Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-01 会場:104 時間:5 月 27 日 09:00-09:45

Volcanic islands as model systems to quantify pedogenic thresholds and determine their impact on Polynesian land-use

Volcanic islands as model systems to quantify pedogenic thresholds and determine their impact on Polynesian land-use

CHADWICK, Oliver[1*]
CHADWICK, Oliver[1*]

[1]University of California, USA
[1]University of California, USA

Soils and weathering profiles are complex emergent features at the surface of terrestrial Earth. They form a boundary layer hosting the chemical and physical interaction of biology and hydrology with rock. Soil development derives from the dissipation of chemical energy through reaction with rock minerals; few of the original reactants survive, but they are replaced by secondary products unique to the weathering environment. Soil processes filter and transform gasses and liquids passing through them, which in turn leads to chemical and mineralogical evolution of the fabric of soil itself. Soil chemical reactions are controlled by a number of feedbacks that buffer the system from rapid changes in external inputs, however there are limits beyond which the chemical system rapidly shifts into a new chemical domain governed by different buffer reactions. Globally soil distribution patterns are underlain by specific soil process domains that are separated by pedogenic thresholds at points of domain failure. Considering how soil process domains and thresholds determine the global distribution of properties, which control everything from agricultural productivity to carbon sequestration is a primary research focus for modern biogeochemistry. Soils are complex systems, which makes it difficult to develop clear understanding of how specific driving factors control soil process domains. It is common therefore to develop model systems that allow us to tackle specific questions with fewer complications. Here I discuss the use of volcanic islands in the Pacific Ocean as a model system to study how pedogenic thresholds control phosphorus and calcium availability to plants. I then combine that knowledge with archeological information to understand how the geographic constraints imposed by these thresholds determined Polynesian land use and agricultural productivity. As Polynesians radiated across the Pacific they encountered islands that presented many different local environments ranging from reef protected lagoons and minimal high island terrain to high volcanic islands with still active volcanoes. They brought with them an agricultural starter kit, but from there on they needed to adapt to their new surroundings. They practiced two major types of intensive agriculture: non-irrigated dryland and flooded-field irrigated farming. Typically young islands had soils with rich nutrient stores, whereas older islands had depleted soils that were not productive. By contrast, young islands had few large valleys to support irrigated agriculture, whereas the older ones had broad valleys allowing development of highly productive irrigation systems. Thus cultivators in rainfed systems brought their crops to areas where near-surface rocks were still weathering and supplying nutrients such as calcium and phosphorus, whereas in irrigated systems flowing water brought the products of weathering to crops. The contrast had profound implications for the development of culture across Polynesia. Behind these anthropological observations lies an equally fascinating story about how dramatically different soil properties are produced by non-linear responses to environmental forcing. In this talk I will explore the pedology of volcanic islands and relate it to pre-industrial human land-use decisions.

キーワード: Soil Chemistry, Biogeochemistry, Andisols, Soils
Keywords: Soil Chemistry, Biogeochemistry, Andisols, Soils

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-02 会場:104 時間:5 月 27 日 10:00-10:30

Can soil properties alone predict ecosystem processes?
Can soil properties alone predict ecosystem processes?

北山 兼弘 [1*]
KITAYAMA, Kanehiro[1*]

[1] 京大・森林生態
[1]Forest Ecology, Kyoto University

Soils are a reservoir of nutrients, which supplies plants with essential elements. Soil chemical properties can change spatially and temporary in relation to parent materials, climate and pedogenesis as a function of time. In places, the concentrations of essential elements in soils are extremely impoverished, which can eventually limit the net primary productivity of terrestrial ecosystems. Accounts by Elser et al. (2007), Vitousek et al. (2010) and many others indicate that available P is depleted in deeply weathered soils in the tropics due to a long process of geochemical occlusion and losses without substrate rejuvenation and that P limits the productivity of many tropical rain forests.

Colleagues and I have been extensively studying soil P fractions and productivity in Bornean tropical rain forests. Indeed, the concentrations of soil total P or labile P fraction are generally impoverished in comparison to temperate ecosystems but can still vary greatly reflecting parent materials or the status of pedogenesis. For instance, the concentrations of soil total P in seven tropical rain forests below 700 m asl in north Borneo are generally low, but range from 66 to 512 (μ g/g). That of Bray-1 extractable P ranges from 0.2 to 4.2 (μ g/g). Yet, above-ground net primary productivities of these forests are remarkably high and converge to a narrow range. Therefore, soil chemical properties do not correlate with productivity in plausibly P-limited tropical rain forests. Why soil P fractions cannot explain productivity?

We ecologists consider net primary productivity as a fundamental ecosystem process, which is expressed as the rate of net carbon fixation in an ecosystem context. Trees invest P for carbon fixation and the efficiency of the carbon fixation is expressed by the ratio of C flux to P flux, i.e. P-use efficiency in productivity. In these forests, P-use efficiencies greatly vary by 5-fold from 800 to 4000 (gC/gP) indicating that trees can adjust to the magnitude of P deficiency to maintain productivity. This is the major reason why soil P fractions cannot explain productivity.

Biological mechanisms to explain the enhancement of P-use efficiencies are two fold, one is the efficiency of photosynthetic C fixation per unit P in leaves and the other is the residence time of P in tree bodies. Colleagues and I investigated relative importance of these two mechanisms and found that the variation of residence time of P can much better explain the variation of P-use efficiency. Tropical trees increase the residence time of P in their bodies by increasing leaf life span and also by increasing P resorption from senescing leaves when facing to increasing P deficiency. We consider these are the two important plant traits which plants have acquired as adaptation. Our studies imply that understanding adaptive mechanisms as well as soil chemical properties is essential to understand ecosystem processes.

Keywords: Adaptation, Biogeochemistry, Net primary productivity, Nutrient-use efficiency, Soil P fractions, Tropical rain forest

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-03 会場:104 時間:5 月 27 日 10:30-10:45

熱帯山地林における低リン土壌への適応としての樹木根の形態と生理特性の関係
Linkage of root physiology and morphology as an adaptation to soil phosphorus impoverishment in tropical montane forests

潮 雅之 [1*] ; 藤木 泰斗 [2] ; 日高 周 [3] ; 北山 兼弘 [4]
USHIO, Masayuki[1*] ; FUJIKI, Yasuto[2] ; HIDAKA, Amane[3] ; KITAYAMA, Kanehiro[4]

[1] 龍谷大学理工学部, [2] 三菱 UFJ リサーチ&コンサルティング, [3] 北海道大学, [4] 京大農学研究科
[1]Ryukoku Univ., [2]MURC, [3]Hokkaido Univ., [4]Grad. Sch. Agric., Kyoto Univ.

