

Japan Geoscience Union Meeting 2011

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

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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*}

¹none

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

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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

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MIS023-03

Room:303

Time:May 22 09:45-10:15

Unveil the Depth of Methanogenesis in Deep Subsurface and Microbial Ecology

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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 $\delta^{13}\text{C}-\text{CH}_4$. 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 $\delta^{13}\text{C}-\text{CH}_4$ 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

MIS023-04

Room:303

Time:May 22 10:45-11:15

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

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In most studies that have been conducted to date, the gross uptake rate of nitrate has been estimated by incubation experiments using ¹⁵N tracer techniques. In this conventional approach, ¹⁵N labeled NO₃⁻ is added into bottles or mesocosms that simulate in situ conditions, which leads to the production of particulate organic-¹⁵N (PO¹⁵N) through assimilation over a known incubation period of several hours to several days. This PO¹⁵N 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 ¹⁵N tracer method has several problems with determining accurate nitrate uptake rates. For example, the usual ¹⁵N tracer method does not include assimilated nitrogen released to dissolved organic-¹⁵N (DO¹⁵N) 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 NO₃⁻ overcomes the aforementioned problems inherent in the conventional ¹⁵N-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 ¹⁷O 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 = 10⁶ 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

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

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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

MIS023-06

Room:303

Time:May 22 11:30-11:45

Photosynthetic activity and community structure in intertidal microbial mats

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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 $\text{H}^{13}\text{CO}_3^-$ 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

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

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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, *Thermoplasma* has main polar lipid (MPL), which has L-gulose a characteristic rare sugar as a major component of polar head group of MPL. *Thermoplasma* 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 actinomycetes. 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-[3-²H] and [3,4-²H₂]-glucose were synthesized. Then, incubation experiments with the labeled compounds into low-glucose-containing *Thermoplasma* 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-gulose were further analyzed in detail, and the position and the fragments determined content of deuterium.

For the experiment with D-[3-²H]-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-[3-²H]-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 [3,4-²H₂]-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-glucose 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 eukaryote 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

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MIS023-08

Room:303

Time:May 22 12:00-12:15

Compound-specific radiocarbon dating as a tool for biogeochemical processes

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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 Takano², Yoshito Chikaraishi², Nanako O. Ogawa², Hiroyuki Imachi², Hisami Suga², Yusuke Yokoyama¹, Naohiko Ohkouchi²

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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 ($\delta^{15}\text{N}$) 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 $\delta^{15}\text{N}$ values of their amino acids were similar to aquatic photoautotrophs, whereas the case the microbes assimilated amino acids from diets, they showed ^{15}N -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

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. Ogawa¹, Naohiko Ohkouchi¹

¹JAMSTEC

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 ¹⁵N-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 ¹⁵N 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

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The nitrogen isotopic composition of amino acids ($\delta^{15}\text{N}_{AA}$) is useful for estimating trophic position of the organism (McClelland and Montoya 2002, Chikaraishi et al. 2007, 2009). In this study, $\delta^{15}\text{N}$ 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 (Cottomephoridae & 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 $\delta^{15}\text{N}$ of bulk organic matter (Yoshii et al. 1999), though they were consistent for the lower position species. The $\delta^{15}\text{N}_{AA}$ results also showed four species of pelagic sculpin are in the close trophic position, despite large differences in $\delta^{15}\text{N}_{TN}$ (~ 3.4 per mil) between Cottomephoridae 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.

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

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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°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 $10\text{mmolNm}^{-2}\text{s}^{-1}$ 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 $3.0\times 10^{-6}\text{mmolNm}^{-2}\text{s}^{-1}$ 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

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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

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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

MIS023-14

Room:303

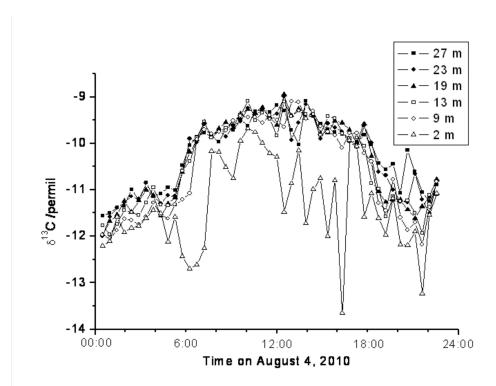
Time:May 22 15:00-15:15

Real time, continuous measurements of CO₂ and H₂O isotopes in the forest using laser absorption spectrometers

Ryuichi Wada^{1*}, Masahiro Takemura¹, Mai Ouchi¹, Tomoki Nakayama¹, Yutaka Matsumi¹, Satoru Takanashi², Yuichiro Nakai², Kenzo Kitamura², Naoyuki Kurita³, Yasushi Fujiyoshi⁴, Kenichiro Muramoto⁵, Tetsuya Hiyama⁶, Gen Inoue⁶, Naomi Kodama⁷, Takashi Nakano⁸

