Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

AGE03-P01 Room:Poster Time:April 30 14:00-15:15

Quantification of soil pollution concentration of plating metals by bioassay using luminous bacteria

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Cd, Cr(6+), Pb, As and CN are substances which closely related to metal plating. These are regulated as Class II Specified Chemical Substances by Soil Contamination Countermeasures Act. However, many other plating metals have not been subject to this law. Some heavy metals, which are used as plating metals, may be harmful to the human body if taken in excess. They must be also assessed risk in the same way as a Class II Specified Chemical Substances.

On the other hand, there is a bioassay using luminous bacteria as one of the acute toxicity evaluation test on hazardous substances. Since there is normally correlation between the concentration of hazardous substances and the intensity of the acute toxicity, it may be possible to estimate the concentration of harmful substances from the intensity of the acute toxic effects.

Focusing on Fe, Ni, Cu, Zn, Ag and Sn which are widely used as common plating metals, in this study, systematic bioassay tests using luminous bacteria (Vibrio fischeri) were performed. Based on the data obtained in the experiments, quantification of the correlation between the concentration of the plating metals and the intensity of the acute toxicity was attempted.

Keywords: Soil contamination, Plating metal, Bioassay, Luminous bacteria, Quantification

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Effects of in-situ, long-term thermal loading on groundwater quality in marine sediments of Arakawa Lowland, Japan

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Subsurface temperature increase (”subsurface warming”) has been documented below many large cities worldwide. The observed subsurface temperature increase has shown close relations with surface warming effects due to global warming and urbanization. Recently, ground source heat pump (GSHP) systems have become popular as a renewable energy technology for space cooling and heating. Operation of GSHP systems for space cooling discharges waste heat into the subsurface environment and, thus, induces additional subsurface temperature increase. However, any potentially negative impacts of GSHP-induced temperature increase on the subsurface environment have not been studied in detail. The objective of this study was therefore to investigate the effects of in-situ, long-term thermal loading on groundwater quality.

A GSHP system was installed in a 50-m deep borehole with a corresponding 50-m long U-tube heat exchanger at the campus of Saitama University in the Arakawa Lowland, Japan. Four groundwater monitoring wells were installed in a marine sand sediment aquifer (around 17-m depth) at 1-m (W1), 2-m (W2), 5-m (W5), and 10-m (W10) distance from the U-tube. At each monitoring well, temperature detectors were placed in 10 depths at approximately 5-m interval, and the subsurface temperature was monitored before and during thermal loading. For the thermal loading, approximately 40 ℃ water was circulated inside the U-tube heat exchanger for 13 months, and groundwater was frequently sampled from all four monitoring wells every 1 to 2 weeks. A wide spectrum of chemical properties (including pH, EC, DO, ORP ”oxidation-reduction potential”, dissolved gases, dissolved organic carbon, inorganic ions, and trace elements) were measured to characterize groundwater quality.

The subsurface temperature at the nearest monitoring well (W1) increased gradually with approximately 8 ℃ from 17 ℃ (base-line) to 25 ℃ during 13 months of thermal loading. In contrast, at the farthest monitoring well (W10), there was no significant change in subsurface temperature, and W10 was therefore selected as a reference (non-temperature affected) monitoring well. A number of chemical components in the groundwater, including boron and potassium, increased markedly at W1 compared to W10. Since marine sediments typically contain high concentrations of chemical components including boron and potassium, the observed increase in groundwater concentration is likely due to thermally-induced dissolution and/or desorption from the marine sediment. The possible mechanisms behind the observed concentration increases will be discussed.