ボルネオ熱帯林はリン欠乏土壌の上に成立しているにも関わらず、高いレベルの生産性やバイオマスを維持している。樹木根のリン獲得機構は森林の生産性/バイオマス維持に重要な貢献を果たしている可能性がある。しかしながら、樹木地上部の特性（例えば葉の栄養塩濃度や光合成特性）に比べると樹木根の土壌リン欠乏に対する適応は分かっていないことが多い。本研究では、樹木根の土壌リン可給性への応答を明らかにするため、土壌リン可給性に大きな違いがある３つのボルネオ熱帯山地林で根の形態的・生理的特性の変化を測定した。具体的には、３つの森林で合計３７優占樹種・１４９個体の樹木実生を採取し、根のリン酸分解酵素活性（有機態リンから無機態リンを獲得する活性の指標）と根の表面積、直径、組織密度を測定した。

その結果、樹木群集スケールでは土壌リン可給性が減少するにともない、根のリン酸分解酵素活性と根の単位重量あたりの表面積が上昇し、根の直径は減少した。この関係は複数の森林サイトに分布する単一の樹木種に着目しても定性的には同じだった。根のリン酸分解酵素活性は根の表面積と有意な正の相関を示し、根の直径と有意な負の相関を示した。これは細い根が高いリン酸分解酵素活性を保持していることを示唆している。さらに我々は種レベルで根のリン酸分解酵素活性と葉のリン濃度と比較し、有意な負の相関を見出した。これは根のリン獲得機構が葉のリン濃度に影響している、あるいは葉のリン濃度が根のリン獲得機構に影響を与えていることを示唆している。

結論として、根の生理的・形態的特性は土壌リンの可給性にともなって変化した。さらに、樹木根の特性は葉のリン濃度と同調して変化していた。土壌リン可給性の変化に伴う樹木の地上部・地下部特性の同調的かつ適応的な変化がボルネオ熱帯山地林での生産性やバイオマスの維持に貢献しているのかもしれない。

キーワード: リン酸分解酵素活性, 植物-土壌相互作用, 樹木根, 根表面積, 土壌リン可給性, 熱帯山地林
Keywords: Phosphatase activity, Plant-soil interactions, Tree roots, Root surface area, Soil phosphorus availability, Tropical montane forests

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-04 会場:104 時間:5 月 27 日 11:00-11:15

比重分画した黒ボク土におけるリンの蓄積分布と化学種
Distinctive pools and chemical species of phosphorus among density fractions of allophanic and non-allophanic Andisols

高本 慧 [1] ; 橋本 洋平 [1*] ; 和穎 朗太 [2] ; 浅野 眞希 [3]
TAKAMOTO, Akira[1] ; HASHIMOTO, Yohey[1*] ; WAGAI, Rota[2] ; ASANO, Maki[3]

[1] 東京農工大学, [2] 独・農業環境技術研究所, [3] 筑波大学生命環境系
[1]Tokyo University of Agriculture and Technology, [2]National Institute for Agro-Environmental Sciences, [3]University of Tsukuba

Andisols with abundant aluminum (Al) and iron (Fe) oxyhydroxides are characterized by a high phosphorus (P) retention capacity. Such property leads to a significant inhibition of plant growth in Andisols unless properly managed. Andisols are classified into two types in accordance with the difference in the clay mineral compositions. One type is referred to as allophanic Andisols, in which allophane and imogolite are present in the clay fraction. The other type is referred to as non-allophanic Andisols, in which Al- and Fe- humus complexes and 2:1 phyllosillicates are predominant. Based on the result of chemical extraction, it has been suggested that these clay minerals appear to contribute to P retention capacity of Andisols. Separating the different soil minerals in accordance with their density can limit the number of P-bearing phases, facilitating characterization of species and accumulating pools of P. The objective of this study was to characterize the species and distinctive pools of P in allophanic and non-allophanic Andisols using density separations in combination with sequential extraction and solution ^{31}P nuclear magnetic resonance (NMR) spectroscopy.

Allophanic and non-allophanic Andisols collected from Tsukuba and Osaki, respectively, were fractionated by sodium polytungstate into five density levels including 1.6-1.8, 1.8-2.0, 2.0-2.25, 2.25-2.5, and $>$2.5 g cm^{-3}. Phosphorus in each density fraction was extracted sequentially by deionized water, 0.5 M $NaHCO_3$, 0.1 M NaOH and 1.0 M HCl. After the extracts were filtered, the concentration of inorganic P (P_i) in all fractions was determined colorimetrically with a molybdenum blue method. The concentration of total P (P_t) in each fraction was determined by the same method after the solution was treated using H_2SO_4-persulphate digestion. The concentration of organic P (P_o) was calculated as the difference between P_t and P_i of each fraction.

The total concentration of P was similar in the allophanic and non-allophanic Andisols (6.2 g kg^{-1}). A large proportion of P_i and P_o in the bulk and each density fraction was extracted by NaOH, indicating that P in both Andisols was mainly associated with Al and Fe (oxy)hydroxides. The density fraction that accumulates P was contrastingly different between allophanic and non-allophanic Andisols where over 90% of P_i and P_o in the former was accumulated in the $>$2.0 g cm^{-3} fraction, whereas about 70% of P_i and P_o in the latter was found in the $<$2.0 g cm^{-3} fraction. According to the ^{31}P-NMR analysis, ortho-P monoesters were the primary organic P species for the allophanic and non-allophanic Andisols, although it was 2-folds more abundant in the latter than the former. In the non-allophanic Andisols, myo-inositol hexakisphosphate, an ortho-P monoester, was accumulated in the 1.8-2.25 cm^{-3} fraction.

キーワード: リン, NMR, 化学種
Keywords: phosphorus, NMR, chemical speciation

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-05 会場:104 時間:5 月 27 日 11:15-11:30

日本の海洋島において野生化ヤギと海鳥の活動が表層土壌の化学的特性におよぼす影響

Influence of feral goat and seabird activities on chemical properties of surface soils on an oceanic island in Japan

平舘 俊太郎 [1*] ; 森田 沙綾香 [1] ; 畑 憲治 [2] ; 大澤 剛士 [1] ; 須貝 杏子 [2] ; 可知 直毅 [2]
HIRADATE, Syuntaro[1*] ; MORITA, Sayaka[1] ; HATA, Kenji[2] ; OSAWA, Takeshi[1] ; SUGAI, Kyoko[2] ; KACHI, Naoki[2]

[1] 独立行政法人農業環境技術研究所, [2] 首都大学東京
[1]National Institute for Agro-Environmental Sciences, [2]Tokyo Metropolitan University

Ogasawara Islands, subtropical oceanic islands in north-western Pacific of Japan, have been listed as Natural World Heritage by UNESCO since 2011 because of their valuable ecosystems sustaining many indigenous spices including plants and snails. Nakoudojima Island and its peripheral reefs are the important components of the heritage, but the island has been exposed to the serious influence of soil erosion damaging the indigenous ecosystems. Many areas on the island have been covered with native forests before the introduction of goats (*Capra hircus*) of ca. 200 years ago. The introduced goats had been naturalized on the island since 1945 at the latest, and they had destroyed the native vegetation by grazing and trampling, resulting in a shift of the native forests into grasslands and loss of the surface soils. To fix the problem, all the feral goats on the island had been eradicated in 1999. Although the recovery of seabird nesting for brown booby (*Sula leucogaster*) and wedge-tailed shearwater (*Puffinus pacificus*) has been observed, the soil erosion has still been serious and plant biomass has been very low in some places on the island at least in 2014.