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Measurements of CO₂ and H₂O 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 CO₂ and H₂O isotopologues (¹⁶O¹²C¹⁶O, ¹⁶O¹³C¹⁶O and ¹⁸O¹²C¹⁶O for CO₂, D₂O and H₂¹⁸O for H₂O) using infrared absorption laser spectrometers (Aerodyne Inc. for CO₂ and Los Gatos Research Inc. for H₂O). The CO₂ isotope laser spectrometer can measure the isotope ratios (delta¹³C, delta¹⁸O) of ambient air CO₂ 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 CO₂ and H₂O isotope ratios were repeated continuously during the 10 days. The figure shows observed data for carbon isotopic composition of CO₂, delta¹³C, 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: CO₂ isotopes, H₂O isotopes, forest, laser spectroscopy, ecosystem, atmospheric CO₂

Japan Geoscience Union Meeting 2011

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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 Fukumoto¹, Kenichi Satake¹

¹Geo-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 ($^{87}\text{Sr}/^{86}\text{Sr}$) 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 Yoh¹, Keisuke Koba¹, Takayuki Shiraiwa², Takeo Onishi³

¹Tokyo Univ of Agri and Tech, ²Hokkaido Univ, ³Gifu 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 Yoh², Naohiko Ohkouchi³, Youhei Yamashita¹

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

General discussion for this session, "Biogeochemistry"

Keywords: Biogeochemistry

Japan Geoscience Union Meeting 2011

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

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MIS023-P01

Room:Convention Hall

Time:May 22 16:15-18:45

The role of prokaryotes in the oceanic carbon cycle

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Over the past three decades, several studies have examined the abundance, biomass, and production rate of prokaryotes in various marine environments. These studies have revealed that prokaryotes consume, on average, 50% of primary production in pelagic ecosystems and play important roles in major biogeochemical processes, such as nutrient cycling and organic matter fluxes. In addition, studies have shown that prokaryotic biomass is comparable to, or even exceeds, phytoplankton biomass in oceanic environments, with prokaryotes representing an important trophic link in marine pelagic food webs. Moreover, studies, which are based on novel molecular biology analyses, have revealed surprisingly diverse prokaryotic communities in marine environments. And these studies have revealed spatiotemporal patterns in prokaryotic community composition. However, our knowledge of the role of individual prokaryotic subgroups in biogeochemical cycles remains limited. To examine the internal dynamics of prokaryotic communities and their implications for biogeochemical cycling in marine systems, it is important to understand 1) the spatiotemporal variation in individual bacterial subgroups; 2) mechanisms underlying community structure controls; 3) contributions of individual groups to carbon flow in microbial food webs. In this presentation, I discuss recent progress in microbial oceanography, emphasizing the importance of prokaryotes in determining the oceanic carbon cycle.

Keywords: prokaryotic community, oceanic carbon cycle

MIS023-P02

Room:Convention Hall

Time:May 22 16:15-18:45

Linkage of sulfur and nitrogen cycling in a sulfur high-content ecosystem-Nitrate reduction coupled to sulfur oxidation-

Atsushi Hayakawa^{1*}, Mizuho Hatakeyama¹, Bayasgalan Baatar¹, Yuichi Ishikawa¹, Shin Hidaka¹

¹Akita Prefectural University

[Introduction] While most studies have focused on organic carbon as the electron donor for denitrification, reduced sulfur can also provide energy to support denitrification. Pyrite (FeS₂), which is composed of a reduced sulfur of sulfide mineral, is easily oxidized to SO₄²⁻ and can be coupled to reduce NO₃⁻ when NO₃⁻ contacts with pyrite in anoxic condition. Recent study indicated NO₃-driven SO₄²⁻ production could be widespread and biogeochemically important in fresh water sediments (Burgin and Hamilton, 2008). Therefore, NO₃⁻ reduction coupled to SO₄²⁻ production might be superior in Akita prefecture which has the stratum that called 'Kuroko' which contains a lot of sulfide minerals. [Aim] In this study, we focused on the linkage of sulfur and nitrogen cycling through denitrification. The purpose of this study was to evaluate NO₃⁻ reduction and N₂O emission coupled to sulfur oxidation by a long-term incubation of soil from a sulfur high-content ecosystem in Akita prefecture, Japan. [Materials and Methods] Study site is the nature trail of Goshogake (N39.970, E140.801) at Akita prefecture in Towada-Hachimantai National Park, Japan. The sediments used in the incubation experiment were sampled from mudflat (A) and riverside (B) from the 10-20 cm depth. Fresh sediments corresponding to approximately 20 g dry weight and 400 ml each treatment water were added to 550 ml glass bottles and closed with butyl rubber septa and aluminum crimp. Four treatment water were prepared in this study; 1. Deionized water, CT; 2. KNO₃ (100 mg N L⁻¹), N; 3. KNO₃+Glucose, N+Glu; 4. KNO₃+CaCO₃, N+CaCO₃. Bottles were incubated at 25 deg C for 220 days. To achieve anoxic condition in bottles, the solution and headspace of the bottles were sparged with N₂ gas for 30 min. Immediately after water sampling, pH and EC were measured by a portable pH and EC meter. Concentration of NO₂⁻, NO₃⁻, SO₄²⁻ were measured by an ion chromatograph. Concentration of NH₄⁺ was determined by colorimetry using the indophenol blue method. Nitrous oxide concentration in the headspace of the bottles was measured by a gas chromatograph with ECD. Easily oxidizable-S content in the sediments was measured by the difference between H₂O₂-S and H₂O-S (Murano et al., 2000). [Result and Discussion] In the N treatments, NO₃⁻ concentration decreased by 57-100% after 208 days from the incubation started. In the N+CaCO₃ treatment of the B sediment, NO₃⁻ concentration decreased to 0 mg N L⁻¹ after 208 days. Concentration of SO₄²⁻ increased in all the treatments, and the maximum concentration was observed in the N+CaCO₃ treatment of the B sediment. Both NO₃⁻ consumption and SO₄²⁻ production rate tended to be larger in the B sediment than that in the A sediment. Nitrate consumption rate significantly correlated with SO₄²⁻ production rate during the incubation period ($r=0.990$, $p<0.01$, $n=8$), which indicated NO₃⁻ reduction coupled to sulfur oxidation. Easily oxidizable-S content in the B sediment was higher than that in the A sediment, which would cause the difference of the NO₃⁻ removal rates among the sediments. In this session, we would like to discuss a stoichiometry of this biogeochemical reaction based on the present results. Ammonium were detected in all the N treatments but were considerably low. Therefore, NO₃⁻ reduction by dissimilatory nitrate reduction to ammonium (DNRA) would be negligible. Nitrous oxide production was observed in all the N treatments, however, the significant difference among the treatments or the sediments was not observed. In the B sediment, the SEM photographs showed a framboidal form which represent pyrite. X-ray analysis also showed clear peaks corresponding to pyrite and marcasite both of which the chemical composition were FeS₂. Therefore, NO₃⁻ reduction was coupled to pyrite and marcasite oxidation to SO₄²⁻. This study indicated the linkage of sulfur and nitrogen cycling through denitrification in a sulfur high-content ecosystem.

