmol = 10^6 mol) during the period between the observations, the average triple oxygen isotopic compositions of nitrate were uniform at +2.5 permil, which corresponded to an average mixing ratio of atmospheric nitrate to total nitrate of 9.7 +- 0.8%. Using the total mass of the atmospheric nitrate deposited onto the entire catchment area of the lake during a period of 2 months (0.047 Mmol), we estimated that 0.52 +- 0.34 Mmol of the remineralized nitrate was fed into the water column through nitrification, while 2.6 +- 0.4 Mmol of nitrate was simultaneously removed from the water column by assimilation. The lake water dissolved nitrate was characterized by rapid removal through assimilation during summer until it was almost completely removed from the euphotic layer, as well as continuous feeding into the lake through nitrification and deposition, regardless of the seasons, which corresponds to a gross annual flux of 3.2 +- 0.3 Mmol yr^{-1} and 0.35 +- 0.2 Mmol yr^{-1}, respectively. These results indicate that atmospheric nitrate deposited into the lake will be assimilated quickly having a mean residence time of 1.2 +- 0.1 years. Besides, more than 90% of the assimilated nitrate will be remineralized to nitrate and assimilated again via active nitrogen cycling in the lake.

Keywords: nitrate, atmospheric deposition, assimilation rate, nitrification rate, nitrogen cycle, triple oxygen isotopes

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MIS023-05 Room:303 Time:May 22 11:15-11:30

Biosphere and its biogeochemical processes: a linkage between past and present during recycles of organic matter

Yoshinori Takano[1]*

[1]Institute of Biogeosciences, JAMSTEC

Deep-sea sediments harbor a novel biosphere with uncultured prokaryotic lineages and their global biogeochemical processes. Exploring these habitats poses interdisciplinary challenges for the biogeochemical and geomicrobiological community. The limits of deep biosphere are on-going subject, which were not yet known in terms of environmental properties, including depth, temperature, energy availability, and geologic age; subseafloor microbes play a significant role in chemical reactions that were previously thought to have been abiotic processes. These limits are set by a variety of physical and chemical properties such as temperature, availability of energy and nutrients, pH, pressure, water availability, and salinity. In addition, molecular analyses and cultivation experiments demonstrate a high diversity of microbial life in the sub-seafloor, although the relative abundances and roles of archaea, bacteria, eukarya, and viruses have been largely unknown.

Recent intensive researches on deep biosphere revealed that carbon isotopic signatures of sedimentary archaeal membrane polar lipids indicate utilization of sedimentary organic carbon by the living archaeal community. Further deep drilling of marine sediments and igneous crust offers a unique opportunity to explore how life persists and evolves in the deep sub-seafloor ecosystems. Here, the author overviewed about historical background of the deep biosphere and its latest progresses in terms of biogeochemical processes together with prokaryotic ecology and limit of life on the Earth.

Takano, Y., Chikaraishi, Y., Ogawa, O.N., Nomaki, H., Morono, Y., Inagaki, F., Kitazato, H., Hinrichs, K.-U., Ohkouchi, N., (2010) Sedimentary membrane lipids recycled by deep-sea benthic archaea. Nature Geoscience, 3, 858-861.

Keywords: Organic compound, Recycle process, Biogeochemistry

Japan Geoscience Union Meeting 2011
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MIS023-06 Room:303 Time:May 22 11:30-11:45

Photosynthetic activity and community structure in intertidal microbial mats

Akiko Tomitani[1*], Henricus T. S. Boschker[2], Lucas J. Stal[2]

[1]Institute of Biogeosciences, JAMSTEC, [2]Netherlands Institute of Ecology

Cyanobacteria are known as the first oxygenic photosynthetic bacteria, which played a major role in oxygenation of the earth's atmosphere. How they evolved oxygen-generating photosystems and have interacted with environmental change is key to an understanding of the history of early life and earth; but it has remained unclear. Here we integrate geochemical and molecular-biological studies of intertidal microbial mats to assess physiology and diversity of photosynthetic organisms. Microbial mats are a multi-layer of diverse benthic microorganisms, often dominated by phototrophic bacteria. They are distributed in a wide range of habitats, including marine intertidal flats that experience strong fluctuation of oxygen/sulfide concentrations, hence serve as a modern model system suitable for the study of cyanobacterial response to the redox shift in the past.