To conserve the indigenous natural ecosystem and help the recovery of the natural vegetation, we conducted field survey and investigated the chemical properties of surface soil (0 – 5 cm) and aboveground plant biomass in relation to the topography of this island. Under grassland vegetation where influence of feral goat would have been severe, the chemical properties of surface soils, such as soil pH value, total C and N contents, exchangeable acidity, and plant-available phosphate (Bray II P), were highly variable even in a small area. By comparing soil profile characteristics under natural and disturbed vegetation and distribution patterns of these soils on the island, the changes in the soil chemical properties were reasonably assigned to the effect of soil erosion caused by feral goats for increased soil acidity (mainly found in inland valley area) and to the effect of seabird activities for increased Bray II P and soil acidity (mainly found in outer rim area with high altitude). It was also clarified that the high soil acidity was significantly related to the low productivity of plant biomass. Soil erosion would have removed surface soils having weak acidity and exposed subsoils having strong acidity to the ground surface, resulting in inhibition of plant growth and delay of vegetation recovery. Based on the findings obtained in the present study, several options were proposed to stop soil erosion and to recover the vegetation, although careful preliminary examination would be necessary for applying them.

キーワード: 媒島, 世界自然遺産, 土壌中の植物有効態リン酸, 土壌の置換酸度, 外来種, 土壌流出
Keywords: Nakoudojima Island, natural world heritage, plant-available phosphate in soils, soil exchangeable acidity, exotic species, soil erosion

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-06 会場:104 時間:5 月 27 日 11:30-11:45

日本におけるテフラ由来土壌の生成
Pedogenesis of tephra-derived soils in Japan

井上 弦 [1*]
INOUE, Yudzuru[1*]

[1] 埼玉大学大学院理工学研究科
[1]Graduate School of Science and Engineering, Saitama University

In Japan, there are still 110 active volcanoes today, which occupy approximately 7 percent of those in the world. Some volcanoes in Japan are erupting now and continuing deposition of tephras on the land surface. They will become the parent material of the soils. Of the soils in Japan, tephra-derived soils 'Kuroboku soils (Andosols/Andisols)' are the second-most common group under the main classification scheme in usage, *the Unified soil classification system of Japan* (FCSCN, 2003). Many tephra-derived soils are distributed near and around numerous volcanoes in Japan. Tephra-derived soils composed of black soils (abundant humic soils), brown soils (mainly brown loamy soils: including tephric loess and loess), and Regosols (Tephric) (FAO, 2006) (very weakly developed mineral soils). It has been suggested that the black soils develop when the supply of organic matter by Gramineae grass exceeds the rate of addition of tephra parent materials (Inoue, 2002). It is usually stabilized by the formation of allophane and Al- (or Fe-) humus complexes. Origin of the abundant humus is confirmed by the high correlation between organic carbon content and phytolith content of Gramineae grass (Inoue et al., 2000; 2001 etc.). Most of the Japanese Holocene tephra-derived soils are rich in humus. Older buried humic-rich soils can also be observed in Late Pleistocene tephra-soil sequence in Japan (Inoue et al, 2011a). One of the tephra-derived soils 'brown soils' having poor in humus include an aeolian-reworked tephras (tephric loess; Pullar and Pollok, 1973) as main parent material. Tephric loess occurs in tephra-soil sequences in Japan and is also interlayered with 'background' loess derived from long-term (continuously-deposited) loess (aeolian dust) deposition from Gobi, Taklamakan desert, and the loess plateau in central Asia (Inoue and Naruse, 1987). This loess is barely observed in Japan. Sase and Hosono (1996) shows that pedogenesis of brown soils occurs under the forest vegetation by using vegetation changes from phytolith composition in tephra-soil sequence.

Pedogenesis includes both 'topdown' and 'upbuilding' models (Almond and Tonkin, 1999; Lowe, 2000; Inoue, 2001). Topdown pedogenesis is 'classical' soil formation that occurs by leaching, illuviation, and other processes that form andic materials with horizons developing in a downward-moving front. Upbuilding pedogenesis operates where the soil forms while additions to the soil surface of such materials as tephra or loess occur. If additions are sufficiently slow — typically as thin incremental deposits in distal areas — then topdown pedogenesis continues while the land surface slowly rises (referred to as 'developmental upbuilding'). If additions are thick or frequent, as typically occurs nearer volcanic sources, then the antecedent soil is buried and isolated, and soil formation begins again on the new materials at the land surface ('retardant upbuilding') (Inoue et al., 2011b; Lowe et al., 2008). The profile character is thus determined by the interplay between the rate at which tephras are added to the land surface and topdown processes. Understanding Andosol/Andisol genesis thus often requires a stratigraphic approach combined with an appreciation of buried soil horizons and polygenesis (Lowe and Tonkin, 2010). The terms 'developmental upbuilding' and 'retardant upbuilding' were first used by Johnson and Watson-Stenger (1987) and Johnson et al. (1990) as part of their dynamic-rate model whereby soils evolve by 'ebb and flow' through time (Schaetzl and Anderson, 2005). As mentioned above, most of the tephra-derived soils in Japan are formed by upbuilding pedogenesis and may be described as multisequal soils.

At the present day, theories concerning pedogenesis of tephra-derived soils in Japan are changing from long-established theories. The soils in the regions having numerous active volcanoes occur distinctive pedogenesis unlike in non-volcanic regions.

キーワード: 土壌, テフラ, 土壌生成, テフラ由来土壌, 黒ぼく土, 植物珪酸体
Keywords: soil, tephra, pedogenesis, tephra-derived soil, Andosols/Andisols, phytolith

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-07 会場:104 時間:5 月 27 日 11:45-12:00

7300 年前のアカホヤ火山灰堆積後に降水量と気温が屋久島の土壌―植生系の形成に与えた影響
Effect of climate on vegetation-soil system after volcanic ash deposition 7300 years ago on Yakushima Island

向井 真那 [1*] ; 相場 慎一郎 [2] ; 北山 兼弘 [1]
MUKAI, Mana[1*] ; AIBA, Shin-ichiro[2] ; KITAYAMA, Kanehiro[1]

[1] 京都大学大学院農学研究科, [2] 鹿児島大学大学院理工学研究科
[1]Graduate School of Agriculture, Kyoto University, [2]Guraduate School of Science and Engineering, Kagoshima University

