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

AGE04-01 Room:301A Time:May 24 10:00-10:15

Adsorption behavior of organoarsenic compounds in soils

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The arsenic pollution is a world problem. Natural originated inorganic arsenic compounds are predominant cause of the water-related disease. In addition, anthropogenic originated organoarsenic compounds such as phenylarsonic acid (PAA) and diphenylarsinic acid (DPAA) are also pollution source. For example, DPAA polluted well water caused serious health problems in Kamisu, Japan. These phenyl arsenic compounds are considered as a decomposition product of chemical warfare agents produced during World Wars I and II, and even now such compounds still remain in the ground. Recently, adsorption and mobility of these aromatic arsenic compounds in agricultural soils have been investigated. However, their adsorption mechanisms on soil are still unknown. In general, the adsorption property of chemical compounds influences its migration process in natural environments such as soil-water system. Thus, it is important to understand the adsorption mechanism of the arsenic compounds to predict future fate of them in environment. Recently, we reported adsorption structures of PAA and DPAA on ferrihydrite obtained by X-ray absorption fine structure (XAFS) analysis and quantum chemical calculations [1]. In this study, we conducted As K-edge XAFS measurements for organoarsenic compounds adsorbed on soil, as well as adsorption experiments, to understand their adsorption behavior in soils. The results of EXAFS analysis suggest that all arsenic compounds in this study adsorbed on Fe or Al (oxyhydr)oxide in the soil mainly regardless of the organic functional groups. This fact indicates that the Fe/Al-(oxyhydr)oxides can control the mobility of organorasenic compounds in the ground.

References:
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Keywords: adsorption behavior, organoarsenic, XAFS, soil

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

AGE04-02 Room:301A Time:May 24 10:15-10:30

Impact of Injecting Heated Water into Aquifer on Groundwater Quality

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In late years, usage of geothermal heat energy, one of the renewable energy sources, draws attention in Japan. The geothermal heat can be used through heat pumps for building heating and cooling. A heat pump can extract heat energy either from the ground using underground heat exchangers or from pumped groundwater. While the former is referred to as a closed-type ground source heat pump (GSHP), the latter is known as an open-type ground source heat pump. The open-type GSHP systems also require either recharging heated or cooled groundwater into aquifers or discharging it into surface water systems. There are various advantages of using the open-type GSHP systems; energy efficiency is much higher than the closed-type GSHP systems. On the other hand, altering groundwater temperature may cause environmental impact such as elution of toxic elements from the aquifer or changes in microbial activities in the aquifer. However, such environmental impact caused by the open-type GSHP systems has been rarely studied and is generally poorly understood. To maintain its sustainable usage, more data on environmental impacts need to be collected from field experiments. The main objective of this study is, therefore, to investigate the impact of injecting heated water into the aquifer on groundwater temperature and its quality.

A field experiment was conducted from October 7 to December 2 in Fuchu campus of Tokyo University of Agriculture and Technology in 2014. Groundwater pumped from a pumping well was heated to 30 oC before it was injected to a confined aquifer at GL-50m from an injection well installed 10-m away from the pumping well at a rate of 20 L/min. The temperature of the ground below GL-10m is almost constant at 17 oC year-round at the experimental site. The heating load was therefore equivalent to 18.1 kW. Changes in temperature and element concentrations in groundwater were observed at two 50-m long observation wells installed at 1.4-m (O-1) and 5.3-m (O-5) away from the injection well. Temperature sensors were installed every 5 m at O-1 and O-5. Groundwater samples were collected from two aquifers; one at GL-40m (shallow) and another one at GL-50m (deep), from O-1 and O-5, every two or three days during the experiment. EC, pH, DO, ORP, and turbidity were measured immediately after samples were collected, while concentrations of sixteen trace elements and major ions were measured later using ICP-MS and IC, respectively.

Temperatures of the deep aquifer at O-1 and O-5 rose from 17 oC to 23 oC and 22 oC, respectively, while those of other depths remained almost unchanged or increased slightly, indicating that heated water was indeed directly injected to the deep aquifer. While pH, EC, and DO did not changed, ORP showed a gradual decreasing trend in both aquifers. Turbidity was largely affected by injecting heated water as it increased to 60 NTU at the deep aquifer at O-1. That of the other aquifers stayed almost unchanged before, during, and after injecting heated water. As concentrations of elements might be affected not only by changes in temperature, but also by physical injection, it may be required to separate the impact of different processes. One of the approaches to do that is to take concentration ratios with an inert tracer. This is known as an internal standard method. As there was no artificial tracer added in this experiment, zinc, one of the more stable elements, was used as a tracer. Ratios to Zn concentration increased significantly during heating for some elements, such as Al.

From the field experiment, it was clearly shown that the turbidity of groundwater was strongly affected. As for trace elements and major ions, while it was shown that injecting heated water might increase concentrations or concentration ratios for some elements, more careful data analysis needs to be done to clarify the mechanism of such effects.