Microbial mats were sampled from two sites located in the sandy beach facing the North Sea, in the Dutch barrier island Schiermonnikoog. The materials used in this study were collected in early and mid summer, to make comparison between seasons as well as locations. In order to investigate the effect of redox conditions on phototrophic activity, the mats were incubated with $H^{13}CO_3^-$ under up to 16 different growth conditions in a temperature- and light-controlled room, and were freeze-stored until RNA extraction. Group-specific rRNAs were captured using magnetic beads with biotin-modified probes to link taxonomic distribution directly with physiological property.

Phylogenetic analysis of 16S rRNA clone libraries confirmed high taxon specificity of the oligonucleotide probes used in this study. It showed that the mats examined here were predominated by non-heterocystous filamentous cyanobacteria (Oscillatoriales), together with minor fractions of heterocystous (Nostocales) and coccoid (Chroococcales) species. Stable isotope measurement of the isolated rRNA indicated carbon fixation in all tested materials, and higher ^{13}C incorporation into cyanobacterial rRNA was observed when the mats were grown under anoxic conditions. Their photosynthetic activity diminished, but was not completely blocked, by addition of DCMU, an inhibitor of PSII, indicating possible contribution of PSI dependent photosynthesis in the system. Increase of sulfide concentration, however, did not enhance physiological activity, possibly due to inhibitory effect of excess sulfide on biological metabolism.

Continuing study of microbial communities under redox fluctuating environments will provide us a clue to an understanding of not only evolutionary process of photosynthetic organisms but also its interrelation with early biosphere.

Keywords: microbial mats, cyanobacteria, redox condition, stable isotope, diversity, RNA

Japan Geoscience Union Meeting 2011
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MIS023-07 Room:303 Time:May 22 11:45-12:00

Biosynthetic pathway of L-gulose, a rare sugar existed in the main polar lipid of a thermophilic archaea

Yusuke Nakayama[1], Noriaki Yamauchi[2]*

[1]Grad School of Sci., Kyushu Univ., [2]Fac. of Sci., Kyushu Univ.

Thermophilic archaea live under harsh conditions such as high temperatures (60 to 100 C) and low pH (2 to 3). The resemblance of their living environment to primitive Earth conditions has been pointed out. The lipid of this species is characteristic ether-bonded isoprenoidal macrocyclic, which consists of a double-face monolayer membrane. Among them, *Themoplasma* has main polar lipid (MPL), which has L-gulose a characteristic rare sugar as a major component of polar head group of MPL. Themoplasma had no cell wall, the outer sphere of the body directly contact with the harsh environment. So, the biosynthesis of the characteristic component of MPL is intriguing at the point of the adaptation of organisms to the environment like a primitive Earth conditions.

L-Gulose was existed at the biosynthetic intermediate of L-ascorbic acid (vitamin C) in plants, and sugar component of bleomycin, a clinically important antitumor antibiotic produced by actinomyces. Biosynthetic pathways of L-gulose are existed all three domain of the category of living system, eubacteria, archaea and eucarya. This pathway might be shown an indicator of the correlation of three domains.

This study was aimed for elucidation of a biosynthesis pathway of L-gulose in Thermoplasma for the clue to the relationships of metabolic evolution of thermophilic archaea and the other two domain of living organisms. At first, classical chase experiment of labeled compound in the biosynthesis of MPL in *Thermoplasma acidophilum* was conducted.

At first, the deuterium-labeling compounds, D-[3-^{2}H] and [3,4-$^2H_2$]-glucose were synthesized. Then, incubation experiments with the labeled compounds into low-glucose-containing Themoplasma medium (7 days, 60 C, pH2.5) were performed. The lipid was extracted from the collected organism, and hydrolyzed to give a monosaccharide-containing fraction that was bonded to the MPL. The mixture was derivatized and the penta-O-TMS-monosaccharide mixture was analyzed by GC-MS. The mass spectra of the chromatographic peaks corresponding to L-glucose were further analyzed in detail, and the position and the fragments determined content of deuterium.