Keywords: sulfur denitrification, nitrate reduction, sulfur oxidation, pyrite, N₂O, DNRA

MIS023-P03

Room:Convention Hall

Time:May 22 16:15-18:45

Syntrophic nitrogen exchange between zooxanthellae and host corals as viewed from amino acid nitrogen isotopes

Takanori Fujii¹, Toshihiro Miyajima^{1*}, Hiroshi Ogawa¹, Masamichi Machida¹, Yasuaki Tanaka², Naoko Morimoto¹, Atsushi Watanabe², Kazuo Nadaoka²

¹The University of Tokyo, ²Tokyo Institute of Technology

The reef-building coral is one of the most prominent animal-plant symbiotic systems, exhibiting extremely high primary production in oligotrophic tropical oceans. As an essential factor behind this, the existence of conservative internal recycling pathways of nutrients such as nitrogen (N) and phosphorus has been supposed; however, exact mechanisms of nutrient recycling still remain to be clarified. In normal animal-plant interactions, animals acquire N from plants through grazing, and plants can reuse N once animals excrete N as urea or ammonium. Are similar trophic linkages operating between zooxanthellae and host corals within the symbiotic associations? To address this question, we used compound-specific N isotope analysis of amino acids. Using amino acid N isotope signature ($d^{15}\text{N-AA}$) of animal tissues, one can evaluate simultaneously the apparent trophic level (ATL) of the animal, and the $d^{15}\text{N-AA}$ of plants at the basis of food chain on which the animal depends. From the latter, the $d^{15}\text{N}$ of dissolved inorganic nitrogen (DIN) on which the plants depend can also be estimated and used for N source evaluation. We collected specimens of *Acropora pulchra* and some other hermatypic corals from fringing reefs around Ishigaki Island and Sekisei Lagoon, southwestern Japan, separated zooxanthella cells and host coral tissues using centrifugation, and measured bulk and amino acid $d^{15}\text{N}$ values using EA/IRMS and GC/C/IRMS, respectively. The $d^{15}\text{N-AA}$ patterns of zooxanthellae and host tissues from single colonies were quite similar to each other, and ATL mostly ranged between 0.9 and 1.5 (ATL of primary producers being defined as 1.0) with no significant difference between zooxanthellae and the host. There was no evidence that host corals graze on zooxanthellae. The bulk $d^{15}\text{N}$ values of both zooxanthellae and host tissues were low in pristine sites and got higher in polluted sites, indicating that they directly reflected $d^{15}\text{N}$ of external N sources available at each site. While pieces of *A. pulchra* colonies were incubated with *Artemia* as food source for 2 weeks, the bulk $d^{15}\text{N}$ and $d^{15}\text{N-AA}$ s gradually increased towards those of *Artemia*, and the increase rates were similar between zooxanthellae and host tissues. ATL also increased from 0.97 to 1.33 (zooxanthellae) and 1.37 (host tissues), which indicates that zooxanthellae did not simply reuse excreted metabolites from the host. Our results suggest that zooxanthellae and the host share a common reservoir of amino acids, from which they synthesize proteins for their biomass. Sources of amino acids for this reservoir would depend on origins: DIN may be incorporated and synthesized into amino acids primarily by zooxanthellae, while external food sources may be caught and digested into amino acids primarily by the host. Irrespectively of origins, the most part of acquired N seems to be stocked in the common amino acid reservoir before being used further for biomass synthesis. Thus, N exchange pattern between zooxanthellae and the host coral would be different from those found in non-symbiotic plant-animal interactions, and can not be regarded as simple recycling. It rather seems to be an effective system for sharing resources from several different origins between zooxanthellae and the host, to enhance their survival and growth under high-energy, low-nutrient conditions.