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

AGE04-03 Room:301A Time:May 24 10:30-10:45

Effects of particle size and thermal properties on thermal dispersion characteristics in porous media

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Understanding heat transport process in saturated porous media is essential, in regard to a widespread use of ground source heat pump systems and design of geologic repositories for high-level nuclear wastes. However, knowledge of thermal dispersion occurred due to advective heat flow is limited in the mechanisms of heat transport process. In this study, one-dimensional heat and solute transport experiments were conducted using glass beads with different size fractions, and stainless steel sphere with high thermal conductivity. Effects of particle size, thermal properties, and flow velocities on thermal dispersion characteristics and the difference between thermal and solute dispersion characteristics were discussed based on the column experiments. Glass beads with smaller size fraction showed smaller increase in thermal dispersion coefficient at higher flow velocity as compared to the one with larger size fraction. Flow velocity dependency on thermal dispersion coefficient was insignificant for stainless steel sphere, indicating thermal conduction dependent heat transport is dominant in the column due to higher thermal conductivity of the stainless steel.

Keywords: thermal dispersion, solute dispersion, thermal properties

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

AGE04-04 Room:301A Time:May 24 11:00-11:15

Effects of temperature environment in dissolution and chemical forms of heavy metals of sediment in Arakawa lowland

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Global warming, heat island phenomenon in urban areas, and increased use of geothermal energy would affect the subsurface thermal, chemical, and biological environment. Change in subsurface temperature might affect dissolution and transport of chemical materials and the subsurface microbial activities. However, effects of temperature change on the subsurface environment including dissolution and chemical forms of heavy metals have not been fully clarified. In this study, effects of temperature on dissolution and chemical forms of heavy metals in sediment of Arakawa Lowland, Kanto district, Japan have been investigated by laboratory experiments.

Laboratory experiments to evaluate the relation between temperature and dissolution characteristics were conducted under three different temperature conditions (15^{o}C, 25^{o}C and 40^{o}C). Five chemical forms of heavy metals in residues from the dissolution experiment were also fractioned (Water soluble, Exchangeable, Bound to carbonates, Bound to iron and manganese oxides and Bound to organic matter) by the sequential extraction method. These experiments were conducted on sediment samples obtained from boring cores at around 17m, 31m, 39m and 44m depth (denoted as 17m-sample, 31m-sample, 39m-sample and 44m-sample, respectively).

Results showed that temperature conditions affected dissolution characteristics and chemical forms of heavy metals. Especially, boron in 17m-sample (marine sediment) and arsenic in 31m-sample (non-marine sediment) dissolved more at higher temperature and linear relations between temperature and dissolved concentration of these components were observed. Additionally, temperature condition also affected their chemical forms. Under 40^{o}C and 25^{o}C conditions, Bound to iron and manganese oxides and Exchangeable forms of boron in 17m-sample both decreased and Water-soluble boron increased compared to the 15^{o}C condition. Also under 40^{o}C and 25^{o}C conditions, Bound to iron and manganese oxides form of arsenic in 31m-sample decreased and Water-soluble and Exchangeable arsenic both increased compared to the 15^{o}C. These results imply that hardly-soluble forms of boron and arsenic might change to readily-soluble forms at higher temperature.

Keywords: subsurface temperature, dissolution characteristics, chemical forms, alluvial sediment

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

AGE04-05 Room:301A Time:May 24 11:15-11:30

LOCALLY AVAILABLE SOILS AS LINER MATERIALS FOR DEVELOPING COUNTRIES: A COMPARISON WITH GEOSYNTHETIC CLAY LINER

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Solid waste management has become a major issue for the urban areas of developing countries. Due to rapid increase in urbanization coupled with the rise in community living standards the generation of municipal solid waste is highly accelerated in past few decades. At present most of the landfill practice in developing countries is open dumping without proper measures to mitigate the migration of contaminants to surrounding environment. It is the need of hour to construct engineering landfills with impermeable liners to avoid groundwater and surface water pollution. Most of the engineered landfills in developed countries are equipped with commercially available liner material known as Geosynthetic Clay Liner (GCL). GCLs are popular due to their extremely low hydraulic conductivity which is primarily due to the presence of a thin layer of bentonite. However, due to economic constraints, developing countries cannot afford engineered landfills equipped with such commercially available liners. In contrast, Locally Available Clayey Soils (LACs) are less expensive and can be used as bottom liners under the provision that they meet the recommended criteria for base liner. A detailed comparison between GCL and LAC with respect to both geotechnical and hydraulic performance can therefore provide the basis for using appropriate LACs as landfill liner material.

This study employed locally available soils obtained from Moragahakanda area of Srilanka(hereafter referred to as Soil M). Swell index, plasticity index and Hydraulic conductivity tests were carried out on Soil M and its mixtures with bentonite component of GCL. Soil-bentonite mixtures were prepared by mixing Soil M with 5 % and 10 % bentonite. Experimental Investigations were carried out using de-aerated water and 1M $CaCl_2$ as hydrating liquids. The hydraulic conductivity tests were carried out on non consolidated and pre-consolidated samples to investigate the effect of consolidation on hydraulic conductivity of candidate soils. Data on pure bentonite was used to examine the performance of Soil M and mixture soils compared to GCL. Results showed that the nature of hydrating liquid has an insignificant effect on swell Index and plasticity index of the candidate soils when compared to pure bentonite. Hydraulic conductivity was found to decrease with an increase in bentonite content when permeated with de-aerated water. However, the effect was found insignificant for $CaCl_2$ permeation. An increase in consolidation pressure caused a decrease in hydraulic conductivity irrespective of permeating liquid and bentonite content. At very high consolidation pressure, all the candidate soils were found to exhibit much lower values of hydraulic conductivities than the maximum recommended value for base liners.