For the experiment with D-[3-^{2}H]-glucose, the C-3 hydrogen containing fragment (*m/z* 305 for non-labeled material) shows the highest fragment peaks at *m/z* 306, which means 1 deuterium was incorporated from the D-[3-^{2}H]-glucose to L-gulose attached at C-3. The degree of incorporation was about 40 %, extensively high for this kind of incorporation experiment. Next, for the experiment with [3,4-$^2H_2$]-glucose, almost the same result-high degree of incorporation of deuterium at C-3 was observed. This means the C-4 hydrogen was lost during the conversion of D-gluose to L-gulose.

A preliminary experiments revealed the L-gulose was biosynthesized with the step-by-step epimerization of C-2 and C-5 of D-glucose. And the possibility of most chemically simplest pathway (D-glucose can converted to L-gulose with 2 steps, reduction at C-1 and oxidation of C-6) was denied. Further, these experiments strongly indicate that the C-4 oxidation along with the enolization of C-4 and C-5 was occurred at the mechanism of stereochemical inversion of C-5. The mechanism was seen in the stereochemical inversion of hydroxyl group in the monosaccharide, and the close resemblance of this case and the biosynthesis of vitamin C were observed. In other words, L-gulose biosynthesized with a similar process existed in eukaryote (plant). And it suggests that the relation of the metabolism evolution of archaea and eucaryote compared with eubacteria at the point of metabolic evolution of monosaccharide. That is consistent with a molecular phylogenic tree made by 16S ribosomal RNA, and the distribution of two isoprenoidal biosynthetic pathways (mevalonate pathway vs MEP pathway), which also synthesize characteristic isoprenoidal lipid in archaea.

Keywords: thermophilic archaea, isoprenoidal lipid, rare sugar, biosynthesis, metabolic evolution

MIS023-08 Room:303 Time:May 22 12:00-12:15

Compound-specific radiocarbon dating as a tool for biogeochemical processes

Naohiko Ohkouchi[1*], Yusuke Yokoyama[2]

[1]JAMSTEC, [2]AORI, Univ. Tokyo

I review the radiocarbon dating of individual organic compounds as a tool for investigating biogeochemical processes. Combination of source-specific organic molecules (biomarker) and radiocarbon dating provides a powerful tool for potentially resolving the various problems related to biogeochemical processes both in the ocean and on land. Development of small-scale radiocarbon dating during the late 1990s expands the utility of this method to less abundant samples. Furthermore, recent advances in high-performance liquid chromatography (HPLC) provide a tool for fast, easy purification of individual organic compounds from complex mixtures of organic matters in the sediment and soil. Since the establishment of this technique in the mid-1990s, many applications have been conducted to various compounds. For example, transport of sedimentary molecules like alkenones can be used for tracking the horizontal movement of organic matter produced by the phytoplankton in the water column. In this presentation, I overview the merit and limitation of this method for the future use in biogeochemical study.

MIS023-09 Room:303 Time:May 22 12:15-12:30

Nitrogen isotopic signatures of amino acids in microbes: culture experiments and applications to marine sediments

Yasuhiko T. Yamaguchi[1*], Yoshinori Takano[2], Yoshito Chikaraishi[2], Nanako O. Ogawa[2], Hiroyuki Imachi[2], Hisami Suga[2], Yusuke Yokoyama[1], Naohiko Ohkouchi[2]

[1]AORI, Univ. Tokyo, [2]Biogeos, JAMSTEC

The microbial roles in biogeochemical cycles remain largely unknown, mainly because of the lack of tools to explore in situ metabolic activities of microbes. The compound-specific nitrogen isotopic composition (d15N) of amino acids, especially for glutamic acid (Glu) and phenylalanine (Phe), had been demonstrated as a promising tool for estimating the food sources of organisms in the grazing food web.

Applicability of this amino-acids method to microbes or detritus food web, however, remains uncertain, because the method has been constructed based on the analytical results of aquatic photoautotrophs (cyanobacteria and algae), terrestrial higher plants, and animals, but not chemotrophic microbes. In this study, the nitrogen isotopic compositions of amino acids were investigated in 5 cultured microbes namely a fungus (Saccaromyces cerevisiae), a bacterium (Escherichia coli) and archaea (Sulfolobus tokodaii, Halobacterium salinarum and Methanothermobacter thermautotrophicus) with controlling their nitrogen sources.