Keywords: coral, symbiosis, amino acids, nitrogen cycle, stable isotopes

MIS023-P04

Room:Convention Hall

Time:May 22 16:15-18:45

Nitrogen availability and natural abundance of ^{15}N of soil microbial biomass

Azusa Hokari¹, Keisuke Koba^{1*}, Yu Takebayashi¹, Asami Nakanishi², Yoshiyuki Inagaki³, Yoshito Mochiduki¹, Megumi Kuroiwa¹, Naoko Tokuchi², Muneoki Yoh¹

¹Tokyo Univ Agric Tech, ²FSERC, Kyoto Univ, ³FFPRI

Nitrogen (N) availability in forest is a strong driver controlling net primary production of plant. Soil microbes regulate the N availability since they are responsible for the production of available N (inorganic and some organic N) for plants and soil microbes. Thus, balance of N and carbon (C) availability to soil microbes is quite important for the understanding of N cycle in terrestrial ecosystems and soil C/N ratio has been used as a parameter for that. However, C/N ratio of bacteria and fungi differs greatly and relative importance of them to the total soil microbes can differ among different soils, simple C/N ratio cannot determine the actual balance of C and N availability.

Recently, natural abundance of ^{15}N ($d^{15}\text{N}$) of the soil microbe has been proposed as a new parameter that can provide the information on relative C and N availability to the soil microbes (Dijkstra et al. 2006, 2008). Enrichment in $d^{15}\text{N}$ ($\text{Dd}^{15}\text{N}_{\text{MB-Soil}}$) of the soil microbes from the substrate (bulk soil N or extractable soil N) should be high when N availability is high because the soil microbes would excrete the excess N with low $d^{15}\text{N}$ due to the isotopic discrimination during the N metabolism. Even this new parameter r of $\text{Dd}^{15}\text{N}_{\text{MB-Soil}}$ is expected to provide new insights into the actual C and N availability of the soil to the soil microbes, the measurement of $\text{Dd}^{15}\text{N}_{\text{MB-Soil}}$ is tedious due to the low concentration of soil microbial N. We explored the potential of $\text{Dd}^{15}\text{N}_{\text{MB-Soil}}$ in a temperate forest in Japan with denitrifier method that can allow us to measure $d^{15}\text{N}$ with small sample size (20-50nmol-N).

We collected the soil samples (Ao, 0-10 and 10-20cm depth) from Kamigamo Experimental Forest, Kyoto Univ, Japan from two plots located in upper part and lower part of a mountain slope. We measured $d^{15}\text{N}$ the extractable N (NH_4^+ , NO_3^- , TDN and DON) in 0.5M K_2SO_4 soil extract. We also used the fumigation-extraction method to measure C and N content, and the $d^{15}\text{N}$ of soil microbial biomass. DOC concentration in the 0.5M K_2SO_4 soil extract and $d^{15}\text{N}$ of bulk soil N were also measured for the reference.

$d^{15}\text{N}$ of soil microbial biomass was significantly correlated with that of bulk N ($P < 0.001$) but always higher than that of bulk N. Actually, $d^{15}\text{N}$ of soil microbial biomass was quite similar with $d^{15}\text{N}$ of DON, suggesting that the soil microbial biomass N is the source of soil DON as previously suggested (Koba et al. 2010). $\text{Dd}^{15}\text{N}_{\text{MB-Soil}}$ significantly correlated with soil C/N ($P < 0.01$), which suggested that $\text{Dd}^{15}\text{N}_{\text{MB-Soil}}$ should reflect the C and N balance for soil microbes. However, the intercept of the regression lines obtained from two sites differed greatly. This difference in the relationship between $\text{Dd}^{15}\text{N}_{\text{MB-Soil}}$ and soil C/N strongly suggested that the same soil C/N does not indicate the same balance of C and N availability to the soil microbes. We discuss the usefulness of the new parameter of $\text{Dd}^{15}\text{N}_{\text{MB-Soil}}$ in the presentation together with other parameters such as DOC/DON and $d^{15}\text{N}$ of inorganic N.

MIS023-P05

Room:Convention Hall

Time:May 22 16:15-18:45

Isotopomer analysis of nitrous oxide produced in a seasonally frozen soil

Tetsuaki Yamazaki^{1*}, Shohei Hattori¹, Yosuke Yanai², Sakae Toyoda¹, Naohiro Yoshida¹

¹Tokyo Insititute of Technology, ²NARO

Nitrous oxide (N₂O) is a potent green house gas of which radiative forcing is about 200 times larger than that of CO₂ and contributes to ozone depletion in the stratosphere. In seasonally frozen soil, it is known that more than 50% of the annual N₂O emission occurs during spring snowmelt period. In order to investigate the N₂O production/consumption mechanism under the soil thawing events, we performed isotopomer analysis of N₂O at an experimental agriculture field plot in northern Japan. It is suggested that intramolecular ¹⁵N site preference (SP) of N₂O, that is defined as difference in isotope ratios between central (N^a) and terminal (N^b) nitrogen in the N₂O (NNO) molecule, is a powerful tool to quantitatively analyze the contribution of important production pathways such as nitrification, fungal denitrification, chemo-denitrification and bacterial denitrification together with the presence of N₂O reduction, in addition to the isotope ratio of N (d¹⁵N) and O (d¹⁸O).