Keywords: Locally Available Soils, Geosynthetic Clay Liners, Soil-Bentonite Mixtures, Plasticity Index, Swell Index, Hydraulic Conductivity

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

AGE04-06 Room:301A Time:May 24 11:30-11:45

Significant Improvement to Imaging Hydraulic Heterogeneity in Heterogeneous Geologic Media via Hydraulic Tomography

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Hydraulic parameters such as hydraulic conductivity (K) and specific storage (Ss) of geologic media are heterogeneous at multiple scales. A large number of techniques have been developed to deal with this heterogeneity, but little information is available on its performance in predicting groundwater flow and solute transport. In this presentation, I review the various heterogeneity mapping methods and introduce the concept of Hydraulic Tomography (HT). HT is a new approach to map the heterogeneity of the subsurface. It is analogous to geophysical tomography but different in a sense that the method relies on multiple pumping tests as sources of signals. These signals or drawdowns are detected in neighboring monitoring intervals. With a suitable inverse model, one can then estimate the three-dimensional spatial variability in K and Ss. One significant advantage of the approach is that it provides direct information on connectivity in hydraulic parameters, which is very important in contaminant transport problems. Research over the last decade has shown that this is a very robust technique and the estimated parameters are more reliable in predicting independently conducted pumping tests and tracer tests. I will introduce various synthetic, laboratory and field experimental results, compare HT against other heterogeneity mapping methods, and discuss future research directions.

Keywords: heterogeneity, contaminant transport, fractured rocks, stochastic hydrology, subsurface characterization, connectivity

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

AGE04-07 Room:301A Time:May 24 11:45-12:00

Interactive effects of EC and pH on nitrous oxide emissions and denitrification

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Long-term fertilizer applications and saline water irrigation lead to the accumulation of salts and changes in soil pH. These changes may in turn affect N_2O emissions from soil. Interactive effects of EC and pH on N_2O emissions were studied by using paddy soil in Ushimado, Okayama Prefecture, Japan. Closed incubation experiments were conducted in 100-mL glass bottles for 72 h at 25^{o}C. Each bottle contained 5 g of air-dried soil and 25 mL of solution, which includes KNO_3 (10 mg NO_3-N L^{-1}) and NaCl (0 M, 0.005 M, 0.01 M, 0.05 M, 0.1 M, 0.2 M) for adjusting different electric conductivity (EC) levels under different pH: acid (HCl 0.005 M), neutral (no adjustment), and alkaline ($NaHCO_3$ 0.005 M). Nitrous oxide concentration in the headspace of the bottle was measured 3 h, 24 h, 48 h, and 72 h after incubation with gas chromatograph (GC-8A, Shimadzu, Kyoto, Japan). After gas collection, the solution was taken out for measuring pH, EC and concentrations of NH_4^+ and NO_3^-. Results indicated that pH was a significant factor controlling N_2O emissions (P <0.05). Nitrous oxide emissions were greater in higher EC treatments under the acid treatment. Nitrous oxide emissions peaked at 24 h of incubation and fell sharply afterwards due to further dentrification process. At 24 h, the highest N_2O emissions was measured in 0.2 M NaCl (7.5 mg kg $soil^{-1}$), followed by in 0.1 M, 0.05 M, 0.01 M, 0.005 M and 0 M treatments, which were 6.7, 5.1, 3.8, 2.0, and 1.2 mg N kg $soil^{-1}$, respectively. Nitrous oxide reductase was sensitive to both high EC and low pH condition. In neutral and alkaline treatments, there was no significant effect of EC on N_2O emissions during 72 h incubation (P >0.05). The N_2O emissions were 0 mg kg $soil^{-1}$ at 3 h after incubation then ranged from 0.02 to 0.11 mg N kg $soil^{-1}$. Ammonium concentration increased over the incubation periods. Higher EC promote NH_4^+ release. There was no significant difference in NO_3^- removal among treatments at different EC levels (P >0.05). We conclude that low pH increased N_2O emissions and higher EC under acid conditions promoted N_2O emissions.

Keywords: Denitrification, EC, nitrous oxide, paddy soil, pH

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

AGE04-08 Room:301A Time:May 24 12:00-12:15

Spatial prediction of soil water retention curves from particle size distribution data using Arya-Paris model

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Predicting soil water retention curves (SWRC) or their model parameters at any unsampled locations using a geostatistical spatial interpolation technique requires a number of high quality retention data. Obtaining SWRC is, however, generally tedious, time consuming, and sometime expensive. Therefore, pedotransfer functions (PTF), which allow one to predict soil hydraulic properties, such as SWRC, from easily measured soil properties, have been developed. One of the common PTF by Arya and Paris (AP) predicts water retention curves from particle size distributions (PSD) and dry bulk densities. In this study a geostatistical spatial interpolation technique was coupled with the AP model to predict water retention curves at given unsampled locations from PSD. There are two approaches available: (1) First, SWRC are predicted from PSD at given observed locations using the AP model. SWRC are then predicted at given unsampled locations through the geostatistical spatial interpolation technique from those predicted by the AP model. This approach is referred to as the PTF-first and Interpolation-later approach or the PI approach. (2) First, PSD and the bulk densities are predicted at given unsampled locations using the geostatistical spatial interpolation technique from observed PSD. Then, SWRC are predicted at the unsampled locations by the AP model from the interpolated PSD and bulk densities. This approach is then referred to as the Interpolation-first and PTF-later approach or the IP approach. Current study compares the performance of these two approaches to predict SWRC at any given unsampled location. Ordinary kriging (OK) one of the most commonly used geostatistical interpolation technique was used. The data used in this study were obtained from the Las Cruces trench site database, which contains water retention data for 448 soil samples. The dataset was then split into two sets, prediction and validation sets. This allows for the computation of prediction errors (mean absolute error or MAE and mean error or ME). The results show that performances of the PI and IP approaches were comparable, while the PI generally requires less workload as the number of kriging one needs to perform is much less for the PI compared to the IP. It was also shown that MAE were almost the same between the PI and the IP.

