Discussion on application of observation wells for groundwater levels and land subsidence

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There have been occurred depletions of hydraulic potential in aquifers and land subsidence due to groundwater abstraction in many urban areas in Japan. Municipalities and the National Government have restricted the abstraction by laws and ordinances and have developed the network of observation wells for hydraulic potentials and land subsidence.
Recent years, in many urban areas, the monitoring of hydraulic potentials and land subsidence has been reduced because the hydraulic potentials and land subsidence have recovered and calmed by regulations. However, groundwater demand has increased again, especially after 2011 Great East Japan earthquake. In addition, the Basic Act on the Water Cycle decides that the municipalities have to monitor groundwater environment for conservation of water cycle. Therefore, the municipalities are forced to maintain the monitoring of observation wells and to manage appropriate groundwater development.
On the other hand, from the viewpoint of scientists and engineers who engage earth science, the observation wells are the "window" that can provide useful data of subsurface environment and are the important "tools" for appropriate understanding of unsteady groundwater environment system due to urbanization. In this presentation, application and issues of the observation wells will be discussed.

Keywords: observation wells for groundwater levels and land subsidence, application, groundwater issues, unsteady system, sustainable management

Evaluation of subsurface warming in the Tokyo metropolitan area, Japan

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Three-dimensional subsurface temperature distribution and its long-term change were examined by repeated observations of temperature-depth profiles at monitoring wells from 2000 to 2015 and groundwater temperature monitoring from 2007 or 2012, to evaluate effects of regional groundwater flow and environmental changes due to urbanization on subsurface thermal environment in the Tokyo metropolitan area, Japan.
Subsurface warming has been found at shallow depths in the whole study area by our previous study (Miyakoshi et al., 2010). Especially, subsurface temperature beneath the city center was particularly high not only at shallow part but also deep part. In contrast, relatively low temperatures were found beneath the suburban area. Comparison result between past subsurface temperature data (2003 to 2005) and present subsurface temperature data (2013 to 2015) shows that subsurface warming is found at the shallow part in the last 9 to 10 years. Subsurface temperature increase in the city center is larger than the suburban area, and the temperature difference between both areas shows an increasing tendency. Additionally, subsurface warming in the present data was recognized deeper than the past data. This result suggests that distribution of subsurface warming is expanding toward the deeper part.
Moreover, results of subsurface temperature monitoring showed difference of subsurface warming tendency by area and depths. The difference suggests that subsurface warming was affected by not only surface warming but also many factors such as geological condition, groundwater flow and waste heat from subsurface structure. Results of this study suggest that mechanism of subsurface warming is able to be evaluated by combined analysis of geological condition, groundwater flow and subsurface temperature changes. This study was supported by JSPS KAKENHI Grant Number 25871190.
This study was conducted as a part of Civil Engineering Center, T.M.G.- Akita Univ. - AIST Joint Research and Saitama Pref. –Akita Univ.– AIST Joint Research.

Keywords: subsurface temperature, groundwater flow, subsurface warming, groundwater environment, urbanization, Tokyo metropolitan area

On geochemical and isotopic characteristics of shallow urban groundwater in Shinagawa district, central Tokyo, Japan

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Water chemistry of shallow groundwater in the highly-populated Shinagawa district, central Tokyo, Japan, is discussed with special reference to its nitrate, sulfate and chloride concentrations. As a result of the water chemistry analysis, shallow groundwater proved to be characterized by a high nitrate, sulfate, and chloride concentrations. The enriched $\delta^{15}N$ and $\delta^{18}O$ values of nitrate and $\delta^{34}S$ values of sulfate suggest leaking sewers is a potential source of nitrate and sulfate ions in shallow groundwater.

Keywords: Tokyo, megacity, shallow groundwater, groundwater pollution, isotope, hydrochemical process

Studies on the groundwater environment in Choshi area (1)

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Groundwater contamination of nitrate nitrogen becomes a serious problem in the area which is active in agriculture and stockbreeding. Choshi area also suffers from the contamination problem because that area is also one of active areas of agriculture in Chiba prefecture. In order to grasp the situation of the nitrate nitrogen pollution on groundwater in Choshi area, the current research investigated the water qualities from 5 spots of the water wells and from 4 spots of spring in Choshi area from June 2014 to December 2015. Nitrate nitrogen concentration of 3 spots of spring water, which are extracted from the underside of a farmland, exceeded 10 $mg/L^{-1}$of the groundwater quality standard value (the maximum was 30 mg/L^{-1}). On the other hand, in the well water from a spot near the TONE River, which is located far from a farmland, the nitrate nitrogen concentration was less than 4 mg/L^{-1}. This result suggested a possibility that some spring water was affected by nitrate nitrogen in leaching water from a farmland.