Keywords: subsurface temperature, thermal pollution, long-term thermal loading, GSHP, marine sediment, groundwater quality

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Characterization of water repellency parameters in soil water repellency characteristic curves for JP and NZ soils

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Soil water repellency (SWR) is the phenomenon where soil does not wet when water is applied to its surface. Characterization of water repellency in natural soil is very important to understand the soil hydrological processes, surface flow and infiltration rates. Objectives of this study were (i) to characterize SWR using molarity of ethanol droplet (MED) test, sessile drop method (SDM) and water drop penetration time (WDPT) test, and (ii) to identify the relationships between the determined SWR parameters and soil organic carbon (SOC) contents. Soil samples were collected from different soil depths of representative Andosols and Cambisols in Japan (Nishigo, Hiruzen and Nikko; all sites under forest) and New Zealand (Ngahinapouri, Wahihora and Whatawhata; all sites under pasture). The soil-water contact angle was directly measured using SDM, and indirectly derived from MED and WDPT measurements. All the A horizons of the Japanese soils showed water repellency, and the New Zealand soils were also water repellent at all depths except the Ngahinapouri, B horizon. Then, soil water repellency characteristic curves (SWRCCs) were obtained for water repellent (WR) soils, i.e., soil-water contact angle / degree of WR as a function of the volumetric water content (θ). Three WR parameters were determined from the SWRCCs. They are (i) the integrated areas below a SWRCC, $S_{WR(}\theta), (ii) the soil water content at maximum (\theta_{WR-Max})$ and (iii) minimum (θ_{WR-Min}) WR. Further, WR parameters were studied with soil organic carbon (SOC) contents. These relationships were agreed well with recently published work of Kawamoto *et al*. (2007) and Karunarathna *et al*. (2010). The SOC contents of New Zealand soils varied between 1.4% (WR) to 12.1% (WR), for the Japanese soils they ranged between 2.6% (Non-WR) and 26.3% (WR). Although the Japanese soils had high SOC contents in >10 cm depths, they were not WR (for Nikko >5 cm depth-Not WR). Therefore, further studies are needed to assess SWR as affected by SOC.

Keywords: soil water repellency characteristic curve, water repellency parameters, soil organic carbon

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A result of Cs redistribution in a forest soil after FNP-I accident.

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Cesium is a large atom which does not likely to hydrate. Similar to potassium and ammonium cation it prefers to site at siloxane ditrigonal cavity of silica sheet of phyllosilicates. Cesium is strongly, almost irreversibly, captured at frayed edge site of layered clay particles. These facts may make partition coefficient of cesium to be very large. The large partition coefficient may produce larger retardation of cesium transport with percolating water. At the same time large partition coefficient may cause enhance in migration of Cs with moving colloids. A comparison of Cs content distribution of near surface soil of between cleared forestry and a forestry with 5cm litter layer in Iitate village, Fukushima suggested organic colloids could be a transporter of Cs at litter covered forest. Soil total carbon content as well as C/N ratio had relation with soil Cs content. A depth where soil had higher organic carbon and lower C/N ratio tended to show high Cs content.

Keywords: Cs, forest, soil organic matter, colloids

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AGE03-P05 Room:Poster Time:April 30 14:00-15:15

Observation of Pore Structure for Differently Compacted Landfill Final Cover Soils Using Microfocus X-ray CT

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The final cover soil on a solid waste landfill consists of many layers of materials and is highly compacted. It is used to prevent rain/surface water infiltration in to the waste layer. On the otherhand, the landfill site has a significant emission source of greenhouse gases. Gas and mass transport in soils occurs through the soil pore network, which is highly affected by soil physical properties including compaction, particle size, moisture content and total porosity. However, there are a limited number of studies on visualization and quantification of soil pore network for highly compacted soil like final cover soil. The objectives of this study were setting of microfocus X-ray Computed tomography (CT) for scanning landfill final cover soils in conjunction with 3-D image analysis techniques and analyzing the soil pore structure parameters. In this study, soil samples were collected from landfill site in Saitama prefecture, Japan. Soil pore structure was analyzed using micro focus X-ray CT (Shimadazu inspeXio SMX-90CT, Shimadzu Corporation) for air dried final cover soil samples of particle size (d$\leq$2mm) with different dry densities 1.4, 1.55 and 1.65 gcm^{-3} by a hand compaction. The tested soil texture was silty sand. The scanned images were taken by the micro focus X-ray CT. Then, by the use of software VGStudio MAX, they were reconstructed in 3-D images. Finally, using software of EXFact analysis they were analyzed to obtain pore structure parameters such as pore size distribution, coordination number, specific area and pore-network tortuosity. For determining suitable scanned images for soil pore structure and network, several scanning conditions for the microfocus X-ray CT have been tested i.e. different combinations of voxel size (10, 30 and 50 μmm), scan number, view number, field of view(FOV), region of interest(ROI), and percent of interior pore for pore structure analysis. Base on the results from the tested conditions, we will propose a suitable condition on the microfocus X-ray CT scanning for macropore network (typically, effective pore diameter $>$100 μmm) in differently compacted final cover soils.