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

AGE04-P01 Room:Convention Hall Time:May 24 18:15-19:30

The Effect of Artificial Macropores on the Amount of Organic Matters in Soils and Plant Biomass

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Artificial macropores with fibrous material were installed in degraded red yellow soils to enhance vertical infiltration along with organic matter and nutrients. They enhanced vertical infiltration without cultivation which could cause small particle loss from the surface soils. Macropore and no macropore plots were prepared and total carbon in 10, 30, 50 cm depth were measured every half year. Infiltrated soil water was sampled through capillary force soil water sampler to measure total organic carbon and ion concentration. Results showed that soil total carbon in macropore plot increased in spring while it decreased in fall. Control plot showed few fluctuations. Total carbon concentration in soil water also showed higher trend in macropore plot, thus the TC fluctuation in soils could be caused by infiltrated soil water conducted by artificial macropores. Ion concentration was also measured to find that nitrate nitrogen was higher in summer season in macropore plot, which would be a source for biological decomposition of organic matter and also for nutrient for plant growth. Resulted plant biomass in macropore plot was two times larger than that in control plot. Additionally, plant species number observed at the macropore plot was 12, while it was 8 in control plot. This vegetation would be possible organic matter source for future soils. Finally, carbon increment in poor nutrient soils after macropore installation was calculated as 0.0036 g-C g-soil-1 yr-1 (20.4 t-C ha-1 yr-1), which was very successful. The study had successfully showed that relatively simple technique of artificial macropore with fibrous material could increase the organic matter in soils and recover the vegetation in ill-drained soils.

Keywords: macropore, infiltration, carbon sequestration

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

AGE04-P02 Room:Convention Hall Time:May 24 18:15-19:30

Characterization of Long-Term Leaching Properties of Lead from Naturally Contaminated Soils

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[1]AIST

Recent amendment of the Soil Contamination Countermeasures Act in Japan requires countermeasures to the soils including naturally occurring heavy metals, i.e., the soils even if they are naturally contaminated. Among a variety of toxic heavy metals, Lead remains a top priority for study, because it is one of the most common contaminants not only in Japan, but worldwide.

To characterize the long-term leaching properties of lead from naturally contaminated soils, six samples taken from the surroundings of different, abandoned metal mines were collected and tested. Chemical compositions, mineral compositions, cation exchange capacity, total organic carbon, total and leaching concentrations, existing form and sequential leaching concentrations of lead were systematically analyzed and examined.

The results of this study demonstrated that 1) X-ray fluorescence analysis cannot obtain comparative value of total concentration of lead for naturally contaminated soils compared with the standard test method based on acid extraction. 2) Leaching concentration does not depend on total concentration. Soil samples containing low total concentrations that are below environmental standard may have high leaching concentrations. 3) Leaching concentration is not stable during sequential and/or long-term leaching. Leaching concentration that meets environmental standard at a time may fail to meet environmental standard someday even under similar pH conditions. 4) Leaching properties of lead from naturally contaminated soils are fundamentally controlled by its existing form. 5) Compared with removing toxic heavy metals, immobilization and/or solidification together with risk-based management of naturally contaminated soils could be more cost-effective and practical.

Keywords: Naturally Occurring, Heavy Metals, Lead, Long-Term Leaching Properties, Sequential Leaching Test

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

AGE04-P03 Room:Convention Hall Time:May 24 18:15-19:30

Soil pipe effect on rainfall-runoff process

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Introduction

At hillslope, soil pipes are often formed by activity of soil fauna and plant roots as well as internal erosion. Many researches indicated that soil pipes parallel to the slope bed greatly influenced hillslope hydrological phenomena. In order to understand hillslope soil water dynamics, it is important to understand and model role of the soil pipes. For this reason, quantitative discussion of the effect of soil pipes on rainfall-runoff process is needed. Several model experiments and numerical analyses using soil box with artificial soil pipes indicated that soil pipes changed groundwater table profile. However, since most previous researches handled the steady-state condition, understanding of soil pipe effect on transient water dynamics during a rainfall event is still limited.

Our research objective is to clarify the effect of soil pipes on unsteady soil water dynamics under rainfall.