The diffusion chamber method using silicone tube, which is recently applied to gas sampling from each soil depth, is useful method for revealing biological processes in soils. In order to apply this method to isotopomer analysis, diffusion equilibrium of N₂O (concentration, d¹⁵N, d¹⁸O, SP) was confirmed by laboratory experiment. As a result, no significant difference in concentration and isotope ratios between outside and inside of the silicone tube was detected, suggesting the diffusion method can be applied to in situ soil gas sampling for N₂O studies.

We, then, investigated the isotopomer signatures of soil N₂O collected from the seasonally frozen soil under soil thawing events. Isotopomer ratios showed no significant variation during N₂O production peak in subsoil. Both SP and d¹⁵N of N₂O were within the range of the reported values for bacterial denitrification, suggesting that N₂O produced during spring snowmelt period was derived from bacterial denitrification and the contribution of N₂O reduction was likely to be very low.

Keywords: Nitrous oxide, Isotopomer, Frozen soil, Denitrification

MIS023-P06

Room:Convention Hall

Time:May 22 16:15-18:45

The effect of manure on nitrous oxide flux in agricultural soils

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¹NIAES

Nitrous oxide plays important roles in atmospheric chemical processes. Nitrous oxide is known as a greenhouse gas, and is one of several gases responsible for global warming. In addition to its contribution to global warming, nitrous oxide plays the most important role in ozone depletion in the stratosphere.

Agricultural soils is major source of atmospheric nitrous oxide. Because N fertilizer stimulates these N oxide gases emission derived from both nitrification and denitrification processes in soils. However, the strength of its still have a large uncertainty. The rates at which nitrous oxide emission is induced by fertilization widely ranged 0.003 ? 0.03 (IPCC, 2007). Its variation was considered to depend on fertilizer types, plant species, soil types and the environmental factors during measurement period. However, there are fewer reports on nitrous oxide emission from organic fertilizer application than from chemical fertilizer application. To investigate the effect of organic fertilizer application on nitrous oxide flux, a wider variety of organic materials needs to be assessed.

In this study, to quantify the various organic materials and various nitrogen fertilization effect on nitrous oxide flux, we develop a hierarchical Bayesian model. We modelled N oxide gases flux assumed as lognormal distribution and incorporated random effect in block (chamber position) to take the variability of flux into account. By using this model, we quantify the response of nitrous oxide flux with various organic materials application from lysimeter field to the environmental factors. Also, this approach enables to quantify uncertainty, which is represented as probability density functions.

In the presentation, we will discuss about the difference in response of nitrous oxide flux among application of organic materials .

Keywords: Nitrous oxide flux, Hierarchical Bayes model

MIS023-P07

Room:Convention Hall

Time:May 22 16:15-18:45

Nitrogen dynamics in earthworm casts: possible hotspot of N₂O production in soil

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Introduction

Nitrous oxide (N₂O) has been recognized as a potent and long-lived green house gas. Its global warming potential (GWP) is 310 times greater than CO₂. N₂O is also linked to ozone depletion strongly. So increasing anthropogenic emission of N₂O is now pressing problem. To understand, estimate the effect of human activity on N₂O budget, correct estimation of N₂O production rates from relatively small scale, like regions, landscapes, and individual fields, are needed.

Earthworms change soil structure and influence nitrogen and carbon cycle in soil. Previous study shows that earthworm casts have high nitrification and denitrification rate. In the few studies N₂O emission from casts are measured but almost no study focus on the change of N₂O emission related to cast ageing.

We evaluated the change of pH, mineral N content, N₂O emission rate, C/N, total organic C, and microbial respiration related to cast ageing and investigate what causes the change of N₂O emission rate. We also use two different species of earthworm and check the species effect.

Materials and Methods

Earthworms (*Amyntas hupeiensis* and *Metaphire megascolidioides*) and soil are collected on Kamakura central park, Kamakura, Kanagawa and pre-incubated in laboratory during 3 days. The samples of fresh casts from each earthworms and soils (5.0g of wet matter) were placed into glass bial and incubated. We measured N₂O emission rate after 0,1,4, and 10 days of the cast formation. Subsequently, sample in the bial are separated and pH, C/N ratio, NH₄⁺, NO₃⁻, TDN (Total Dissolved Nitrogen), TOC (Total Organic Carbon) were measured.