Keywords: Microfocus X-ray Computed Tomography (CT), Pore network and structure, Final cover soil

Japan Geoscience Union Meeting 2014
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AGE03-P06 Room:Poster Time:April 30 14:00-15:15

Consolidation characteristics of landfilling waste samples in Japan: Effects of waste compositions and various mixing pr

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Solid waste materials are highly heterogeneous depending on various waste compositions, making it difficult to understand their consolidation characteristics. The purpose of study is to find out effects of waste compositions and mixing proportions on the consolidation characteristics of compacted solid waste materials. In this study, totally 6 different waste materials, un-burnable domestic waste, un-burnable industrial waste, incineration ash, crushed concrete, organic sludge and inorganic sludge, were used as tested materials.

By using the standard proctor test, compaction curves and maximum dry bulk densities were determined for each sample. Compaction results showed that maximum dry bulk densities of the Incineration ash (1.65 g/cm3) and crushed concrete (1.45g/cm3) were higher than the inorganic sludge (0.90 g/cm3) and organic sludge (0.742 g/cm3) respectively. The maximum dry bulk densities for mixed sample of inorganic sludge, concrete and incineration ash were larger than each independent waste sample. In especial, the maximum dry bulk density for the mixed sample with ratio 1:1:1 (dry mass basis) was 1.48 times larger than that for inorganic sludge.

Consolidation tests were carried out for selected pre-compacted waste samples with degree of compaction higher than 90 % after the compaction tests. For the consolidation tests, oedometer test apparatus which dimension of 10 cm diameter and 10 cm height was used for the waste materials with particle size larger than 2mm. Results of each independent sample showed that the coefficient of consolidation (Cv) for crushed concrete and incineration ash was higher than organic and inorganic sludge wastes while compressibility of un-burnable industrial waste was higher than the other materials due to a presence of compressible material. As the mixing ratio of crushed concrete in the mixed samples increased, the compression index (Cc) decreased. When the inorganic sludge and crushed concrete are mixed with the ratio 1:3, the Cc value of the mixed sample decreased up to 75% as compared to the one for only inorganic sludge. In addition, by mixing the inorganic sludge with the crushed concrete, the Cv values for mixed samples increased in the order of 10^{1}~10^{2}. Effect of mixed proportion of the various wastes on consolidation parameters will be further investigated.

Keywords: Compaction, Consolidation, Sludge, landfill

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AGE03-P07 Room:Poster Time:April 30 14:00-15:15

Remediation of a Tsunami affected saline and sodic soil by calsium carbonate and rice straw

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Japanese government recommends leaching of soluble salts as well as adding calcium amendments for remediating saline and sodic soil after Tsunami by the earthquake on March 11, 2011,. Application of calcium carbonate ($CaCO_3$) is recommended for soils having pH lower than 6 and calcium sulfate ($CaSO_4$) is that for pH higher than 6. However, since $CaCO_3$ has low solubility to water, it has not been often used in reclamation of sodic soils (Shainberg et al, 1989).

Solubility of CaCO3 is controlled by CO_2-H_2O-$CaCO_3$ equilibrium in water. The concentration of calcium ion in $CaCO_3$ solution is affected by CO_2 concentration (partial pressure) of air phase. The higher partial pressure of CO_2 causes the higher concentration of Ca^{2+}. In general, addition of organic matter may enhance soil respiration and increase partial pressure of CO_2 in soil. This might potentially enhance solubility of $CaCO_3$ and increase Ca^{2+} concentration in soil solution.