Experiment and numerical analysis

We packed toyoura sand homogeneously to form a soil box of 60 cm long, 30 cm high and 4 cm thick, with an outlet at the downstream end. As the artificial soil pipe, perforated acrylic pipes with the inside diameter of 7 mm were buried. The artificial soil pipes had many drain holes of 3 mm in diameter at the lateral side to pass soil water between soil matrix and pipe. The pipes were covered by nylon mesh to prevent inflow of sand particles. Soil pipes were buried at 2.5 cm above the impermeable bed. Soil pipes are commonly considered to be discontinuous in the soil, so we set three soil-pipe conditions, i.e. no pipe, continuous pipe and discontinuous pipes. Rainfall simulator was set above the soil surface to add the rainwater to the soil. At first, constant rainfall was added to attain steady state percolation through the soil. Then, rainfall intensity had risen for a while, and then returned to be the same intensity at the beginning of the rainfall. This procedure gave a pulse-like change in rainfall intensity. During the experiment, we measured rainfall intensity and discharge from an outlet by the tipping bucket. Also, soil water pressure at twelve observation points was monitored using tensiometers.

In the numerical analysis, we tried to reproduce the experiment using HYDRUS-2D software. Soil pipe was modeled as virtual soil matrix with high hydraulic conductivity and low air-entry value. Soil hydraulic function was described by the van Genuchten-Mualem model. Applied rainfall was expressed by the flux boundary and downstream outlet was assigned as seepage face boundary.

Keywords: soil pipes, rainfall-runoff process

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

AGE04-P04 Room:Convention Hall Time:May 24 18:15-19:30

Effects of temperature change in a marine subsurface aquifer on groundwater quality

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Ground Source Heat Pump (GSHP) systems are getting increasingly used worldwide. GSHP systems utilize the groundwater temperature via heat exchange for cooling or heating of buildings, and GSHP is generally recognized as a renewable and sustainable energy system. For example, applying GSHP instead of conventional heating/cooling systems makes it possible to reduce CO_2 emissions to the atmosphere, save energy, and restrain urban heat island phenomena. On the other hand, GSHP systems dispose heat or cold to the subsurface, which causes subsurface temperature change and, consequently, may cause changes in chemical composition of the groundwater (possible groundwater contamination) as well as a disturbance of the subsurface microbial ecosystem. However, the effect of temperature change on the subsurface environment is not well understood. Therefore, we conducted a long-term thermal loading and natural cooling test and investigated the temperature change effects on groundwater quality. The experimental site is located in Saitama University, Japan. The experimental system was installed with a U-tube as the heat exchanger. Four groundwater monitoring wells were installed for an upper (marine) and a lower (non-marine) aquifer at 1m (W1), 2m (W2), 5m (W5) and 10m (W10) distance from the U-tube heat exchanger. Thermal loading into the subsurface was applied for totally 13 months by circulating 40 ℃ water inside the U-tube heat exchanger. Results showed groundwater temperature at W1 increased about 8 ℃ (from 17 ℃ to 25 ℃) for the first 6 months and then stayed almost constant. In the upper aquifer, concentrations of boron, DOC, and several other chemical components increased together with the increase in subsurface temperature. In the lower aquifer, a similar effect of temperature could only be observed for one chemical while data were not sufficient for other chemical compounds. After thermal loading, the effect of natural cooling on groundwater quality was investigated for 14 months. At the end of the thermal cooling period, the subsurface temperature and the concentrations of components that had increased during thermal loading all decreased to approximately the initial values observed before heating had started. For these components, an approximate linear relationship between change in chemical concentration and change in subsurface temperature was observed.

Keywords: Ground Source Heat Pum(GSHP), thermal loading, temperature change, groundwater quality, marine aquifer, natural cooling

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

AGE04-P05 Room:Convention Hall Time:May 24 18:15-19:30

Theoretical and Technical Criteria for Selecting and Designing Laboratory Diffusion Tests

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Mass transport in geo-environments is primarily controlled by advection, dispersion and sorption if no chemical and/or bio-chemical reactions and chain decay are involved. When permeability is low and/or hydraulic gradient is extremely small, mass transport in a geological stratum such as a clay layer will be controlled by diffusion and sorption.

To properly select a test method, and to effectively perform a laboratory diffusion test, theoretical solutions to both through and in-diffusions are overviewed. Based on discussion of analytical technologies for different kinds of chemicals, such as contaminants and/or nutrients associated with bio-remediation of volatile organic compounds (VOCs), this presentation illustrates how to selection a test method, how to shorten required testing time, how to determine sampling interval and how to interpret experimental data.

Keywords: laboratory diffusion tests, through-diffusion, in-diffusion, theoretical solution, analytical precision

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

AGE04-P06 Room:Convention Hall Time:May 24 18:15-19:30

Consideration of various factors on the expression of Soil Water Repellency

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Soil water repellency (SWR) is a phenomenon that exhibits soil hydrophobicity mainly related to the presence of organic matter coating in soil grains. Agricultural farm manure, organic fertilizer, different vegetation type as well as microbial activity in the soil could be the reasons to develop hydrophobicity of soil. Importance of SWR studies is to understand the nonuni-formed infiltration, surface run-off and soil erosion etc. The objectives of this study are (i) to investigate the difference of SWR measurement in the field and laboratory condition and (ii) to identify the relationship between the SWR and soil physical and chemical properties. Two sites were selected; greenhouse vegetable farm at Mizuho-farm, Miki city, Hyogo prefecture in Japan and pasture land at Tihoi farm, Waikato in New Zealand. Field measurement and soil sampling in Mizuho-farm were carried out on December 2013 and October 2014. Sampling in Tihoi farm was carried out on February 2014 and December 2014. At the Mizuho-farm, two greenhouses were selected (No. 7 and No. 21) and field water drop penetration time (WDPT) were carried out using transect walk, grid locations (10 m x 3.0 m area), auger samples for depth profile and random points measurements. In addition to correlate the biomass production to SWR, biomass percentage were estimated using quadrate (0.3 m x 0.3 m) method.