When the microbes synthesized amino acids de novo, the relative d15N values of their amino acids were similar to aquatic photoautotrophs, whereas the case the microbes assimilated amino acids from diets, they showed 15N-enrichment on the amino acids close to that of animals. The results suggest that the nitrogen-isotope fractionation process of amino acids are likely common among various organisms covering 3 domains (Eukarya, Bacteria, and Archaea) and among various environmental conditions such as growth temperature, pH, or salinity.

Therefore, nitrogen isotopic composition of amino acids would potentially be a powerful tool to clarify in situ microbial metabolism (amino-acids synthesis or decomposition) and their biogeochemical roles (especially in nitrogen cycle and in organic-matter diagenesis). The small variations in values of Glu and Phe suggest the use of the Glu-Phe pair is the most promising combination as in the case of analysis of grazing food webs. In the presentation, we also show its applications to marine sediments in various settings.

Keywords: compound-specific isotope composition, amino acids, microbes, marine sediments, organic matter diagenesis, nitrogen cycle

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MIS023-10 Room:303 Time:May 22 12:30-12:45

Nitrogen isotopic composition of amino acids as a tool for studying food webs: a case study of terrestrial insects

Yoshito Chikaraishi[1*], Nanako O. Ogawa[1], Naohiko Ohkouchi[1]

[1]JAMSTEC

Knowledge of the trophic position of organisms in food webs allows understanding of biomass flow and trophic linkages in complex networks of ecosystems. Stable nitrogen isotope analysis of amino acids is a new method with the potential for estimating the trophic position of consumers in food webs. However, this amino acid method is established by the experimental observations only from aquatic organisms such as phytoplankton, zooplankton, and fish. It is uncertain whether the amino acid method can be applied to food webs in the terrestrial environment. To evaluate the applicability of the amino acid method to studies of terrestrial insect food webs, (1) we investigate the ^{15}N-enrichment factor of amino acids from plant leaves to its consumer herbivores such as caterpillars, and (2) we apply this method to estimate the trophic position of natural insects including herbivorous bees and carnivorous wasps and hornets. Although the isotopic distribution pattern differs considerably between aquatic photoautotrophs and terrestrial C3 and C4 plants, the ^{15}N enrichment factors in herbivores are well consistent with those in the aquatic consumers reported in previous studies. Moreover, the trophic position estimated by the amino acid method is consistent with the biologically expected trophic position of the natural insects (e.g., 2.0 for bees, 3.0 for wasps, and 3.5-4.0 for hornets). Thus, an estimate of trophic position based on the nitrogen isotopic composition of amino acids is applicable to not only aquatic food webs but also terrestrial insect food webs. In the presentation, we briefly review amino acid methods and then show its application to natural insects in terrestrial environments.

Keywords: amino acid, nitrogen isotopic composition, food web, trophic position

MIS023-11 Room:303 Time:May 22 14:15-14:30

Pelagic ecosystem in Lake Baikal: Reconstruction from nitrogen isotopic analyses of amino acids

Nanako O. Ogawa[1*], Yoshito Chikaraishi[1], eitaro wada[1], Naohiko Ohkouchi[1]

[1]JAMSTEC

The nitrogen isotopic composition of amino acids (delta^{15}N$_{AA}$) is useful for estimating trophic position of the organism (McClelland and Montoya 2002, Chikaraishi ei al. 2007, 2009). In this study, delta^{15}N of bulk organic matter and 12 amino acids including glutamic acid and phenylalanine were determined for major pelagic organisms in Lake Baikal. By using the equation proposed by Chikaraishi et al. (2009), we estimated the trophic position of these organisms and evaluate their trophic relationships. The results are consistent with simple trophic structure of pelagic food web reported by previous studies with field observations. The highest trophic position (5.0 +/- 0.1) observed for seal (*Pusa sibirica*) suggested that its major diet are pelagic sculpin (Cottocomephoridae & Comephoridae, 4.3 +/- 0.2) and freshwater salmon (*Coregonus autumnalis migratorius*, 3.6 +/- 0.2). These results are differ for the top predators of seal and sculpin from previous studies by delta^{15}N of bulk organic matter (Yoshii et al. 1999), though they were consistent for the lower position species. The delta^{15}N$_{AA}$ results also showed four species of pelagic sculpin are in the close trophic position, despite large differences in delta^{15}N$_{TN}$ (~3.4 per mil) between Cottocomephoridae and Comephoridae observed by both previous and this studies. It suggests these pelagic sculpin are competing their trophic niche in the lake. It is also suggested that the efficiency of amino acid estimation of trophic position is more emphasized for the species at higher trophic position in the ecosystems, than those in lower positions.