Increase in Ca^{2+} concentration in soil decreases exchangeable sodium percentage (ESP) of the soil. Lower ESP may inhibit soil dispersion and help to keep aggregation. Stability of aggregates has a role on soil permeability, and it affects efficiency of leaching practice.

Objective of this study was to investigate the effect of changes in partial pressure of CO_2 by organic matter decomposition on dissolution of $CaCO_3$, and subsequent Na^+-Ca^{2+} ion exchange of a Tsunami affected soil.

Soil was collected at a former paddy field at Terashima, Miyagi, Japan, where was damaged by Tsunami at the Great East Japan Earthquake. EC (1:5) of the soil was 5.2dS m^{-1}. The soil was mixed with rice straw and/or $CaCO_3$, and then packed into plastic columns of an inner diameter of 8.5cm and 20cm-high with the bulk density of 0.95g cm^{-3}. Amount of rice straw and $CaCO_3$ application was 10t ha^{-1} and 1t ha^{-1}, respectively. The soil columns were incubated for 23 days. During the incubation, 18mm of water was supplied for each three days. The temperature inside and around the columns, and soil water pressure were continuously monitored. The CO_2 concentration in soil air phase was measured at 5-days interval.

After the incubation, the columns were leached by 4 pore volumes of 4mmol L^{-1} KCl solution with. The leachate was collected for further analysis of EC, pH and concentration of cations. After the leaching, the soil columns were separated to 3cm thick layers. Each 3cm thick soil sample was used to measure EC, pH, soluble cations, and exchangeable cations of the soil.

In average, soil CO_2 concentration inside the column was high under the rice straw treatment regardless of $CaCO_3$ application. The CO_2 concentration rose at the periodical water application, and gradually decreased with time. Rise in CO_2 concentration could be due to the enhanced organic matter decomposition and the restricted CO_2 diffusion by higher soil water content following the water application.

Exchangeable cations of the column soil were measured after the leaching. Exchangeable Ca^{2+} slightly increased at whole layer of the four treatment. Increase in exchangeable K^+ coincided with decrease in exchangeable Na^+, suggesting ion exchange between Na^+ and K^+ was a dominant reaction during the leaching.

In this experiment, the effect of organic matter and $CaCO_3$ application on remediation of the Tsunami affected saline and sodic soil was not clear. With fluctuating soil water content, soil CO_2 concentration was not always high during the column incubation experiment. It is expected that depression of soil CO_2 concentration with decrease in soil moisture after water application could not enhance dissolution of applied $CaCO_3$.

Keywords: Tsunami affected soil, saline and sodic soil, rice straw, calcium carbonate

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AGE03-P08 Room:Poster Time:April 30 14:00-15:15

Enhancing Radioactive Fallout Removal from the Surface Soils by using artficial macropore transport system

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Fukushima nuclear power plant damaged by the East Japan Great Earthquake caused radioactive fallout around the Tohoku-region. Because radioactive fallout was positively charged,it was reported to be absorbed to soil surface. Surface soil scraper and deep plowing would be,therefore effective for the removal of radioactive materials. However,these techniques were available for flat and wide area like school yard or farm land.

in many orchards,fruit absorbed radioactive Cesium, which indicated radioactive fallout did not immediately absorb to soil surface but stayed as exchangeable ion for a while and was absorbed by plant root. therefore the technique for sloped land is also needed for better management for radioactive fallout.

we applied artificial macropores to effectively remove radioactive fallout from the surface soil. artificial macropore filled with bamboo fiber was made in siol(Field:d=1 length=50cm,Lab:d=0.6cm,length=20cm). Zeolite was placed at the bottom of the macropores(Field:50cm,Lab:20cm)to absorb transported Cesium.Four treatments were prepared for field experiments,such as macropore with ammounium sulfate,no macropore and no macropore with ammonium sulfate. In the lab experiments, Potassium was used for safety reason and a 400mm artficial rainfall was applied for one month. Results showed artificial macropore effectively transported radioactive Cesium/Potassium to deeper profile. In the lab experiment, artificial ,macropore successfully delivered Potassium to deeper profile while no radioactive Cesium was observed from the drainage water.