屋久島では現在、標高傾度に沿って植生の垂直分布が見られる。7300 年前に屋久島の北西 20km に位置する鬼界カルデラの噴火により噴出したアカホヤ火山灰がほぼ全域に堆積し、当時の植生は壊滅的な影響を受けたと言われる。従って、現在の屋久島の植生は 7300 年間の土壌生成とともに垂直的に分化、成立したものと考えられる。陸上生態系（土壌－植生系）の形成には、気候、地形、生物、母材、時間という 5 つの独立した要因が関わる。屋久島では母材や時間が一定であり、現在の植生垂直分布には気候が大きな影響を及ぼすと考えられるが、気温と降水量のどちらがより強く関わっているのかは明らかではない。そのため、7300 年前に火山灰が堆積した後、気温と降水量が土壌－植生系の成立に与えてきた影響について、土壌栄養塩とリターの栄養塩利用効率との関係を通して検証することを本研究の目的とした。

異なる標高に設定した 7 つの永久調査地から表層土壌（0-10、10-20cm）を採取し、これらの土壌の化学分析を行った。Tiessen & Moir（1996）のリン連続抽出法に従いリンを分画し、画分毎のリン濃度を決定した。また、土壌から 1.5N の KCl 溶液を用いて交換態陽イオンと無機態窒素を抽出し、それらの濃度を決定した。これらの森林から新鮮なリターを採集し、リター中のリンと窒素の濃度を測定した。リター生産におけるリンと窒素の栄養塩利用効率として、リターのリンと窒素の濃度の逆数を使用した。得られた値と、降水量と気温との関係を調べた。降水量と気温は、国土交通省国土政策局が公表している国土数値情報平年値メッシュデータを各森林の GPS 情報と照合して入手した。

土壌の全リン濃度と無機態窒素濃度は、それぞれ降水量よりも気温と強い相関があった（リン：R=0.77 p<0.05、 窒素：R=0.72 p=0.07 （10-20cm 深　気温との相関））。リンの画分の中で、特に吸蔵態リンは温度と有意な正の相関が見られた（R=0.76 p<0.05（10-20cm 深））。一方、土壌中の交換態カルシウムとマグネシウムの濃度は、気温よりも降水量との相関が強かった（カルシウム：R=-0.88 p<0.01、マグネシウム：R=-0.86 p<0.05（10-20cm 深　降水量との相関））。また、土壌全リン濃度と無機態窒素濃度にはそれぞれの栄養塩利用効率と負の相関があった（リン：R=-0.82 p<0.05、窒素：R=-0.68 p=0.09）

リンは森林生態系では閉鎖的に循環し、系外からの加入は少ない。屋久島は土壌生成年代が 7300 年と新しく、現在の表層土壌中に含まれるリンのほとんどが火山灰由来だと考えられる。Walker & Syers （1976）の土壌生成に伴うリンの形態変化のモデルによれば、土壌生成とともに、土壌中の全リン濃度や一次鉱物由来のカルシウム態リンは減少し、植物の利用しにくい吸蔵態リンは増加する。本研究では、土壌風化がより進むと思われる低標高ほど吸蔵態リンが増加したが、全リンは増加するという結果が得られた。さらに、火山灰供給時の形態として最も多いカルシウム態リンは土壌風化が進むと思われる低標高ほど多かった。これらの結果は Walker & Syers （1976）の示したモデルと異なり、温度と降水量が、風化と栄養塩の溶脱に複雑に影響し、現在の土壌リンの標高パターンが形成されている可能性が示唆された。

本研究の調査地における降水量は年間 3700-4800mm で標高との間に相関関係はなかった（R=-0.21 p=0.66）。高標高では降水が蒸発散量を上回り、土壌有機物の分解とともに酸素が消費されるため、より還元的な環境となる。さらに高標高では土壌 pH が低いために、酸性で可溶化する一次鉱物のリン酸カルシウムが溶脱し、鉄やアルミニウム、さらにそれらに結合するリンの溶脱が促進されたと思われる。その結果、全リンも高標高ほど低下したのであろう。一方、ある程度の蒸発散量が見込まれる酸化的な低地では、全リンが維持されるとともに吸蔵態リンの生成が進んだと考えられる。従って、温度と降水量の効果には複雑な関係が想定されるが、植物にとって可給性の高い無機態リン画分や土壌無機態窒素濃度は低標高ほど高かった。これには温度の窒素無機化に対する直接的な影響と、リン可給性を介在した間接的な影響の 2 つが考えられる。今回はこれらの影響の分離はできなかった。

このように土壌中のリンと無機態窒素は、降水量よりも標高の影響を強く受けた結果、温度に応じて濃度勾配が形成されたと考えられる。これがリンと窒素の可給性を支配するために、森林のリン利用効率と窒素利用効率に大きな影響を及ぼす結果が得られたのであろう。このような土壌の影響が、植物への温度の直接的影響に加わり、屋久島の植生垂直分布が形成された可能性が示唆された。

キーワード: リン, 火山灰, 栄養塩利用効率, 気候, 土壌生成過程, 栄養塩循環
Keywords: Phosphorus, Volcanic Ash, Nutrient-use efficiency, Climate, Pedogenesis

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-08 会場:104 時間:5 月 27 日 12:00-12:15

日本のアロフェン質黒ボク土に含まれる雲母の起源と放射性セシウム固定能に関する研究
Origin of mica in Allophanic Andosols in Japan and its role as a radiocesium fixing material

中尾 淳 [1*] ; 中尾 彩 [2] ; 田中 亮吏 [3] ; 矢内 純太 [1]
NAKAO, Atsushi[1*] ; NAKAO, Aya[2] ; TANAKA, Ryoji[3] ; YANAI, Junta[1]

[1] 京都府立大学大学院生命環境科学研究科, [2] 京都府立大学生命環境学部, [3] 岡山大学地球物質科学研究センター分析地球化学部門
[1]Graduate School of Life and Environmental Sciences, Kyoto Prefectural University, [2]Faculty of Life and Environmental Sciences, Kyoto Prefectural University, [3]Institute for Study of the Earth's interior, Okayama University

The accident at the Fukushima Daiichi Nuclear Power Plant in March 2011 has turned attention to the fate of radiocesium (RCs) in soils in Japan. Allophanic Andosols are common soils in Japan, which generally have clay mineralogy rich in low crystalline minerals such as allophane and imogolite. Since RCs is not adsorbed strongly on these minerals, Allophanic Andosols are assumed to have very low RCs retention ability. The objective of this study is to elucidate the relationship between RCs retention ability and mineralogical properties of Allophanic Andosols in Japan. We hypothesized that trace amount of micas are deposited as a loess component even in Allophanic Andosols, which control the RCs retention ability.

Twenty-three soil samples were collected from a plow layer (0-15 cm) of either paddy or upland fields distributing at alluvial plains in Hokkaido, Tohoku, Kanto, and Kyusyu districts, representative areas of Allophanic Andosols. Particles with a size of 2-20 μm and $<$2.0 μm were fractionated from the soils by sedimentation method. RCs retention ability for each particle was represented by the Radiocesium intereception potential (RIP). Quartz content was estimated by random powder X-ray diffraction analysis for 2-20 μm particles with adding α-Al_2O_3 as an internal standard. Mica content in 2-20 μm particles was estimated by the amount of potassium extracted by fusion with $NaHSO_4$, whereas that in $<$2.0 μm particles was estimated by K extracted by digestion with HF-$HClO_4$. Quartz was isolated from 2-20 μm particles by the selective dissolution with H_2SiF_6, and then $\delta^{18}O$ value for the isolated quartz was determined to estimate the origin.