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MIS023-12 Room:303 Time:May 22 14:30-14:45

Reconsideration of biogeochemical impacts of the Kuroshio based on a recent intensive observation and historical data

Kosei Komatsu[1*], Ichiro Yasuda[2], Sachihiko Itoh[2], Toru Ikeya[2], Hitoshi Kaneko[2], Kiyotaka Hidaka[3], Masahiro Yagi[2], Satoshi Osafune[2], Haruka Nishikawa[2], Takumi Nonomura[4]

[1]GSFS, University of Tokyo, [2]AORI, University of Tokyo, [3]NRIFS, FRA, [4]Fisheries Laboratory, Tottori prefecture

The Kuroshio, the western boundary current in the North Pacific, plays major roles in transporting heat and organic/inorganic materials from the subtropical region to the subarctic one. The Kuroshio undoubtedly must impact on the ecosystem in its neighboring and downstream regions as well as on climate changes via air-sea interactions, however it is generally recognized as a mere boundary between the oligotrophic Subtropical waters to the south and the more productive Slope waters to the north. Surprisingly neither quantitative nor qualitative researches have advanced to clarify the actual distribution of nutrients in the Kuroshio region with focus on the impacts of the jet, the core of the current maximum. On the other hand, as long as in the frontal region, an accumulation of studies has clarified the productive enhancement due to sub-mesoscale processes, but the transport of nutrient and its impacts on the ecosystem have been still unknown because of lack of simultaneous measurement of both horizontal and vertical fluxes of nutrients around the jet.

We conducted an intensive observation in Apr. 2009 and analyzed historical hydrographic data, in order to clarify the 3D distribution of the water properties in the Kuroshio region and to estimate horizontal and vertical fluxes of nutrients and their impacts on the productivity in the surrounding and downstream regions. The observation was carried out by the R/V Tansei-maru in the cruise KT-09-3 at intervals of 10 miles along the 5 lines crossing the Kuroshio in 137-141^{o}E south of Japan. It obtained the 3D distribution of the water properties by CTD with multi- profilers and bottle-samplings, the horizontal velocity by the shipboard and lowered ADCP, and the vertical turbulent diffusivity by the microstructure profiler. As a result we detected that maxima of nitrate, silicate, phosphate and AOU were located along the jet on the isopycnal surface of 24.5-26.0sigma-theta. It is the first detection of the nutrient/AOU maximum along the Kuroshio jet, and the structure is analogous to the characteristic one well-known as Nutrient Stream found in the Gulf Stream region. Moreover, the nutrient/AOU maximum along the Kuroshio jet was also detected on the 24.5-25.5sigma-theta surface in spring at both the upstream side in the East China Sea and the downstream one in the Kuroshio Extension, by analyzing the historical data of JODC.

It should be emphasized that the nutrient concentration on the isopycnal surface of 24.5-25.5sigma-theta gradually decreases along the jet toward the downstream region. It implies that the high nutrient water is originated from the upstream and its adjacent regions and transported downstream epipycnally along the Kuroshio as is the case with the Nutrient Stream in the Gulf Stream. Our observation estimated the maximum of the epipycnal nitrate flux at 10mmolNm^{-2}s^{-1} around the 26.0sigma-theta surface just beneath the current maximum of the Kuroshio jet. A part of the flux is served out to both the northern and southern sides of the jet due to eddy diffusivity, and especially on the northern side the nutrient transport is important for the new production. The depth of the isopycnal surface is much shallower on the northern side because of the strong baroclinicity, where the nutrient is utilized more actively for the primary production under sufficient irradiance.