Keywords: Macropore, Degraded Soils, Radioactive Substance

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AGE03-P09 Room:Poster Time:April 30 14:00-15:15

A Design of Artificial Macropore for Improving Infiltration Process in Degraded Soils

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Soil is largest carbon storage body in all terrestrial medium such as vegetation and the atmosphere. However, these days, soils could not show its function as water storage layer or culture medium for plant, because of climate change or rough management. In this study, artificial macropores are introduced in soils for purposing enhancing infiltration without cultivation. Fibrous material was inserted so that it reinforced the macropore structure. Moreover, capillary force caused by fibers drag the surface water into the deeper soil prior to saturation. Capillary force caused by fabric introduced vertical transport, while micropore(matrix) enhanced horizontal flow. It makes it possible effective infiltration than empty macropores. In the experiment, an ideal design of artificial macropore was searched. The density of fibrous material was altered as 0.2 0.3 0.5 g/100cm3-soil. Artificial rainfall of 2 (weak rain) and 20 (stormy rain) mm h-1 were applied on the soil column (D=5cm, H=30cm). Results showed that retention curve has gradually changed as we changed the density of fibrous material. Thus, the capillary force was effectively created according to the densities surface water was effectively collected by dense artificial macropore when weak rainfall was applied, while stormy rain was effectively drained by light artificial macropore.

Keywords: macropore, soil degradation

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AGE03-P10 Room:Poster Time:April 30 14:00-15:15

Artificial Macropore installation effect on organic matter storage at a degraded land.

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At ill-drained lands, heavy rain would cause erosion which enhances degradation process much faster.According to our previous study, artificial macropore successfully enhanced vertical infiltration and increased organic matter contents. However,there was a concern that infiltrated fresh soil water transported nutrient and oxygen at the same time, resulting decomposition of the organic matter.

In this experiment,we prepared sandy soil column(D=50mm,H=300mm)with Cellulose, for which artificial rainfall of 210mL with nutrients (N,P,K)were applied on the surface soils. Then columns were placed at 30 oC constant temperature room to enhance organic matter decomposition. In order to observe structural difference for carbon storage,three treatments were prepared such as, cultivation,artificial macropore and control,respectively.

Results showed that evaporation was significant for cultivation column, which meant traditional agricultural practice had disadvantage for conservation of soil water conservation. On the other hand,artificial macropore column showed similar evaporation rate for control column in spite of their well-drained structure.Affected by water content,vertical profiles for carbon contents were different for three treatments. Standard deviations for vertical profiles were small for control column,and larger for macropore column and cultivation column.

Keywords: Artificial Macropore, degraded land

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Modelling of Critical Loads for Heavy Metals in Terrestrial Ecosystem in Slovenia

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In Slovenia a modelling application of As, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb and Zn critical loads in soil were performed. The calculation in the Salek Valley involved 30 research areas in the town Velenje area on a 500 x 500 m grid, where the chemical analyses of precipitation and soil were made.

The aim was application of theoretical models for determination the maximum critical levels of heavy metals in terrestrial ecosystem with empirical data. The basis for calculation was an effect-based approach, which limits are based on adverse effects on the ecosystem and the heavy metal concentrations should stay below those limits. As receptor was used a human health trough the eco toxicological risks with use of ground water for drinking water and/or consume crops that are grown on the soil. The simple model based on dynamic mass balance of heavy metals in soil was used for calculation. It was estimated that the critical time well illustrates the acute danger of soil pollution and is recommended as the draft estimation of actual condition in soil which could be valued with few data.