The RIP value for 2-20 μm and $<$2 μm fractions was 1.7$\pm$0.8 mol kg^{-1} and 2.6$\pm$1.3 mol kg^{-1}, respectively. Mica-K content in the respective fractions was 3.2$\pm$1.3 g kg^{-1} and 3.4$\pm$1.7 g kg^{-1}. These values are considerably small compared with those for fine particles in non-volcanic soils. The RIP positively correlated with mica-K content for each fraction, indicating that RCs retention ability is mainly controlled by the amount of micas, in spite of its minority as a mineral component. The mica-K content is proportional to the quartz content, suggesting that the origin of these minerals would be the same. Furthermore, $\delta^{18}O$ value for the isolated quartz was +14.8 ‰ on average with a range of +10.8 to +16.1 ‰, which is clearly higher than those of volcanic materials while similar to those of Chinese loess. Thus, this study strongly indicated that the RCs retention ability of Allophanic Andosols is largely controlled by loess-derived micas.

キーワード: 風成塵, 酸素同位体比, 放射性セシウム捕捉ポテンシャル, アロフェン質黒ボク土, 雲母
Keywords: loess, oxygen isotopic analysis, Radiocesium Interception Potential, Allophanic Andosol, mica

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-09 会場:104 時間:5 月 27 日 14:15-14:30

森林流域の窒素飽和現象解明のための今日的なアプローチと戦略
Relevant approaches and strategies for investigation on the nitrogen saturation in forested catchments

大手 信人 [1*] ; 磯部 一夫 [2] ; 徳地 直子 [1]
OHTE, Nobuhito[1*] ; ISOBE, Kazuo[2] ; TOKUCHI, Naoko[1]

[1] 京都大学, [2] 東京大学
[1]Kyoto University, [2]University of Tokyo

After the Industrial Revolution, global scale nitrogen (N) cycle has drastically been altered by increase of anthropogenic N emissions to the atmosphere. Inorganic N concentration in atmosphere and their depositions reached unprecedented level in Europe, northeast United States and northeast Asia. These have caused ”Nitrogen Saturation” in the forested areas within the high N deposition regions of Europe, North America, China and Japan. Mechanisms of nitrogen saturation have previously been studied from biogeochemical point of view. N dynamics in catchment-scale, however, could not be described sufficiently, because geographical variations of catchment characteristics such as climatic and hydrologic properties are generally large and their effects provide various aspects of responses in high nitrogen depositions. We propose new strategies based on multi-aspects approach combining microbial ecology and catchment hydrology to reconstruct the mechanistic understandings on previously reported ecosystem level biogeochemical responses to the environmental changes such as high N inputs. Combined applications of novel isotopic tracer techniques and newly advanced functional gene analysis onto the multiple forest landscapes will provide us insightful information on spatiotemporal heterogeneity and non-linear responses of N dynamics related to the N saturation phenomena in forest catchments.

キーワード: 森林流域, 窒素飽和, 微生物生態学, 同位体トレーサー, 水文課程
Keywords: forested catchment, nitrogen saturation, microbial ecology, isotope tracer, hydrological processes

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-10 会場:104 時間:5 月 27 日 14:30-14:45

メタトランスクリプトーム解析から見た水田土壌の炭素・窒素循環とそれを駆動する微生物

Carbon and nitrogen transformation and their driving microorganisms in paddy soil, as assessed by meta-transcriptomics

田伏 曜子[1*] ; 伊藤 英臣[2] ; 白鳥 豊[3] ; 磯部 一夫[1] ; 大塚 重人[1] ; 妹尾 啓史[1]
TABUSHI, Yoko[1*] ; ITOH, Hideomi[2] ; SHIRATORI, Yutaka[3] ; ISOBE, Kazuo[1] ; OTSUKA, Shigeto[1] ; SENOO, Keishi[1]

[1] 東京大学大学院農学生命科学研究科, [2] 産業技術総合研究所　北海道センター, [3] 新潟県農業総合研究所
[1]Graduate School of Agricultural and Life Sciences, The University of Tokyo, [2]National Institute of Advanced Industrial Science and Technology (AIST) Hokkaido, [3]Niigata Agricultural Research Institute

水田土壌は水管理により大きな環境変動を受ける。土壌が湛水されると大気から土壌への酸素の供給が緩やかになり、日数の経過とともに表層において酸化層と還元層の分化が起こる。酸化層では好気的環境が維持されており、硝化・メタン酸化などの酸化反応が進行する。還元層は、土壌への酸素の供給速度よりも土壌中での消費速度が上回り、次第に酸素が枯渇して嫌気的な環境が形成される層である。この過程において、脱窒・マンガン還元・鉄還元・硫酸還元・メタン生成といった異化的な還元反応が逐次的に進行する。主として微生物によって駆動されるこれらの酸化還元反応は土壌中の炭素・窒素などの物質循環に重要であり、土壌の肥沃度、水稲生育、地域・地球環境と深く関わっている。従って、水田土壌で活発な微生物群集や、物質循環に関わる機能遺伝子群の転写状況と多様性、それらの変遷を詳細に明らかにすることで、水稲生産性の維持向上や環境保全につながる基礎的知見が得られると期待される。

本研究では、水田から経時的に採取した酸化層・還元層それぞれの土壌について土壌 RNA の超大規模シーケンス解析（メタトランスクリプトーム解析）を行った。rRNA 解析から各層において活発な微生物群集の構造と変動を、mRNA 解析から炭素・窒素循環に関わる機能遺伝子の転写量、持ち主と推定される微生物群とその変動を調べた。メタトランスクリプトーム解析から見えてきた水田土壌微生物と炭素・窒素循環について報告する。

キーワード: 土壌微生物群集, メタトランスクリプトーム, バイオインフォマティクス, 水田, 炭素窒素循環
Keywords: soil microbial communities, metatranscriptome, bioinformatics, paddy soil, CN cycle

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-11 会場:104 時間:5 月 27 日 14:45-15:00

耕作放棄が生態系炭素プールに与える影響
Agricultural abandonment influences the ecosystem carbon pools

下田 星児 [1*] ; 和穎 朗太 [2]
SHIMODA, Seiji[1*] ; WAGAI, Rota[2]

[1] 農研機構 北海道農業研究センター芽室研究拠点, [2] 農業環境技術研究所
[1]NARO Hokkaido Agricultural Research Center Memuro, [2]National Institute for Agro-Environmental Sciences

Land abandonment, which is increasing globally, has significant impact on terrestrial carbon (C) budget, vegetation, and biodiversity. Invasive alien plants often outcompete native plants after agricultural abandonment, which can lead to the alteration in ecosystem C and nutrient balance. Perennial plants have been an exceptionally successful invader in agricultural abandoned fields around the world. Irrespective of soil nutrient status, alien plants rapidly dominates abandoned agricultural fields in the temperate regions. While negative impact of alien plants on local and regional biodiversity is well established in conservation ecology, its impact on C sequestration potential is much less studied. Paddy fields used for rice (Oryza sativa L.) production are the dominant human land-use systems for a long time throughout Japan. Japan has increased to nearly 10% of the total cultivated land area. The aim of the present study was to investigate how the rice paddy abandonment influenced the storage of C in ecosystem components during the secondary succession over decadal time scale.