Moreover our observation clarified quantitatively that nutrient is supplied upward more intensively on the jet and its inshore side than the offshore side due to higher diapycnal mixing observed by direct measurement of microstructure. The diapycnal flux of nitrate amounts to 3.0x10^{-6} mmolNm^{-2}s^{-1} at the 25.0-25.5sigma-theta just above the core of the epipycnal flux, indicating that the high nutrient transported epipycnally along the jet is supplied efficiently upward by the strong diapycnal mixing and that it contributes significantly to the spring new production around the Kuroshio.

Keywords: Kuroshio, Nutrient Stream, jet, epipycnal flux, diapycnal flux

MIS023-13 Room:303 Time:May 22 14:45-15:00

Organo-mineral interactions in soil system: examining the mechanisms behind the formation of largest carbon pool on land

Rota Wagai[1*], Shirato Yasuhito[1], Kondo Miyuki[2], Uchida Masao[2], Phillip Sollins[3]

[1]Nat. Insti. Agro-Environ. Sci., [2]Nat. Inst. Environ. St., [3]Oregon State University, USA

Soil organic matter (SOM) is the largest carbon (C) pool on the earth's surface and plays a fundamental role in biogeochemical cycling and ecosystem functioning. Yet long-term responses of SOM to environmental perturbation remain uncertain. Current predictions on the changes in soil C pool upon warming differ widely among global C models. This uncertainty is largely due to complex feedbacks among soil, biota, climate, and parent material at landscape scale and equally complex interactions between diverse organic compounds and mineral phases at microscopic scale. Here I focus on the latter scale and present some results from an on-going, collaborative study which examines the nature of organo-mineral associations using density fractionation coupled with multiple analytical tools including isotope technique. Using heavy liquid (sodium polytungstate) adjusted at 1.6 up to 2.5 g/cc, we isolated the soil particles differing in the degrees and types of mineral associations. Among dramatically-different soils (e.g., tropical soils developed on ultrabasic rock, temperate soils developed on silicious rock, volcanic-ash derived soil), we found following consistent patterns: (i) decline in C and N concentration due to higher mineral abundance for heavier particles, (ii) progressive decline in C:N ratio from 25-60 to 8-20, (iii) increase in delta N-15 by 2-6 per mil and, to a less extent, delta C-13, and (iv) general increase in the mean residence time of C based on C-14. By focusing on a volcanic-ash soil, we also measured the specific surface area of and the enthalpy of N2 gas sorption onto the soil particles of each density fraction to assess geometric aspects of the organo-mineral associations. Based on these results, we will discuss the physicochemical nature of organo-mineral associations and its biogeochemical implication.

Keywords: soil organic matter, carbon cycle, aggregate, C and N isotopes, organic coating on mineral

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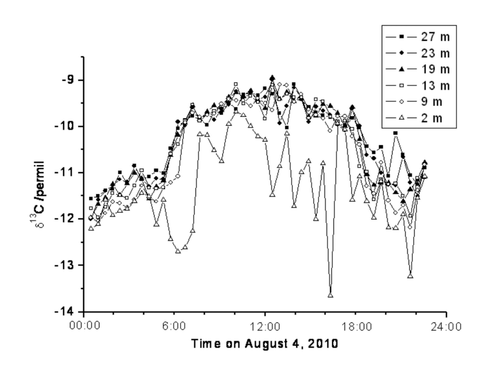
MIS023-14 Room:303 Time:May 22 15:00-15:15

Real time, continuous measurements of CO_2 and H_2O isotopes in the forest using laser absorption spectrometers

Ryuichi Wada[1*], Masahiro Takemura[1], Mai Ouchi[1], Tomoki Nakayama[1], Yutaka Matsumi[1], Satoru Takanashi[2], Yuichiro Nakai[2], Kenzo Kitamura[2], Naoyuki Kurita[3], Yasushi Fujiyoshi[4], Kenichiro Muramoto[5], Tetsuya Hiyama[6], Gen Inoue[6], Naomi Kodama[7], Takashi Nakano[8]

[1]STE laboratory, Nagoya Univ., [2]FFPRI, [3]JAMSTEC, [4]Inst. Low Temp. Sci., Hokkaido Univ., [5]College of Sci. and Eng., Kanazawa Univ., [6]Research Inst. For Humanity and Nature, [7]National Inst. for Agro-Environ. Sci., [8]Yamanashi Inst. of Environ. Sci.