Two different soil conditions at the actual atmospheric input were used in calculation: unpleasant and average. The unpleasant condition was simulated for the surface soil to depth of 5 cm, and the advanced to soil depth of 20 cm and density of 1.500 kg/m3. The critical time for both conditions is calculated for As, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Zn. The comparison between heavy metals indicates high accumulation of As and Hg, and thus their quit fast approach to the critical loads. In second rang of atmospheric input are Cd, Pb and Zn which are accumulated much slowly, followed by Mo, Ni, and Co, and the slowest progress make Cr. The estimated periods to reach the permitted Slovene limits in surface soil are calculated for As, Hg 100, Cd 140, Pb 230, Zn 350, Cu 830, Mo 1.700, Ni 1.800, Co 1.900, and for Cr 6.000 years.

Keywords: heavy metals, soil, contamination, modelling

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Predicting soil moisture in arable land under climate change with soil-profile physical properties database

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Soil is foundation of agriculture and ecosystems. Soil physical condition such as soil moisture and temperature directly and indirectly affects yields and quality of crop production. Therefore predicting soil moisture of arable lands under climate change is important and valuable for yield prediction and adaptation under climate change. For predicting soil moisture condition of agricultural lands in arbitrary areas, use of soil database and datasets of General Circulation Model (GCM) projections should be useful since physical properties of soils and meteorological condition vary with location. Most of available GCM projections have spatial and temporal resolution of 100 km and a month. However, using GCM projections as input data for soil moisture and temperature prediction, temporal and spatial scale of the input data is favorable to be small since effective surface soil layer of agricultural production is generally shallow. In this study we investigated possibility of predicting soil moisture of arable lands in arbitrary areas with local-scale (approximately 20km×20km) daily GCM projection dataset " ELPIS-JP " (Iizumi et al., 2012) and the agricultural soil-profile physical properties database, Japan, " Solphy " (Eguchi et al., 2010).

In this study, soybean fields of Yoshioka and Ookubo, which are located in neighbors (approximately 2 ~ 3km), in Toyama city were chosen as experimental sites and scenario studies were done for predicting soil moisture condition with HYDRUS model (Simunek et al., 2008) under climate change in the future (2071 ~ 2090). Soil physical properties of each site were determined with water retention data in the SolphyJ database by using RETC program (Yates et al., 1992). Before the scenario studies, validation of HYDRUS model and soil physical properties which are obtained with SolphyJ database was conducted by comparing observed and simulated soil moisture of the Yoshioka field. The projection of MIROC-hires 3.2 A1B scenario was chosen among 26 (10 GCMs × 3 Special Report of Emission Scenario) ELPIS-JP scenario datasets. For preparing input data for numerical simulation of soil water movement, daily ELPIS-JP datasets were temporally downscaled to hourly or minutes scale by using weather generator " CLIGEN " (Nicks et al., 1995)

Simulated results suggested that the duration of excess soil moisture condition following heavy rainfall events are more likely at Ookubo than Yoshioka even though they are located in neighbors and have similar soil textures. Increase in surface runoff fluxes is possible to be larger in Ookubo than in Yoshioka as well. These results imply that even in a small watershed it is important to consider soil spatial distribution in predicting effects of climate change on agricultural production. Also, combination of temporally downscaled GCM projection dataset and agricultural soil-profile physical properties database may be useful for predicting soil moisture in arbitrary areas.

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Keywords: Climate change, Soil moisture, Numerical simulation, SolphyJ, ELPIS-JP

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A Case Study of Combining Geophysics Prospecting Techniques to a Soil Contaminated Site

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This study utilizes a combination methods of Electrical Reisitivity Tomography (ERT), Ground Penetrating Radar (GPR), and Horizontal Loop Electromagnetic (HLEM) to examine a heavy-metal contaminated site before and after the remediation. It was a processed sludge tacking site of a smelting plant. The sludge is homogeneous red, and the main pollutants are chromium, arsenic and lead. The plant has been closed for more than twenty years. At the time when it was shut down, instead of removing the stacked sludge and underground structures (tank), the site was leveled directly and planted with lawns. Now, it is difficult to know the distribution of the sludge, the depth of its cover, and the correct location of the underground structures.