If paddy fields, the typical agricultural land in Japan, are left abandoned, the amount of soil C in the abandoned fields up to 20 years after being abandoned is lower than that of paddy fields under cultivation. If the field is abandoned for a long time, the amount of soil C increases due to organic matter from weeds, but it is considered that the process will take more than 20 years. We hypothesize that the invasion of alien plants to the abandoned paddy fields enhances ecosystem C storage by their high N use efficiency and high productivity. As results, the temporal change in soil C was similar among vegetation type through amount of input C was similar in present study.

キーワード: 土地利用変化, 水田, 草原, 侵入, リター
Keywords: land use change, paddy, grassland, invasive alien plants, litter

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-12 会場:104 時間:5 月 27 日 15:00-15:15

環境変化に対する土壌炭素応答：温暖化応答およびプライミング効果を例に
Responses of organic carbon in a variety of soils controlled by temperature and cellulose supply

飯村 康夫 [1*]
IIMURA, Yasuo[1*]

[1] 滋賀県大環境科学
[1]The University of Shiga Prefecture

Carbon stored in the upper meter of mineral soils is estimated to be 2500 Gt, which is approximately 3.3 times the size of the atmosphere and 4.5 times the size of the vegetation. Therefore, soil organic matter is often considered as a significant carbon reservoir on the earth′s surface. Although changes in soil organic carbon contents (by natural or anthropogenic causes) have a significant impact on the global carbon cycle, the mechanisms of soil organic carbon stabilization and destabilization and the factors controlling these mechanisms are not very well understood. We thus focused on the response of organic carbon in a variety of soils (black soil, brown soil, and red-yellow soil, etc.) controlled by temperature and fresh carbon (cellulose) supply. In addition, we considered the factors controlling the temperature sensitivity and priming effect.

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-13 会場:104 時間:5 月 27 日 15:15-15:30

比重分画法と安定同位体トレーサー法を用いた土壌有機物安定化プロセスの定量的解析：火山灰土壌と熱帯強風化土壌の比較
Organic matter stabilization in Andisol and Ultisol revealed by isotopic tracer experiment and density fractionation

早川 智恵 [1*] ; 和穎 朗太 [2] ; 稲垣 善之 [3] ; 浅野 眞希 [2]
HAYAKAWA, Chie[1*] ; WAGAI, Rota[2] ; INAGAKI, Yoshiyuki[3] ; ASANO, Maki[2]

[1] 東大院農, [2] 農環研, [3] 森林総研
[1]Univ. Tokyo, [2]NIAES, [3]FFPRI

For predicting C cycling in terrestrial ecosystem, dynamics of organic matter (OM) in soil can be a large component that increases uncertainty. Once OM is supplied into soil system mainly as plant detritus and root exudates, OM is decomposed by microorganisms and a proportion of OM is stabilized through association with soil mineral particles. The OM in soils has a wide range of size, density, and chemical reactivity. Organo-mineral particles of heavy-density fraction are highly resistant against microbial degradation compared to mineral-free OM (i.e., plant detritus and low-density fraction). The high C sequestration capacities of soils (e.g., Andisol) are hypothesized to be regulated by incorporation rates of microbial-processed OM into heavier fraction. To test this hypothesis, we conducted incubation experiment using tracer to quantify the pool sizes, influx and efflux rates, and mean residence times (MRTs) of different density classes.

Different types of soils were sampled from two agricultural lands; a volcanic-ash soil (Andisol) from Japan and a highly-weathered tropical soil (Ultisol) from Indonesia. The incubation experiments were carried out after addition of ^{13}C-labelled glucose (99 ^{13}C atom%, 0.1915 mmol ^{13}C g 1soil as solution) or ^{13}C, ^{15}N-labeled glutamic acid to the soils (2-mm sieved, 5 g dry weight). The soils were incubated for 276 d at 30oC and 50% water holding capacity. After the incubation, soil was separated into three fractions according to its density using sodium polytungstate as heavy liquid: low ($<$1.8 g cm^{-3}), middle (1.8-2.25 g cm^{-3} for Andisol, 1.8-2.5 g cm^{-3} for Ultisol), high ($>$2.25 g cm^{-3} for Andisol, $>$2.5 g cm^{-3} for Ultisol) density fractions. We measured the mass, isotopic ratios (^{13}C/^{12}C, ^{15}N/^{14}N) and total C and N concentrations of the density fractions as well as the amount of CO_2 respired during the incubation by alkali trap method. We also measured the specific surface areas (SSA) of soil minerals and the concentrations of Al, Fe oxides/hydroxides.

For both soils, ca. 70 to 80 % of added ^{13}C were mineralized to CO_2 within 1 month after substrate addition. The density fractionation showed that 13C recovery in the low-density fraction was low (0.5 - 3.8%) throughout the incubation period. The ^{13}C recovery within the mid- and high-density fractions was greater than 20%. This indicates that labile substrates were immediately incorporated into the mid- and high-density fractions through microbial processing in the both soils. The highest ^{13}C recovery was observed in the mid-density fraction of Andisol and in the high-density fraction of Ultisol, respectively. MRTs of ^{13}C in the density fractions positively correlated with SSAs for respective soil types. This can be explained by differences in mineralogy which contribute to OM stabilization through sorption; short-range-order minerals (e.g., allophane and imogolite) in Andisol and iron oxides in Ultisol, respectively. Our results support the hypothesis that newly-added OM is stabilized through association of microbial metabolites with mineral particles. However, dominant density class and turnover of stabilized OM could be variable depending on soil types and clay mineralogy with high specific surface areas.

Keywords: 13C-glucose, 13C, 15N-glutamic acid, Andisol, Ultisol, organo-mineral particle

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-14 会場:104 時間:5 月 27 日 15:30-15:45

環境中におけるタンニンの構造と機能の変化
Changes in the structure and function of tannins in natural environments

眞家 永光 [1*]
MAIE, Nagamitsu[1*]

[1] 北里大学獣医学部
[1]School of Veterinary Medicine, Kitasato University

Tannins are polyphenols that are contained in plants where they can account to 20% of the plant dry weight depending on its species and organs. Tannins are known to bind to proteins, making insoluble complexes that are resistant to microbial degradation. While tannins are considered to play various roles in ecosystems, we are not fully understand the dynamics and functions of tannins in them. Here, I would like to present the changes in the structure and function of tannins in water and soil environments. Furthermore, their possible influence on nitrogen cycling in mangrove ecosystems will be proposed.