Similar to that, WDPT were measured at Tihoi-farm on selected transect lines along the sloping land (ridge and furrow) and most top of the pasture land. At the same time, surface soil samples and core samples were selected to measure laboratory WDPT and soil physio-chemical properties for Japan and New Zealand sites. Results were analyzed to compare field and laboratory WDPT measurements and effect of physio-chemical properties on degree of SWR.

Keywords: Soil Water Repellency, water repellency parameters, soil organic carbon, mass transport

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

AGE04-P07 Room:Convention Hall Time:May 24 18:15-19:30

Difference in Arsenic Removal Performance among Types of Magnesium Reagents

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In some areas of developing countries, health effects have been feared because underground water contaminated with arsenic has been used as drinking water. Therefore it is desired that effective and inexpensive 'arsenic removal agents' should be developed and provided to reduced health risk. To develop the arsenic removal agents (arsenic adsorbents or flocculants), systematic experiments that focused on the components related closely to arsenic removal need to be carried out and also the fundamental data that obtained in the experiments need to be stored and organized. In this study, magnesium was focused as one of the components effective for arsenic removal. Arsenic removal tests were carried out using artificial arsenic contaminated water. Six types of magnesium reagents (magnesium chloride, magnesium sulfate, magnesium oxide, magnesium hydroxide, and light and heavy types of magnesium carbonate) were tested. Then the arsenic removal performance was evaluated on the basis of reagent addition concentration and magnesium content in reagent.

Keywords: arsenic removal, magnesium salts, arsenic contaminated water, arsenic removal ratio, arsenic removal efficiency

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

AGE04-P08 Room:Convention Hall Time:May 24 18:15-19:30

Application of Time Lapse Electrical Resistivity Tomography to the Soil and Groundwater Contaminated Site: Case Studies

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Electrical Resistivity Tomography (ERT) is a useful geophysical tool for investigation of the soil and groundwater site. It could be applied in estimating the groundwater flow direction and contaminants space distribution. With these applications, we could establish monitoring or sampling wells in potential pollution areas. ERT survey could delineate the contaminated areas with high concentrations in relatively simple geological sites. Even in the seriously DNAPL leakage cases, it is possible to directly detect the DNAPL pool. However, when the site condition is complex (e.g. the electrical characteristic of contaminants and geological materials is similar), it is difficult to distinguish the differences between contaminants and geological materials in electrical resistivity profiles. Therefore, the Time Lapse-ERT (TL-ERT) can be applied to monitor the distribution of electrical characteristic changes underground and to indirectly indicate the flow direction of contamination. Furthermore, the TL-ERT is also an efficient approach to evaluate remediation effectiveness in remediation or post-remediation sites. When the lapse of time is short, TL-ERT is similar to real-time monitoring. It is more efficient to estimate the transportation direction of pollutant or medicament by using TL-ERT combined with Cross-Hole Electrical Resistivity Tomography (CHERT). It can not only get high resolution electrical resistivity images but also increases the benefit of new monitoring wells.

Keywords: NAPL, ERT, Time Lapse, Geophysical survey, Pollution, Resistivity imaging

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

AGE04-P09 Room:Convention Hall Time:May 24 18:15-19:30

Assessment of enhanced infiltration by artificial macropore with HYDRUS-2D

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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. If soils are degraded and poor in organic matter, sometimes surgace crust would be created after the heavy rain, in this situation, soil surface structure could greatly influence on rainwater infiltration. Thus artificial macropores were created for degraded soils to enhance infiltration. Artificial macropore is a vertical tubular hole with fibrous materials inside. Fibrous material allow enhancing vertical infiltration while maintaining its. In the experiment, HYDRUS-2D was used to reproduce artificial macropore effect on vertical infiltration along with surface runoff. Macropores were open to the soil surface while drawing surface runoff water simultaneously. However, HYDRUS-2D can not calculate surface runoff on the soil. In order to calculate surface runoff, we configured virtual space set with high saturated water content and high hydraulic conductivity within the calculating domain. The virtual space was assumed as virtual-air. We conducted computer simulations along with actual experiment using same conditions such as soil texture, rainfall intensity and artificial macropore. In the result, surface runoff and inflow into artificial macropore were accurately described by configuring virtual-air. The above results would allow us to reproduce the effect of artificial macropore to enhance infiltration in HYDRUS-2D with virtual-air.

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

AGE04-P10 Room:Convention Hall Time:May 24 18:15-19:30

Measuring Fresh and Old Organic Matter Contents in Degraded Soils using FTIR spectroscopy.

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Soil is the largest of all terrestrial carbon stores, and it also have important functions such as water storage and plant support roles. However, soil run-off by climate change and changing farmland management has caused decrease of soil organic matter (SOM).In our previous research, we have successfully introduced surface organic matter into soil by enhancing infiltration and stimulate vegetation growth. It would be useful if we could distinguish the contribution by fresh plant and SOM.In this study, we applied Fourier transform infrared (FTIR) spectroscopy for measuring SOM.