Results and Discussion

N₂O emission from soils is almost constant during incubation period (-0.004 to 0.004 microgN/g/day). N₂O emission from *A. hupeiensis*'s casts decreased from 0.023 microgN/g/day (0-day cast) to 0.005 microgN/g/day (10 day cast). N₂O emission from *M. megascolidioides*'s casts also decreased from 0.147 microgN/g/day (0-day cast) to 0.027 microgN/g/day (10-day cast). Irrespective of species, N₂O emission from casts is significantly higher than soil, so casts may contribute to N₂O emission from soil in the actual field.

pH decrease and NO₃⁻ concentration increase with time are shown in casts from both species. NH₄⁺ and TDN concentration in *A. hupeiensis*'s casts increased in 4-day and 10-day cast. In *M. megascolidioides*'s casts, on the other hand, NH₄⁺ concentration is gradually decreased and TDN concentration are almost constant. Previous study shows decrease of NH₄⁺ concentration. So NH₄⁺ increase in *A. hupeiensis*'s casts may caused by ammonification, mucus secretion. Microbial respiration in casts are higher than soil in both species. TOC concentration shows sharp decline between 0-day and 1-day and fluent decline between 4-day and 10-day casts from both species.

N₂O emission from casts and TOC are related significantly (*A. hupeiensis*: r²=0.61, *M. megascolidioides*: r²=0.47), and it shows possibility that TOC decrease control N₂O emission from casts. It is known that microbial activity in earthworm casts decreases after cast formation. This decrease is thought to be caused by decrease of available carbon, antagonistic interactions between microbial communities, and so on. The results from this study support the limitation by available carbon.

Keywords: earthworm, cast, nitrogen dynamics, nitrous oxide (N₂O)

MIS023-P08

Room:Convention Hall

Time:May 22 16:15-18:45

Conversion of nitrate to dissolved organic nitrogen in stream water through serpentinite bedrock in a forested watershed

Masaaki Chiwa^{1*}, Jun'ichiro Ide², Naoko Higashi¹, Ryoko Maruno¹, Kyoichi Otsuki¹

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The concentration of NO_3^- in stream water has been elevated in forested watersheds due to chronic atmospheric nitrogen (N) deposition over the last few decades. N saturation in forested ecosystems, defined as an excess of N deposition supply over biotic demand, results in significant N leaching from forested watersheds. Recent studies, however, indicated that chronic high N deposition has had variable effects on stream water NO_3^- concentrations across the northeastern United States. This is because many factors affect NO_3^- leaching from forested watershed.

In this study, to test the hypothesis that passing groundwater through different bedrock causes a marked difference in the nitrate (NO_3^-) concentration in baseflow stream water, two nearly adjacent watersheds, site O (serpentinite and chlorite schist: NO_3^- 55 $\mu\text{mol L}^{-1}$) and site S (amphibolite: NO_3^- 113 $\mu\text{mol L}^{-1}$), were investigated and the underlying mechanism affecting NO_3^- concentration as groundwater passes through bedrock was identified. The conversion of NO_3^- to dissolved organic nitrogen (DON) in groundwater as it through bedrock could be the primary reason for the lowered NO_3^- concentration at site O. Plausible mechanisms could be NO_3^- reduction to nitrite (NO_2^-) by reduced metals, such as iron, chromium, and nickel found in serpentinite bedrock and the subsequent reaction of NO_2^- with dissolved organic matter to produce DON. The results from this initial study showed that certain bedrocks can reduce NO_3^- concentrations in stream water by converting groundwater NO_3^- to DON.

Keywords: Nitrogen saturation, Nitrogen leaching, Conversion, Forested watershed, Serpentinite

Japan Geoscience Union Meeting 2011

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

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MIS023-P09

Room:Convention Hall

Time:May 22 16:15-18:45

Changes in dissolved organic matters in streamwater during a stand development of Japanese cedar plantations

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In order to elucidate the regulating factors of dissolved organic matter in streamwater, we examined dissolved organic carbon and nitrogen (DOC and DON, respectively) concentrations and the 3-dimensional fluorescence in more than 30 watersheds covered with planted Japanese cedar of different stand ages. A remarkable increase in the DOC concentration was found 3 years after clear-cutting, and the DOC concentrations decreased from 3 to 38 year-old stands. Afterward, DOC concentrations re-increased accompanied with an increase in fulvic acid-like substances, suggesting that soil organic matters and humic substances accumulated during the stand development. We will discuss this change in stream DOM concentration and its quality during the stand development, and an implication for carbon and nitrogen cycling in this forest ecosystem.

Keywords: Dissolved organic matter, Fluorescence, Japanese cedar plantation, Stand age, Streamwater chemistry

MIS023-P10

Room:Convention Hall

Time:May 22 16:15-18:45

Distribution of dissolved iron concentration and optical characteristics of DOM in the estuarine water of Yura River

Koji Fukuzaki^{1*}, Kenta Watanabe¹, Keitaro Fukushima², Yoh Yamashita², Takahito Yoshioka²

¹Graduate School of Agr., Kyoto Univ., ²FSERC, Kyoto Univ.