Keywords: ground water, nitrate nitrogen, water examination

Modification of ammonium diffusion method for $\delta^{15}N$ analysis and application for contaminated groundwater in Nepal Kathmandu Valley

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The objectives of this study are to improve analysis methods of ammonia isotope and to apply for pollution source analysis of the environmental water sample. The target analysis is the groundwater of Nepal Kathmandu Valley. In this area, the dependence rate on groundwater is more than half of the total water demand, and there are many spots of exceed the ammonia standard value.
Ammonia isotope analysis of this study is a modification of the ammonia diffusion method of Holmes et al (1998). We succeeded in shortening the ammonium diffusion time from 14 days (original method) to 5 days. Ammonium concentrations were detected in the range of 2.0~17.1mg/L (n=9) and 1.8~15.3mg/L (n=6) from shallow dug well and shallow tube well, respectively.$\delta^{15}N$-NH_4 was 2.1~23.3‰ (n=9) and 1.2~3.8‰ (n=6) from shallow dug well and shallow tube well, respectively. According to the previous studies, wastewater (human origin) has $\delta^{15}N$-NH_4=24~40‰ (Ambio, 2004) and lake sediment (natural origin) has $\delta^{15}N$-NH_4=-3.4~+2.1‰ (Vreca&Muri, 2006). These results suggest that the main source of ammonium contamination is soil and mixture of soil and wastewater for shallow tube wells and dug wells, respectively.

Keywords: Nitrogen isotope in ammmonia, Groundwater, Kathmandu Valley

Evaluation of Different Groundwater Sampling Methods in the Investigation of Chlorinated Hydrocarbons in heterogeneous aquifers

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Geological heterogeneity affects the diffusion of chlorinated hydrocarbons between high and low permeability strata in groundwater plumes. Because of the concentration gradient, solutes in the low permeability zone will back-diffuse into the high permeability zone, leading to the phenomena of “tailing” and “rebound”. However, these small but significant effects are often ignored, and the resulting mistaken mass transfer coefficient can cause erroneous assessments of the concentration distribution in low permeability zones. There are two parts to this study. One part is the correlation analysis of the concentrations obtained by the common sampling methods (micro-purge sampling and bailer sampling) for the chlorinated alkenes and chlorinated alkanes in 35 monitoring wells. The other part includes case studies to evaluate the use of three standard sampling methods (micro-purge sampling, bailer sampling and passive-diffusion bag sampling) for the analysis and comparison of heterogeneous aquifers.

Based on the results of three statistical hypothesis tests (t test, Z test and F test), there were no significant differences between bailer sampling and micro-purge sampling. The results thus show that both methods have a high correlation with regard to chlorinated alkenes and chlorinated alkanes ($r=0.79\sim0.99$), with the differences between them likely to be due to variations in the location depth and degree of disturbance. The major flow mechanism during bailer sampling and micro-purge sampling is influenced by advection, and the water that is obtained with both methods is mainly from the high permeability zones. Therefore, the correlations between these two sampling methods with regard to the measured concentrations were high. If the geological heterogeneity is more complex, or the high and low permeability zones show complicated inter-bedding, then bailer sampling and micro-purge sampling will erroneously estimate the actual contamination conditions, especially for the pollutants that have diffused into the low permeability zone. Due to the flow mechanism of diffusion, passive-diffusion bag sampling can better reflect the distribution of contaminants in both high and low permeability zones. To ensure the validity of the data, the sampling bags should be in place for at least 14 days, and the necessary precautions taken to prevent interference during this period of time.

Based on hydrogeology and geological heterogeneity, this study suggests that it is necessary to adopt comprehensive strategies, such as a combination of simple well investigations, monitoring well investigations (to examine sandy aquifers, gravelly aquifers, distinct inter-bedding, and so on), deep monitoring well investigations (with the water level or sampling depth exceeding 40 meters) and investigation evaluations (or remediation evaluations). With the use of appropriate sampling methods and investigation techniques, it is possible to reduce the probability of erroneous estimations, and determine the distribution of actual contamination in both high and low permeability zones, as well as the possible pollutant sources.

Keywords: chlorinated hydrocarbons, Geological heterogeneity, diffusion, sampling methods, hypothesis testing