We mixed about 0-5 % of cellulose (assuming plant root) and humic acid (assuming soil organic matter) by the carbon weight with Toyoura standard sand or Bentonite. Diffuse reflectance was employed and peak area was measured for estimating organic matter content. IR spectrum revealed that good correlation was obtained with 3450 and 2900^{cm-1} for cellulose and 2600cm^{-1} for humic acid. Finally, we measured independent organic matter contents of cellulose and humic acid using mixed organic matter of cellulose and humic acid, which was assuming field application. Estimation of carbon contents was well for cellulose when designed concentration was less than 2%, regardless of humic acid concentration. On the other hand, humic acid was well described for concentration more than 3%.We could obtain preliminary results toward characterizing the organic matter content in the field by distinguish the contribution by fresh organic matter and soil organic carbon.

Keywords: FTIR spectrums, soil organic matter, soil carbon

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

AGE04-P11 Room:Convention Hall Time:May 24 18:15-19:30

A Case Study of Combining Geophysical Prospecting Techniques at a DNAPLs Contaminated Site

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Since 2008, site remediation was being conducted on both soils and groundwater which are impacted by dense non-aqueous phase liquid plumes (DNAPLs), in an old waste dump site of abandoned factory located in Hsinchu, Taiwan. This included continuous pumping and treatment on contaminated groundwater from wells. The DNAPLs existed for a long time and no records of previous operation were available. Therefore, significant quantity of DNAPLs remained in the subsurface and infiltrated downwards from the topsoil to lower bedding of fine sand embedded with gravel and siltstone.

In this study, we presented the investigation outcomes of electrical resistivity tomography (ERT) and ground-penetrating radar (GPR) at the DNAPLs-impacted site. Evaluation of RIP technique deployment in detecting buried DNAPLs and assessment of remediation efforts are also discussed. Results indicated zones with anomalously high resistivity to be associated with contaminated DNAPLs presence. Resistivity maps clearly outlined the subsurface distribution and the possible migration path of DNAPLs.

Keywords: Dnapls, electrical resistivity tomography (ERT), ground-penetrating radar (GPR)

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

AGE04-P12 Room:Convention Hall Time:May 24 18:15-19:30

Application of Surgical Remediation to Complex Contaminated Sites in Taiwan

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Because of geological heterogeneity, it is easily to misestimate the distribution of pollutants and to predict the transportation of pollutants difficultly during the investigation and remediation of groundwater contamination. Furthermore, the injection of gas and remediation regents or biological species cannot effectively transport to pollutant area of complex geology, especially in low-permeability strata. Therefore, it is necessary to develop Surgical Remediation(SR) for some geological heterogeneity complex sites. The SR is to applying high resolution of investigation techniques to get more underground characteristic, such as 3D pollutant distribution, geological distribution and biochemical information, and to using better remediation transportation techniques to overcome geological heterogeneity. For example, remediation regents can be spread more widely to remediate pollutants in low-permeability strata.

A geological complex contaminated site in Taiwan, interbedded with sand and silty clay and its permeability reached 2˜3 orders of magnitudes, was studied in this research. The groundwater is highly contaminated with 1,2-Dichloroethane and Vinyl Chloride. (Many of them reached tens of ppm.) The pollutants have distributed over high-permeability strata (sand) and low-permeability strata (silty clay). We introduce the concept of SR, using Multi-Depth Pollutant Sampling Analysis, Multi-Depth Radon Analysis, Bacteria Flora Analysis, Multi-Depth Slug Tests, Well Log Analysis and Multi-Depth Flow Velocity and Direction of Single Well Test, to evaluate the 3D hydrogeology characteristic and the space-time variation of pollutants. We design appropriate injection pressure and flow according to hydraulic conductivity value range, pollution concentrations, and polluted depth and apply Double Packer Injection (DPI) to utilize multi-depth method injecting remediation regents (Japan Patented Biostimulation Reagents, EDC?, which can degrade high-concentration chlorinated contaminants effectively was chosen.) into the specific deep strata, and use the automated monitoring system developed by ourselves to confirm the interrelationship between the pressure of each injection depth and flow changes. The injection parameters are modified accordingly and instantly. Finally, we use the groundwater flow direction and perpendicular direction to evaluate the overall mass flux variation, and combine with novel geophysical, Cross-Hole Electrical Reisitivity Tomography (CHERT), to directly or indirectly evaluate remediation regents variation during transportation and the space-time improvement performance. This research proves that SR can be effectively investigated underground characteristic, and remediation regents can be efficiently transported within high-permeability strata and low-permeability strata to fit in with the expected direction, and pollution concentrations can be reduced significantly in few months to conform to the Control Standard.

Keywords: Geological heterogeneity, Surgical remediation, Double Packer Injection, Automated Monitoring Systems, Cross-Hole Electrical Reisitivity Tomography

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

AGE04-P13 Room:Convention Hall Time:May 24 18:15-19:30

Temperature Dependency on Solute Transport Parameters in Porous Media at Saturated Condition

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Widespread use of ground source heat pump systems may disturb thermal condition of soils, and potentially causes changes in subsurface mass transport. Therefore, understanding temperature dependency of the solute transport characteristics is essential to accurately assess environmental risks due to perturbation of subsurface temperature. In this study, one-dimensional solute transport experiments were conducted in repacked columns under temperature control (10 ^{o}C to 40 ^{o}C) to investigate effects of temperature on solute transport parameters. Toyoura sand and glass beads were used in the experiments. In the transport experiments, 0.01M KCl solution was injected to the core sample with 5-cm diameter and 5-cm height from the bottom end. The concentrations of the electrolyte at the effluent were measured using electrical conductivity, and used for calculating solute dispersion coefficient. The solute diffusion experiments were also performed under different temperature conditions to obtain temperature effect of solute diffusion coefficient. The results showed hydraulic conductivity and solute diffusion coefficient for both materials increased with increasing temperature due to lower viscosity of water at higher temperature. Toyoura sand showed that solute dispersion coefficient at 25 ^{o}C was highest followed by 40 ^{o}C, and 10 ^{o}C, indicating effects of temperature on solute diffusivity and viscosity of water affected solute dispersion characteristics. For glass beads with larger size fraction, temperature dependency on solute dispersion coefficient was insignificant.

