Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AHW27-01 Room:202 Time:May 24 15:30-15:49

Characteristics of heavy metals and metalloids included in natural sediments in the Kanto Plain, Japan

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In order to evaluate the various characteristics of the heavy metals and metaloids contained in the natural sediments distributed over the Kanto Plain, Japan, we examined the leachabilities of arsenic (As), lead (Pb), iron (Fe), chromium (Cr), manganese (Mn), etc. for natural sediments which has no effect of anthropogenic contamination. All the analysis samples were obtained on the Arakawa lowland, the Nakagawa lowland and the Oomiya upland which are located in central part of the Saitama Prefecture. We measured the total contents and the leachabilities of these heavy metals for a total of about 200 samples (25 sites) collected in the depth from 0m to 50m. Chemical compositions of the specimens were determined using X-ray fluorescence spectrometry (XRF) while the solution water chemistry was analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP/MS). In this paper, we will discuss the leachabilities of these heavy metals and metaloids to solution through the leaching test base on the backgroud mentioned above.

Keywords: Heavy metal, Arsenic, Lead, Water-rock interaction, leaching, sediments

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AHW27-02 Room:202 Time:May 24 15:49-16:08

Urban water pollution by perfluorinated surfactants and their precursors derived from surface runoff

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Perfluorinated surfactants (PFSs) such as perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) have been world-widely detected in surface water, groundwater, seawater, drinking water and aquatic organisms. PFOS was added to the listing of the Stockholm Convention on persistent organic pollutants, and PFOS and PFOA were also added to the items for further study in drinking water quality standard in Japan. Concerns and interests about PFSs in water environments are rapidly increasing. PFSs are derived from point sources (e.g. wastewater) and nonpoint sources (e.g. surface runoff). Besides, PFSs are formed through biodegradation of their precursors in waters. However, the occurrences and sources of PFSs and their precursors are not still unraveled. Therefore, studies on water contamination by perfluorinated surfactants and its precursors from urban runoff are introduced in this presentation.

PFSs in wastewater and road runoff were measured to determine their pathways of travel to water environments. Concentrations of perfluorocarboxylates (PFCAs), including PFOA, in road runoff were equal to or higher than those in wastewater influents and secondary effluents, but PFOS concentrations were lower in road runoff.

The contribution of non-point sources to perfluorinated surfactants (PFSs) in the Irumagawa River was evaluated by estimating their fluxes at dry and wet weather. The concentrations and fluxes of PFCAs (e.g. PFOA and perfluorononanoate (PFNA)) were higher during wet weather, but those of perfluoroalkyl sulfonates (PFASs, e.g. PFOS) were not. This result is consistent with previous findings: PFCAs were abundant in road runoff but PFOS was not. These results suggest that road runoff is not a negligible source of PFCAs in water environments.

We then evaluated the contributions of wastewater and surface runoff to PFSs in Tokyo Bay during dry and wet weather. Sewage markers (i.e. pharmaceuticals and personal care products (PPCPs)) of untreated and treated wastewater revealed that PFCAs were derived from combined sewer overflow (41%) during wet weather and surface runoff contributed more than half of PFCA contamination via the CSO.

The formations of PFSs through biodegradation of their precursors in road runoff, rain water, and wastewater secondary effluent were evaluated by using microorganism in groundwater. PFSs were significantly formed from their precursors in road runoff, while those were not in rain water and wastewater secondary effluent. This result indicates that formation of PFSs from their precursors in road runoff can be a pathway to groundwater.

Keywords: Road runoff, Nonpoint pollution, Perfluorinated surfactants, PFOS, Precursors, Emerging contaminants

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AHW27-03 Room:202 Time:May 24 16:08-16:23

Analysis of microbial communities in groundwater of the Kathmandu Valley, Nepal

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In the Kathmandu Valley of Nepal, groundwater is an important water resource for drinking and other domestic uses. Approximately 50% of water supply is derived from the groundwater. However, microbial contamination exceeding the standard for drinking water set by the WHO has been reported. Conventional microbial surveys have mainly focused on *Escherichia coli* and coliform bacteria. There is concern about possibility of underestimating the contamination of disease-causing bacteria except *E. coli* and coliform bacteria. Therefore, we analyzed the microbial communities in the groundwater to detect the other pathogens.

Six water samples were collected from shallow wells and river (five samples for shallow wells and one sample for river). The samples were filtrated with Durapore membranes and DNA extraction was performed from the filters. PCR amplification of the 16S rRNA genes from each DNA sample was carried out with the primer set, EUB8F and EUB907R. The 16S rRNA gene clone library was established and the clonal DNA was sequenced by the dideoxy chain-termination method. The sequence data were compared to those in the GenBank database by using BLAST search program. Moreover, the presence of pathogenic bacteria was detected by nested PCR assay.