The pre-remediation investigation conducted with the application of geophysical prospecting techniques found that the HLEM could efficiently define the distribution of sludge efficiently, and ERT could be used to detect the thickness of the sludge and the location of the underground structures, but GPR results failed to meet expectations which may due to a significant attenuation of electromagnetic energy caused by the nature of the sludge. The post-remediation examination shows obvious different morphologies of the site than it was before the remediation. The results can be used to assess the effectiveness of remediation, and to check if any sludge remains.

Keywords: ERT, GPR, EM, pollution

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Cs migration to rice crop from soil after stripping the contaminated top soil at Iitate Village in Fukushima Prefecture.

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Iitate Village is at about 40 km northwest from a Fukushima Daiichi nuclear power plant. An agricultural fertile layer in agricultural fields was contaminated by radionuclides, e.g., 134-Cs, 137-Cs, and 90-Sr, just after the accident of the Fukushima Daiichi Nuclear Power Plant in 2011. The decontamination work is an important subject for villagers to return to a village and live there again. Three decontamination methods are proposed by a Ministry of Agriculture, Forestry and Fisheries. They are 1) Stripping the top soil off, 2) Removal of fine particles after soil and water mixing, and 3) Tillage reversal. By the report of the Ministry of Agriculture, Forestry, and Fishery, 90% of radioactive contaminant has been removed by the method of stripping the contaminated top soil off. In this time, we examine the Cs migration to rice crop from soil after stripping the contaminated top soil off.

We used ˜4∗20 m paddy field at Iitate Village in Fukushima Prefecture. At first we decontaminated the site using the method of stripping 5 cm top soil off. After that potassium chloride (KCl) was put in all area as basal fertilizer on June 8, 2013. We comparted the area and made three kinds of treatments such as (1) mixed with rice straw that was harvested last year here, (2) only decontaminated, and (3) mixed with farmyard manure, and transplanted rice crop (rice cultivar is hitomebore) on June 9, 2013. We had sampled top soils at three points from each plot twice a month and the 134-Cs, 137-Cs, and 40-K concentration in soils were analyzed using a Ge semiconductor detector. The concentration of 134-Cs, 137-Cs, and 40-K in rice crop was analyzed by a NaI scintillation counter after harvest.

As a result, 134-Cs is about half of 137-Cs. Since the half-life of 34-Cs is two years, it has become approximately a half. Changes of Cs and K concentrations in soil were not observed during a rice cultivation period. The concentrations of radionuclides in mixed rice crop were 572.93±8.05 Bq/kg-dry / Cs-134, 1089.35±11.41 Bq/kg-dry/ Cs-137, and 127.29±27.59 Bq/kg-dry/ K-40. Although these values were comparatively high, soil did not show the high dose. The reason of that would be the volume of mixed rice straw was small and migration of caesium from the rice straw to the soil was hardly happened. The soil dose mixed with manure had been high through the whole cropping period. It might be the original manure dose was high, but the analysis of the manure has not completed yet. The concentration of radionuclides in rice crop below a detection limit of the NaI scintillation counter and it is below the regulation value defined in our country.

Keywords: stripping top soil off, rice crop, caesium

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Nitrogen removal and effect of chemical oxygen demand on removal of nitrogen in Coir Fiber Biofilm Treatment System

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Biological treatment is the most useful process to remove nitrogen from water and wastewater. In this process, ammonium is first oxidized to nitrate by aerobic autotrophic nitrifying microorganisms. Nitrate is then reduced to nitrogen gas by heterotrophic denitrifying bacteria under anoxic conditions. Oxygen and organic carbon must be supplied to act as electron acceptor in nitrification and electron donor in denitrification. This study has carried out microcosm experiments in the laboratory for evaluating wastewater treatment mechanism and efficiency in the Coir Fiber Biofilm Treatment System (COTS). Coconut fiber was used to encourage the development of contaminant-degrading biofilms. A string of coconut-fiber (0.2-m length) was used as a biofilm support media and experiments were carried out using synthetic wastewater. The string of coconut-fiber was put inside the treatment container (0.012-m3 volume) with two conditions: low fiber density (LFD; single string per a container) and high fiber density (HFD; two strings per a container). As a control condition, a blank container without a coconut-fiber string was also used in the experiment. The flow rate is about 870 cm3/day (two-weeks retention time)