The materials supplied from terrestrial areas through a river largely affect the biological activity in the estuarine and coastal region. Iron is an essential element for the phytoplankton that supports the primary production of aquatic ecosystems. However, in an aerobic environment, iron forms insoluble hydroxide and thus, biologically available dissolved iron can be limited. Most of the dissolved iron is complexed with dissolved organic matter (DOM). DOM not only influences the transportation process of materials by formation of the metal-organic complexes and absorption and desorption of elements but also influences bioavailability of the trace metals, such as iron. Therefore, it is important to characterize DOM composition as well as clarifying quantitative distribution of DOM. However, little has known about qualitative information on DOM, and the distribution and dynamics of DOM.

In this study, we investigated optical characteristics of DOM and the distribution of dissolved iron in the estuarine region that important as a place for the biological production. This study was conducted as a part of the Kibunka Project, Field Science Education and Research Center, Kyoto University.

The field sampling was conducted in the estuary region of the class A river, Yura river, located in the northern part of Kyoto Prefecture. Six sampling stations were set between the mouth of the river and about 16km upstream. River water at 2 or 3 depths were collected in each station on July 17th, August 19th, November 18th, 2010, and January 21, 2011. Polyethylene bottles were used for water sampling after thoroughly washed with the sample water. Sampled water were then filtered with the acid cleaned glass fiber filter (GF/F, Whatman), treated with HNO₃ conc. for pH adjustment, and refrigerated in the surface contamination control (SCC) polypropylene bottles until iron analysis. The dissolved iron concentration was measured by inductively coupled plasma atomic emission spectrometry (ICP-AES). For DOC analysis, sampled water was filtered with a combusted (450 degree, 4h) glass fiber filter (GF/F). Concentrations of DOC were determined with a total organic carbon analyzer (TOC-V CSH, Shimadzu). Three-dimensional excitation emission matrix (EEM) was measured by using the fluorescent spectrometer (F-7000, Hitachi). After EEM data were standardized by the Raman scatter correction, several peaks are extracted by the Parallel Factor (PARAFAC) analysis.

Keywords: Dissolved Organic Matter, Dissolved iron, EEM-PARAFAC analysis, Water quality, Salt-wedge intrusion

MIS023-P11

Room:Convention Hall

Time:May 22 16:15-18:45

Characterizing the dynamics of dissolved organic matter by fluorescence spectroscopy

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Dissolved organic matter (DOM) comprises the largest pool of organic matter in a wide range of aquatic environments. DOM in the ocean is one of the largest bioactive carbon reservoirs with a stock of 680 PgC in the global basis. In terrestrial aquatic environments, even though stocks of DOM are small compared to the ocean, it has been recognized that a large amount of organic matter is processed in inland waters and must be considered in the global carbon cycle. In addition, DOM plays a key role in biogeochemical cycles affecting processes such as metal complexation, light attenuation, nutrient availability, and microbial and phytoplankton activity. Recent studies clearly show that dissolved organic carbon (DOC) concentrations in terrestrial aquatic environments change with environmental disturbances such as land management. However, fluxes and mechanisms controlling the DOM dynamics in aquatic environments, e.g., transport of organic matter from land to rivers, have not been well documented and we need to improve our knowledge of this subject. The role of DOM in biogeochemical cycles, e.g., as a driver for microbial loop, is strongly related to DOM chemical characteristics or quality. Thus, we need a better understanding of DOM dynamics in aquatic environments in terms of quantity and quality.

Fluorescence spectroscopy has been widely used for characterizing DOM dynamics in aquatic environments. This technique features high sample throughput and can evaluate the dynamics of at least two very different groups of DOM, namely humic-like and protein-like fluorophores. The protein-like fluorophores have been considered to be representative of fluorescent aromatic amino acids and consequently the biologically reactive components. On the other hand, humic-like fluorophores can be used to evaluate mainly soil-derived organic matter in aquatic environments. Thus, characterization of DOM using fluorescence techniques will provide a better understanding of DOM dynamics in aquatic environments. More recently, the combined techniques of excitation-emission matrix (EEM) fluorescence with parallel factor analysis (PARAFAC) have successfully evaluated the environmental dynamics of fluorescent DOM (FDOM) components in diverse aquatic ecosystems. This technique provides higher resolution on fluorescence components in DOM, and thus, may be ideally suited to detect small, but potentially significant variations in DOM composition in apparently similar aquatic environments.

In this presentation, we will introduce fluorescence techniques, especially EEM-PARAFAC, as a tool for characterizing the DOM dynamics in aquatic environments. As an example, we will present optical properties of DOM that dissolved from flocculent particulate organic matter (floc). This study shows that light exposure of floc from the Florida Coastal Everglades results in significant DOM generation through photo-dissolution processes. DOC concentration for samples incubated under dark conditions displayed a relatively small increase, suggesting that microbial processes and/or leaching might be minor but important processes for the generation of DOM from floc. On the other hand, DOC concentration increased substantially for samples exposed to artificial sunlight, indicating the release of DOM through photo-induced alterations of floc. The fluorescence intensity of both humic-like and protein-like components also increased with light exposure. Terrestrial humic-like components were found to be the main contributors (up to 70 %) to the FDOM pool, while protein-like components comprised a relatively small percentage (up to 16 %) of the total FDOM. While the photo-dissolution of suspended sediment organic matter in coastal regions has also been reported, the photo-dissolution of floc in wetlands can be an important source of DOM to these shallow aquatic environments, particularly after storm events, with the potential to influence nutrient dynamics in such system.