Molecular structure and protein binding ability of CT changes during the decomposition of foliage (Maie et al. 2003)
Tannins are classified into two subgroups, condensed tannins (CT) and hydrolysable tannins (HT). CT are mixtures of polymers of flavan-3-ol units with different degrees of polymerization and mostly hydroxyl substitutions. Molecular structure of CT in foliage changes during the decomposition of foliage. CT molecules composed of prodelphinidin unit (PD), which has more hydroxyl groups than procyanidin (PC), are more susceptible to structural changes. Structural change of CT accompanied with the decrease of protein-binding ability.

Tannins are important source of DOM leached from litter, especially at the early stage of decomposition (Nishimura et al. 2012)
Dissolved organic matter (DOM) leached from litter may contain tannin-derived materials. Since tannins are water-soluble and has wide structural variety among different species, DOM composition in leachate is most diverse at the early stage of the decomposition, but converge into relatively similar composition by time when lignin-degradation products become a major source of DOM.

Tannins-protein complex may contribute to nitrogen cycling in mangrove ecosystem, acting as a delayed release fertilizer (Maie et al., 2008)
Fate of CT leached into water environments can be variable. They may aggregate in saline water, adsorb to sediment, and complex with proteins. CT change their chemical structure quickly in water, becoming ”invisible” to analytical window. CT-protein complexes are refractory to microbial degradation, but photo-reactive. By exposing CT-protein complexes to sun light, proteins can be released into water. In mangrove estuary, a large amount of tannins and proteins could be released into water in a relatively short period when leaves fall into water. CT might be contributing to preserve N in mangrove ecosystem, by acting as a delayed release fertilizer.

References
Maie et al. 2003. Soil Biology & Biochemistry 35, 577-589.
Maie et al., 2008. Limnology & Oceanography 53, 160-171.
Nishimura et al. 2012 J. Environ. Quality 41, 823-833.

キーワード: 溶存有機物, 構造変化, タンパク質結合能, マングローブ湿地, 窒素サイクル, 森林生態系
Keywords: dissolved organic matter, forest ecosystem, mangrove estuary, nitrogen cycling, protein binding ability, structural change

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-15 会場:104 時間:5 月 27 日 15:45-16:00

シベリア永久凍土域におけるタイガ林の有機物層の生分解と養分供給ポテンシャル
Nutrient release during biodegradation of organic horizons in the Siberian taiga underlain by continuous permafrost

川東 正幸 [1*] ; プロクシュキン アナトリ [2] ; 隅田 裕明 [3]
KAWAHIGASHI, Masayuki[1*] ; PROKUSHKIN, Anatoly[2] ; SUMIDA, Hiroaki[3]

[1] 首都大学東京大学院　都市環境科学研究科, [2] ロシア科学アカデミースカチェフ森林研究所, [3] 日本大学生物資源科学部
[1]Graduate School of Urban Environmental Sciences, [2]Sukachev Institute of Forest, Rossia Academy of Science, [3]College of Bioresource Sciences, Nihon University

Organic horizons under the Siberian taiga forest have a significant role of nutrient supply for plants through their biodegradation processes and of heat insulation for permafrost table underneath shallow mineral soil layer. Lower weathering stages of mineral soils underlain by permafrost have lower potential of soil nutrient retention and release, indicating that summer growing vegetation can expect to fill their nutrient requirements released by organic matter degradation. Decomposed organic matter can supply mineral and biogenic nutrients to plants and microorganisms. Organic horizons often suffer from frequent forest fire in the Siberian forest. Forest fire moves through organic horizon on the ground because of low tree density in the forest stands. Relatively low burning temperature can leave organic residue on the forest ground. Ground temperature during forest fire is a key variable for changes in properties of organic horizons. Solutes release potential and biodegradability of organic horizons was evaluated in this study along with heating temperature gradient. To estimate the effect of forest fire on the biodegradation processes of organic horizons, we prepared organic horizon samples heated between 65^{o}C and 550^{o}C under a relatively oxygen limited atmospheric condition.

A sampling site located in the Evenkia province in the central Siberia. Soils are classified as Oxyaquic Cryosols or Gelic Cambisols according to the WRB classification system. Organic horizon samples were taken depending on hummock topography. Air-dried and powdered samples were heated in a muffle furnace between 105 and 550^{o}C for 15minites. Organic residues were applied to incubation experiment to evaluate biodegradation and solutes release. Biodegradation was evaluated from mineralization rates being calculated using temporal changes in CO_2 concentration during an incubation experiment and total organic carbon content in heated solid samples. During the same incubation time course, biogenic elements released from the heated samples were determined after water extraction by ICP-AES, Ion-chromatography and TOC-L with total nitrogen module unit.

Solutes release from heated organic horizon samples by water saturation was different between samples depending on the heating temperature. Larger amount of nutrient elements were released from organic horizons taken from trough points on the hummock. Samples heated at 250^{o}C released the highest amount of solutes mainly dominated by dissolved organic C. Basic cations and major anions including phosphate, nitrate and chloride were also largely released from the sample heated at 250^{o}C. Higher the heating temperature was, solutes concentration was lower. Solution pH was higher with increasing the heating temperature. The ratios of carbon to nitrogen in solid samples were decreased with increasing the heating temperature. The temperature dependence of solutes release was different along with hummock topography.

The maximum mineralization (%) was approximately 4% of total C in samples heated at lower temperature below 180^{o}C. The mineralization rate was not largely different between samples, indicating that the biodegradation process in all heated samples mainly depends on the amounts of easily decomposable carbon source, such as DOC. There are significant correlations between the maximum mineralization rate and DOC or inorganic N. Solutes mainly consisting of nutrients and energy source for microorganisms can be a significant controlling factor for the biodegradation process of organic horizons. The difference in solutes composition and the biodegradation were mainly depending on heating temperature of organic horizons. Heating temperature during a forest fire is an important parameter controlling the further degradation of organic matter in organic horizons and the fate of carbon dynamics in the boreal permafrost affected forest region.

キーワード: 森林火災, 生分解性, 連続永久凍土域, 植物栄養, 火災温度, 腐植物質
Keywords: Forest fire, Biodegradation, Continuous permafrost terrain, plant nutrition, burned temprature, humic substances

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-16 会場:104 時間:5 月 27 日 16:15-16:30

アラスカ内陸部クロトウヒ林の土壌有機物の物理的組成と斜面内の変動
Variation in physical composition of soil organic matter in black spruce forests within a slope in Interior Alaska

鳥山 淳平 [1*] ; 田中 小田 あゆみ [1] ; 森下 智陽 [1] ; 松浦 陽次郎 [1] ; Hinzman Larry D.[2]
TORIYAMA, Jumpei[1*] ; TANAKA, Ayumi O.[1] ; MORISHITA, Tomoaki[1] ; MATSUURA, Yojiro[1] ; HINZMAN, Larry D.[2]

[1] 森林総合研究所, [2] 国際北極圏研究センター
[1]Forestry and Forest Products Research Institute, [2]International Arctic Research Center