The inflow ammonium nitrogen concentration was 500 mg/l- 640 mg/l and the average nitrate nitrogen concentration in influent was 5.9 mg/l- 6.5 mg/l (low nitrate nitrogen loading rate). Dissolved Oxygen (DO) value of the treatment tanks were range between 0-0.3 mg/l. DO concentration in LFD and HFD treatment tanks were slightly lower than the inflow and blank tank during the whole experimental period. The maximum ammonium nitrogen removal efficiency was recorded in the 14 days of startup. It was approximately 45% and 30% in HFD and LFD treatment tank respectively. After that, ammonium nitrogen removal efficiency shows the slightly decreasing trend over the time. The maximum nitrate nitrogen removal was observed for 70 days of operation. It was around 90% and 72% in HFD and LFD tank respectively. Over the duration of the experiment, very low concentrations of Nitrite Nitrogen were observed and it was below 1 mg/l. low nitrite nitrogen is evident that the oxygen limited anaerobic nitrification-denitrification process leads to removal of ammonium nitrogen in this system. This process involves two-step as partial nitrification and Anammox. One of the most critical parameters of the nitrification process is the influent chemical oxygen demand (COD), because it directly influences the growth competition between autotrophic and heterotrophic microorganism population. The average inflow COD concentration in influent was 18300 mg/l- 19800 mg/l. Ammonium nitrogen removal efficiency decreased with the increasing of COD removal efficiency in both LFD and HFD treatment tanks. So there is a negative relationship between organic carbon concentration and biological ammonia removal. High organic loading can result in decreased nitrification due to faster growing heterotrophic bacteria dominating the surface of the biofilm, and leads to oxygen limitations for the nitrifying bacteria growing deeper inside the biofilm. As considering the results obtained from the microcosm system it can be conclude that partial nitrification and the subsequent anaerobic ammonium oxidation (Anammox) are the major process associated with the removal of ammonium nitrogen. This process is a shortcut biological nitrogen removal without increasing nitrite and nitrate concentration in the system. At the same time treatment tank with HFD always tend to eliminate significant amount of ammonium nitrogen than the LFD tank. Difference between results in HFD and LFD treatment tank indicating that surface provided for growth of biofilms is a major factor for improving biodegradation rates. COTS has effect on remove nitrate nitrogen effectively at low nitrate loading rate from the wastewater.

Keywords: Coir Fiber, Biofilm, Nitrogen removal, Chemical Oxygen Demand

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Estimation of water film thickness in geological media based on electric double layer interactions

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Water film plays an important role in mineral-water interactions and mass transport in geological media under water-unsaturated conditions (Nishiyama and Yokoyama, 2013, Geochim. Cosmochim. Acta). To quantify such reactive-transport in water film, the understanding of the properties of water film is essential. Water film is retained on grain surfaces due to the action of electric double layer force associated with the compression of diffuse layers developed from mineral-water and water-air interfaces. In this study, we focused on the thickness of water film and developed a model to estimate the thickness taking into consideration the effect of ion concentration, pH, and electric double layers overlapping.

The surface charge density and electric potential at mineral-water and water-air interfaces depend on the amount of adsorption-desorption of proton and ions. When two diffuse layers developed from the opposite interfaces overlap, the concentration of ions in diffuse layers changes and consequently the adsorption-desorption reactions at the interfaces achieve a new equilibrium state. To take into account this process, we used a triple-layer model and a double-layer model to numerically solve the Poisson-Boltzmann equation describing the ion distribution in diffuse layer between the interfaces. We considered water film on quartz grains and calculated water film thickness as a function of pH and ion concentration. The results show that water film thickens with decreasing ion concentration and increasing pH. The model presented in this study allows film thickness to be estimated as a function of mineral type, ion concentration, and pH. Such model would be useful for considering the reactive-transport under unsaturated conditions including the geological storage of carbon dioxide and soil formation.

Keywords: water film, electric double layer, unsaturated zone