Keywords: Dissolved organic matter, Fluorescence characteristics

MIS023-P12

Room:Convention Hall

Time:May 22 16:15-18:45

Difference in sources of rare earth elements in plants depending on type of infected fungi

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Recently a number of papers have suggested plant induced chemical weathering of soil minerals. It is conceivable that plant-induced weathering is operative for plants to assimilate inorganic elements (nutrient elements) from soil minerals directly. Mycorrhizal fungi have been reported to play a role in this process.

In this study, Eu anomaly and Nd isotope ratio of plants were measured to understand the sources of REEs in plants, assuming that no biological selection of both the elements is operative. The rationale of the assumption is the similarity in chemistry the trivalent rare earth elements.

The uppermost Strengbach catchment is situated in the eastern part of the Vosges mountains (Northeastern France), where various species of plants (ex. Fern, Maple, Pine) were sampled.

In measurement, leaves of each plant sample were used. Plant sample was dissolved with HNO₃ and HF, then REEs in the solution were preconcentrated with solvent extraction (Shabani et al., 1990; Fu et al., 2001), and were determined by ICP-MS.

Nd isotope ratios were determined by TIMS after Nd was separated using LN resin.

The values of Eu anomaly and Nd isotope ratio of plant samples could be understood by mixing apatite, feldspar and soil solution of Strengbach.

If plants assimilated inorganic elements only from the soluble fraction of soil, value of Nd isotope ratio and Eu anomaly of plants can be similar to those of the fraction. However, the values of some plant species were rather close to those of the minerals than those of the soluble fraction of soil. This suggested that plants assimilated inorganic elements from minerals as well as the soluble fraction of soil.

The difference in the values was found to be well-related with types of infected fungi: EcM-infected plants gave the values close to silicate minerals, whereas AM-infected ones those close to the soluble fraction in soil. It is considered that a difference in symbiotic mycorrhizal fungi may produce a difference of weathered minerals.

Keywords: rare earth elements, plant - mycorrhizal fungi, chemical weathering, silicate mineral, Nd isotope ratio, Eu anomaly

Japan Geoscience Union Meeting 2011

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

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MIS023-P13

Room:Convention Hall

Time:May 22 16:15-18:45

Monitoring of mercury pollution by Carbonized tree trunk

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This study shows carbonized tree trunk accumulates atmospheric mercury, and carbonized tree trunk to be used as an indicator of atmospheric mercury pollution.

Keywords: Mercury, Carbonized tree trunk, Monitoring

Japan Geoscience Union Meeting 2011

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

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MIS023-P14

Room:Convention Hall

Time:May 22 16:15-18:45

EM Sounding Characterization of Land Management toward Estimation of Potential Pollutant Load from Non-point Sources.

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A multi-frequency electro-magnetic (EM) sounding method was applied to the agriculture field to investigate the characteristics of non-point pollution load. Soil environmental properties such as differences in land management were analyzed with electrical conductivity (EC) maps. In addition, vertical EC profiles obtained from EM soundings were compared with EC in drainage ditch or river water. As results, surface soil EC maps successfully extracted the differences in land management affected by fertilizer application. Moreover, surface EC at the vertical profiles strongly related with drainage ditch or river EC, showing most of the EC in the drainage river was explained by surface EC maps at the EM sounding data. Therefore, obtained EC maps show potential load in drainage river before infiltration water was processed, which is beneficial for watershed survey, where river water is not always available and the effect of land management becomes sometimes black box.

Keywords: EM sounding, Soil environment, Pollution load, Watershed

Japan Geoscience Union Meeting 2011

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

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MIS023-P15

Room:Convention Hall

Time:May 22 16:15-18:45

Hypothesis-driven field monitoring by using numerical experiments

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In order to understand biogeochemical responses and these temporal changes under the changing environment with global / regional scale, effectively combining field monitoring and numerical experiment using comprehensive process-based model is needed. Rapid improvement of computational power in the last decade allows us more effective monitoring research based on logical inference deduced by hypothesis-driven numerical experiments. We will report an under-going case study under the framework of "hypothesis-driven field monitoring".

We are focusing on temporal change of nitrate concentration in a headwater. We obtained two years discharge and water quality data (T-N, T-P, and NO₃⁻) of two adjacent watersheds that is different in vegetation: one is coniferous forest, and the other is deciduous forest. Two watersheds show clear difference both in discharge and water quality. Especially for nitrate concentration, coniferous forest has larger concentration than that in deciduous forest. Before proceeding to execute more detail field monitoring to clarify mechanisms of this difference, we tried to find possible hypothesis by using numerical experiments. TANKMODEL and TOPMODEL were applied to simulate discharge, and PnET model was used to simulate biogeochemical processes. By considering uncertainties inherent in each parameter by using Monte-Carlo simulations, we tried to narrow down possible dominant processes and to find important processes that are not considered in models.

Keywords: coniferous forest, deciduous forest, nitrate, numerical modeling