Measurements of CO_2 and H_2O isotope compositions are very powerful methods for investigating the carbon and water cycles. We had been deployed in the red-pine forest at the foot of Mt. Fuji for 10 days from the end of July, 2010 and had successfully measured CO_2 and H_2O isotopologues ($^{16}O^{12}C^{16}O$, $^{16}O^{13}C^{16}O$ and $^{18}O^{12}C^{16}O$ for CO_2, D_2O and $H_2{}^{18}O$ for H_2O) using infrared absorption laser spectrometers (Aerodyne Inc. for CO_2 and Los Gatos Research Inc. for H_2O). The CO_2 isotope laser spectrometer can measure the isotope ratios (delta^{13}C, delta^{18}O) of ambient air CO_2 in 10-second integration time with a precision of 0.1 permil in real-time. The height of the observation tower is 30 m. Air was sampled every 260 seconds from six vertical height locations from above the forest canopy to 2 m above the ground. The total interval time was 30 minutes including measurements of standard gases for the calibration. The 30-minutes interval measurements of the CO_2 and H_2O isotope ratios were repeated continuously during the 10 days. The figure shows observed data for carbon isotopic composition of CO_2, delta^{13}C, determined by the laser absorption spectrometer in one cycle (30 minutes) from 00:00 August 4, 2010. We will discuss the details of the observation result at the meeting.



Keywords: CO_2 isotopes, H_2O isotopes, forest, laser spectroscopy, ecosystem, atmospheric CO_2

MIS023-15 Room:303 Time:May 22 15:15-15:30

The study on the foraging rivers of water bird cormorant nesting Yamada-Onuma, Saitama prefecture

Atsuko Iwasaki[1*], Tasuku Fukumoto[1], Kenichi Satake[1]

[1]Geo-environmental Sci., Rissho Univ.

Cormorant is known to collect fishes from rivers and to carry them to the nests. The foraging rivers were suggested by the relationships among strontium isotope ratios ($^{87}Sr/^{86}Sr$) of the river water, fish bones collected at the cormorant nests and the cormorant bones.

Keywords: cormorant, strontium, isotope

MIS023-16 Room:303 Time:May 22 15:30-15:45

The distribution of dissolved iron in rivers in japan and its geographical factors

Atsushi Masaki[1*], Muneoki Yoh[1], Keisuke Koba[1], Takayuki Shiraiwa[2], Takeo Onishi[3]

[1]Tokyo Univ of Agri and Tech, [2]Hokkaido Univ, [3]Gifu Univ

It is believed that forests are the source of dissolved iron because humic substance, which complexes with iron, are rich in this ecosystem. However, few previous studies have explained that dissolved iron concentration is high in stream or river water in forest ecosystem. In this study, we analyzed the data of dissolved iron concentration in 45 first-grade rivers provided in the ”Elemental Concentrations in Japanese Rivers” (2002-2006, published by National Institute of Radiological Sciences), in addition, we measured dissolved iron and dissolved organic carbon (DOC) concentration in a number of rivers (mainly in Hokkaido) by the field investigation. We analyzed geographical (land use type and land slope) information of river basin to find any relationship between the concentration of dissolved iron and geographic factors.

As a result, we found that the concentrations of dissolved iron and DOC in down river are higher than in upper stream. The downstream areas with gentle topography may be the source of dissolved iron and DOC. There is a high relationship between the concentrations of dissolved iron and the plain land area ratio in river basin. It is likely that the gentleness of land surface is an important factor in the point of dissolved iron export. On the other hand, there is no high relationship between the concentrations of dissolved iron and the plain land area ratio in river basin. It is likely that all of forest ecosystem plays a source of dissolved iron. However, the swamp forest near the stream channel may be the important source area of iron. With the data ”Elemental Concentrations in Japanese Rivers”, we found the variability of the concentration of dissolved iron among rivers in Japan.

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MIS023-17 Room:303 Time:May 22 15:45-16:00

Discussion: Biogeochemistry

Hideaki Shibata[1]*, Muneoki Yoh[2], Naohiko Ohkouchi[3], Youhei Yamashita[1]

[1]Hokkaido Univ., [2]Tokyo Univ. of Agric. and Tech., [3]JAMSTEC

General discussion for this session, ”Biogeochemistry”

Keywords: Biogeochemistry