Results of phylogenetic analysis of 16S rRNA gene sequences showed that some clones were similar to *Lactobacillus* and *Staphylococcus* that associated with human life. In addition, a total of 57 clones were closely related to nine kinds of pathogenic bacteria such as *Acinetobacter* and *Legionella*. Furthermore, results of nested PCR assay revealed that multidrug-resistant *Acinetobacter* were presented in the shallow well groundwater.

Keywords: Kathmandu Valley, groundwater, microbial analysis, pathogenic microbes, multidrug-resistant Acinetobacter

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AHW27-04 Room:202 Time:May 24 16:23-16:38

Development of geo-thermal heat pump systems using groundwater

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1. Introduction

Air-conditioning systems of efficient heat pumps using geo-thermal energy are getting popular because of their low environmental impacts. There are two types of geo-thermal heat pumps. One is an closed type which gets heat through the heat exchanger installed underground, and the other is an open type which pumps up groundwater directly for the source of heat pumps. Nowadays, the closed type is widely used with few restrictions of location. On the other hand, the open type which can simplify well equipments is considered to have several advantages in respect of cost, and it has a potential to be spread in the area where groundwater resources are abundant. The authors report the feasibility of open type heat pump air-conditioning systems which combine groundwater circulation heat pumps and a secondary side air-conditioning systems.

2. Heat pumps and secondary side air-conditioning systems

As the secondary side air conditioners, dedicated outside air system that combines outside air handling with a fan coil unit using dry coils was adopted. By the systems, comparatively high temperature groundwater can be used with for sensible heat source, and high coefficient of performance (COP) of a heat pump will be expected. Furthermore, there is a possibility of free cooling which uses groundwater for air-conditioning directly without heat pump in summer, which means proposed system will be suitable for the open type heat pumps. In this study, the hybrid systems of heat pumps and free cooling systems were newly proposed, and their efficiency was examined.

3. Groundwater Water Quality Control

When the heat pumps use groundwater circulation, it is necessary to prevent the bad influence of groundwater quality like water pressure fall and land subsidence caused by recharging well clogging. Common clogging materials are iron, manganese, or fine clay particles. Especially, ferrous iron ions in groundwater are easily oxidized by air and will become suspended solids. Moreover, calcium ions in heat exchangers or wells may precipitate onto pipe surface as a solid material. In this examination, Na type ion-exchange resin was adopted as the water softening and removal method of these ingredients. As a result of laboratory experiments, it was shown that about 1m3 of water can be softened by 1L of ion-exchange resin. This means that it can miniaturize equipment compared with standard coagulation/filtration method, when the iron concentration is comparatively low .

4. Parametric study of pumping wells/ recharge wells layout planning

In this system, recharge wells after using groundwater heat must be installed in the ground as well as pumping wells as a heat source. For preventing short circuits, which means used groundwater may be pumped again from pumping wells; there must be a sufficient distance between pumping wells and recharge wells. Moreover, the trans-seasonal thermal storage effect by ground heat storage capacity may be expected by switching recharge well in summer season to pumping wells in winter season. Groundwater and heat flow coupled analysis using TOUGH2 was simulated to examine the effective wells arrangement. It was shown that a short circuit does not happen when there are more than at least 30-m distance between pumping wells and recharge wells. The trans-seasonal thermal storage effect showed about 2 to 4 C heat advantage.

5. Comprehensive Evaluation of System Performance

The comprehensive quality assessment by a simulation model was performed for 3 cities (Sapporo, Nagano, and Fukuoka) using a model office building of 1,000 m2. This system showed 55 to 60% energy saving effects compared with conventional air conditioners.

This study was carried out as ”The research and development of next generation type heat pump system research development / groundwater control type efficient heat pump system” in the fiscal year of 2011 funded by New Energy and Industrial Technology Development Organization (NEDO).

Keywords: groundwater, heat pump, geo-thermal, water quality control, flow analysis

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Damage of the water treatment facilities from 3.11 earthquake: Case study in Ibaraki Prefecture, Japan

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Ibaraki Prefecture, which experienced few natural disasters in the past, was severely damaged in the earthquake and tsunami of March 11, 2011. About 14 percent of the houses in the prefecture were damaged. A huge tsunami damaged the coastal area of northern part of the prefecture. Kashima Port, Hitachi harbor, and Rokko area were severely damaged by liquefaction. Cuts in water supply occurred throughout the entire prefecture, except for some areas in the southern and western parts of prefecture. In particular, regions such as Kita-ibaraki, the Rokko area, and a part of the southern area recovered their water supplies after April, 2011. These damages were mainly caused by shaking and liquefaction in water treatment facilities.

Keywords: 3.11 earthquake, damage of the water treatment facilities, liquefaction, Ibaraki Prefecture