In boreal region, rapid climate warming compared to lower latitude region can accelerate decomposition of soil organic matter (SOM) and, together with an increase in active layer depth, shift patterns of nutrient use and growth of boreal forests. In discontinuous permafrost region of Interior Alaska, black spruce (*Picea mariana*) grows in environments with various active layer depths and different degree of nutrient limitation. These environmental gradients can also be obtained from different positions in a single slope where climatic condition and fire history are similar. To clarify accumulation pattern of SOM and its relationship to tree growth and slope position, we set a transect plot of 1.5km-long in black spruce forests in Caribou Poker Creek Research Watershed. Tree growth rate at lower altitude (250 m) with shallow active layer in growing season is low compared to that at higher altitude (450 m) with deep active layer. We collected samples from organic layers and mineral soil horizons in 14 soil profiles. The thickness of organic layer ranged 7 to 45 cm and was not correlated with altitude. Soil samples are separated into light and heavy fractions by density fractionation approach. The light fraction of topsoil (surface horizon of mineral soil) accounted for 269 g kg^{-1} of soil mass and 598 g kg^{-1} of soil organic carbon in average. The relationship between light fraction content of topsoil and slope position was unclear. In the session, we focus on the ^{15}N natural abundance of SOM and other components in the forest ecosystem and discuss the nitrogen cycling in black spruce forests with different growth rates.

キーワード: クロトウヒ, 土壌有機物, 比重分画
Keywords: black spruce, soil organic matter, density fractionation

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-17 会場:104 時間:5 月 27 日 16:30-16:45

永久凍土における有機物および養分循環の制御要因
Controls over turnover of organic matter and nutrients in permafrost soils

藤井 一至 [1*] ; 松浦 陽次郎 [1] ; 藤井 創一郎 [2] ; 稲垣 善之 [1] ; 大澤 晃 [2]
FUJII, Kazumichi[1*] ; MATSUURA, Yojiro[1] ; FUJII, Soichiro[2] ; INAGAKI, Yoshiyuki[1] ; OSAWA, Akira[2]

[1] 森林総合研究所, [2] 京都大学農学研究科
[1]Forestry and Forest Products Research Institute, [2]Graduate School of Agriculture, Kyoto University

Introduction: Plant productivity on permafrost soils is limited by nutrient supply from organic matter. Organic matter decomposition and nutrient release can be limited by cold climate, flooding, and recalcitrance of bryophytes (lichen and moss). Plant-soil association (white spruce on mineral soil, black spruce on organic soil, and shrub tundra on lowland soil) suggests the hypothesis that plant acquisition strategies for nutrient (esp., amino acids/inorganic N) can be matched by nutrient supply from soil organic matter. To test this, turnover of organic matter and nutrient release was investigated for three types of ecosystems in Northwest Territory, Canada; white spruce forest (WSF) on the upland soil derived from glaciofluvial sands, black spruce forest (BSF) and tundra (TND) in lower position on fluvial sediments.

Methods: We measured soil organic carbon (SOC) storage [organic and mineral soil layers (0 to 30 cm)], soil temperature and moisture, aeration index [Eh, free Fe oxides (oxalate-extractable Fe)] of soils, and the decomposition rates of litter (lichen, moss, and root litter) and cellulose filter paper buried in the soils. Regarding soil N dynamics, the concentrations of organic and inorganic N in soil solution (zero-tension lysimeter) were measured. Root uptake of dual-labeled (^{13}C, ^{15}N) glutamic acid, ^{15}N-labeled ammonium, and ^{15}N-labeled nitrate was measured 24 h after spike of mixture solution.

Water dynamics: Episodic flooding events were observed following spring snowmelt at all sites. Rapid snowmelt and water percolation enhanced aeration in the sandy soil profile of WSF, while the BSF and TND soils were saturated by water flooding on impermeable permafrost layer (30 cm deep) even in summer. The seasonal cycles of reducing- and oxidizing- conditions were recorded as accumulation of free Fe oxides in the soils.

C dynamics: The C stocks in the organic and mineral soil layers were greater in TND (188 Mg C ha^{-1}) and BSF (207-237 Mg C ha^{-1}) than in WSF (37 Mg C ha^{-1}). When the regression analysis was conducted for 15 soil profiles, there was a positive correlation between SOC storage and free Fe oxide concentration. The high concentrations of free Fe oxides in soils appeared to be an index of poor drainage and high SOC storage. Mass loss rates of cellulose filter paper, lichenous litter, and root litter followed the order: WSF>TND>BSF. Water flooding and cold climate retarded decomposition of organic matter in BSF and TND. The development of hummocky micro-topography, which was recorded as the tilting of drunken forest, resulted in accumulation of sparingly-decomposable lichen and moss debris in BSF. The warmer and aeration conditions in sandy upland soil of WSF enhanced turnover of organic matter.

N dynamics: Dissolved organic N is abundant in soil solution at all sites. Nitrogen species in soil solution was dominated by nitrate and ammonium ions in TND soil, while it was ammonium in WSF and BSF soils. Regarding N uptake by plants, TND plants (shrub birch and grasses) preferentially absorb inorganic N (ammonium and nitrate), while white spruce and black spruce could also utilize amino acid-N. Both C and N of amino acids were assimilated by white spruce roots, while only ammonium was transferred to roots of black spruce probably after rapid mineralization by mycorrhizae or roots. N preference of plants is consistent with the dominant N species in soil solution.

Conclusions:Water flooding as well as cold climate retarded turnover of organic matter in black spruce forest. Despite slow turnover of organic matter, black spruce can utilize amino acids as well as ammonium. In warmer and aerated sandy soil, white spruce can absorb both amino acids and inorganic N. In the lowland tundra soil rich in inorganic N, plants can absorb inorganic N. This highlights the importance of considering plant-soil association to predict responses of ”sensitive” ecosystem to future changes in flooding, fires, and climate.

キーワード: 永久凍土, 土壌有機物, 溶存有機物, アミノ酸, 微生物
Keywords: permafrost, soil organic matter, dissolved organic matter, amino acids, microorganism

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS03-18 会場:104 時間:5 月 27 日 16:45-17:00

土壌・生態系研究のこれから
Possible future directions in soil and ecosystem research

和穎 朗太 [1*] ; 小崎 隆 [2]
WAGAI, Rota[1*] ; KOSAKI, Takashi[2]

[1] 農業環境技術研究所, [2] 首都大学東京
[1]National Institute for Agro-Environmental Science, [2]Tokyo Metropolitan University

Better understanding of soil is fundamental to enhance sustainability of humankind, to conserve natural environment, and to predict/manage future earth environment. Thus, soil scientists can and should play bigger role beyond the field of agricultural science and collaborate more with the scientists of other disciplines. We will discuss possible future directions that we could take to better understand soil processes in earth system's context.

キーワード: 土壌プロセス, 生物地球化学, 生態系, 生態学, 環境科学, 地球表層プロセス
Keywords: soil process, biogeochemistry, ecosystem, ecology, environmental science, earth surface processe