Keywords: solute dispersion coefficient, solute diffusion coefficient, hydraulic conductivity, thermal dependency

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

AGE04-P14 Room:Convention Hall Time:May 24 18:15-19:30

Compaction properties for municipal solid waste at open dumping sites located in Sri Lanka

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Due to rapid urbanization, generation of municipal solid waste is increasing in developing countries. However, most of the waste disposal site in developing countries is an unsanitary open dumping causing serious social and environmental problems such as subsidence and collapse of waste slopes at disposal sites. Sri Lanka is one of countries facing the waste disposal problems (Sato, et al,. 2012), and most of collected waste is dumped at the disposal sites without any engineering consideration such as ground settlement and slope stability. Several studies have been done to investigate geotechnical properties for municipal solid waste samples (e.g., Chen et al., 2009; Reddy et al., 2009), however effects of climate condition and age of waste on geotechnical properties are not well understood.

In this study, to investigate effects of climatic conditions and age of waste fill on compaction properties of buried municipal solid waste. Boring core and box samples of buried municipal solid waste and its subgrade taken from two open dumping sites under different climatic conditions in Sri Lanka: Udapalatha (Average temperature is 17.5 ? 25.0 degree, annual rainfall is greater than 2,500 mm) abandoned open dumping site in the wet zone and Hambantota (Average temperature is 26.3 ? 28.1 degree, annual rainfall is less than 800 mm) open dumping site under operation in the dry zone. The age of collected ranged less than 3 years after dumping for new dumped zones and between 4 and 11 years for old dumped zones. Furthermore, intact boring core and box samples of subgrade were taken from a point at which no waste dumping. Basic physicals and chemical properties such as moisture content, specific gravity (Gs), Atterberg limits, particle size distribution, waste composition, pH and EC, ignition loss were measured in the laboratory. Standard proctor tests were carried out to determine the maximum dry bulk densities and optimum water contents for waste and subgrade samples.

Results show that Gs values for waste samples in both wet and dry zones were less than intact soil, in addition less than 2.50 for waste samples in the wet zone. Based on the waste compositions for two sites in wet and dry zone, for every waste samples, residue content below 4.75mm were rich, and the residue content for dry zone exceed 60%, the waste samples in the wet zone had more various kinds of wastes. The maximum dry densities (ρ_{dmax}) for dry zone were around 1.5 times higher than those of wet zone. *In-situ* dry bulk densities ($\rho_{in-situ}$) were around 80 % compared to ρ_{dmax} for both samples in wet and dry zones. Both ρ_{dmax} and $\rho_{in-situ}$ gave good linear relations to residue content below 2.00mm and loss on ignition. Therefore, the residue content and loss on ignitions seem to be good indices to identify the compaction properties for dumped waste materials.

Keywords: Muncipal solid waste, Maximum dry bulk density

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

AGE04-P15 Room:Convention Hall Time:May 24 18:15-19:30

Compressibility for industrial waste materials with various mixing proportions and settlement analysis

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Solid waste materials are highly heterogeneous depending on various waste compositions, making it difficult to understand their engineering characteristics. The purpose of study is to find out effects of waste compositions and mixing proportions on the optimization of the dry density of 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. The purpose of study is to find out effects of waste composition and mixing proportions on the compaction and to optimize the maximum dry bulk density of the waste samples to reduce the landfilling space requirement with least settlement of the final landfills. Standard compaction/proctor test results showed that maximum dry bulk densities of the incineration ash (1.53-1.74 g/cmˆ3) and crushed concrete (1.37-1.52 g/ cmˆ3) were higher than the inorganic sludge (0.76 g/ cmˆ3) and organic sludge (0.90 g/ cmˆ3) respectively. The maximum dry bulk density for the mixed sample with ratio of 2:6:2 and 2:2:6 (1.65g/ cmˆ3) dry mass basis were 2.17 times greater than that of inorganic sludge. Consolidation properties determined with modified oedometer apparatus with 10cm diameter and 10cm height to incorporate the coarser fractions of the waste materials, showed that compression index (Cc) of the sludge was 0.21 which reduced significantly 0.04 and 0.02 in that of 1:1:1 and 5:2:3 mixed samples respectively. A simple settlement analysis was carried out using measured consolidation parameters, assuming 10-m thick of waste layer below 3-m soil capping. Three different waste layers, only sludge, two mixed samples of concrete and sludge, three mixed samples (sludge, crushed concrete and incineration ash), were tested in the analysis. Results showed that the final settlement for the three mixed samples was 8 times lower than that of the sludge sample.

Keywords: Solid waste, Sludge, Compaction, Consolidation, Compressibility, Settlement