Geochemistry, from rain water to groundwater and pollution in Dhaka water

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Rain water is the source of most ground water and a logical starting point for the study of groundwater geochemistry. However natural and anthropogenic dusts and gases modify the composition. Before the rain turns into ground water, various processes in the soil may affect the concentrations. Dhaka, capital of Bangladesh, is a megacity dependant on groundwater for the majority of its water supply. Recharge to the groundwater aquifer is insufficient to balance abstraction, groundwater levels are in decline and water quality is compromised by seepage from areas of urban and industrial contamination and leakage from polluted rivers. Environmental isotope distributions have been used independently to evaluate the significance of potential sources of pollution. Both approaches identify the polluted River Buriganga as the main threat to groundwater quality, indicating priorities for monitoring and aquifer protection. In this abstract, we will follow the evolution in water chemistry from rain, via soil and contaminated river recharge to the aquifer.

Keywords: Dhaka Rainwater, River pollution, Groundwater

Behavior of As and its related elements to causes groundwater As contamination in the aquifer sediment of Lakshmipur, Bangladesh

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Introduction
Arsenic contaminated groundwater has been the worldwide problem for more than three decades, and still the problem has been remained. Arsenic contamination is the most serious in the Ganges-Bramaptra-Meghna (GBM) river basin than any other places.
Highly As-contaminated groundwater appears mainly in the reducing aquifers. On the other hand, some researchers suggested that oxidation-reaction is important at the initial stage of the arsenic dissolution. In this study, we examined an arsenic dissolution processes based on the analyses of the aquifer sediments from Lakshmipur, downstream of Ganga in Bangladesh, where arsenic contaminated groundwater appears in reducing environment.
Methods
The samples of this study are cored sediments at each 5 ft down to 130ft depth. The sediment samples were chemically treated according to the BCR method (Rauret, *et al.*1998.). The BCR method is a convenient method to analyze the chemical components that are extracted by different types of solutions; 1. Acid soluble phase (mainly weakly adsorbed on the sediment particles and in carbonate minerals), 2.Reducible phase (mainly fixed in and/or strongly adsorbed onto iron oxyhydroxides and manganese oxides), 3.Oxidizable phase (mainly fixed as organic matters but including substances easily decomposed by oxidation), 4. insoluble phase (mainly silicates and sulfide minerals). The BCR cannot use to identify substances to fix the targeted components, e. g., arsenic in this study, but is useful for estimating the dissolution process of the components. The extracted solutions were analyzed using ICP-MS. The analyzed elements were Si, Fe, Mg, Ca, As. Mineralogy and bulk sediment chemistry were analyzedusing XRD and XRF, respectively. Total arsenic concentration of the bulk sediments was quantified by ICP-MS.
Result and Discussion
Fe, Mg, Ca were the highest proportion in the insoluble phase. Positive correlation between Mg and Fe, and Fe and Si in the oxidizable phase and Mg and Fe of reducible phase gave a negative correlation. Mg and Fe, and Fe and Si in the insoluble phase gave positive correlations. These observations suggest the same source(s) of Mg, Fe, and Si. Fe and Mg in the reducible phase increased with depth suggesting that Fe and Mg bearing minerals were oxidized and decompose to precipitate as or with oxides/oxyhydrooxides. .
The highest proportion of As existed in the insoluble phase, following reducible and , oxidisable phases, and the amount in acid soluble phase was small compared with the other As phases. As concentrations of the reducible and insoluble phases correlated with total As concentration, implying that a primary source of As was detrital minerals such as silicates and sulfides, of which oxidation-dissolution released the As into the groundwater. The As and Fe concentrations of oxidizable and insoluble phases had a negative correlation. Thus, the As released via decomposition of As bearing Fe mineral(s) would be adsorbed onto the Fe-oxyhydroxide/oxides.
XRD analysis demonstrated that the studied sediments comprised with Fe-Mg silicates; i. e., biotite, chlorite, and amphibole. Chlorite would be decomposed with increasing depth, or with age, based on the intensity of those basic minerals. Since the chlorite from Ganga basin contained considerable As (Masuda et al., 2012), oxidation-decomposition of chlorite would also be a mechanism to release As into the groundwater. However, the As level of groundwater after the

decomposition of chlorite is controlled by the adsorption equilibrium with Fe-oxyhydroxide.

Keywords: groundwater, arsenic, Bangladesh

Characteristic and origins of "Valuable Water Springs in Toyama Prefecture" using isotopic composition and chemical concertation

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Total eight spots of spring water from Toyama Prefecture were selected as 'The 100 Exquisite and Well-Conserved Waters (EW water)' by Ministry of the Environment in Japan. However, with enhancement of groundwater usage in recent years, water quality and flux diminished gradually. To understand the origins and water qualities of these spring water, we measured hydrogen and oxygen stable isotopes, together with chemical composition of spring water, groundwater, rivers, and rainfall in Toyama Prefecture. All EW water in the Toyama Prefecture lied in the middle of meteoric water line with d-value ($\delta D-\delta^{18}O$) of 30 in winter and 10 in summer. This suggests that EW water was well-mixed and balanced by precipitation in all seasons. Muratsubaki located in the edge of Kurobe alluvial fan, has very similar mineral composition with nearby confined groundwater, suggests having the same catchment origin with Kurobe River. Using $\delta^{18}O$ and water property data, this spring water is known that originated from high mountain area with 1658m elevation and well forested. Furthermore, downstream show higher SiO_2 and lower Na/Ca ratio relative to upstream, well agreed with longer residence time in the downstream (0-5 yrs) comparable with previous study. In contrast, no significant difference of SiO_2 and Na/Ca versus $\delta^{18}O$ between groundwater and river in the Sho River fan, implying short transit time from river to groundwater. This study highlights the importance to examine groundwater source to sustain high quality EW water, e.g. paying attention to water preservation in the forest area.

Keywords: groundwater

Spatial and temporal variation of stable isotopes in precipitation in Hokkaido, North Japan

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Stable isotopes in precipitation have been widely used for paleoclimate and paleohydrology reconstruction, which is based on its temperature effect and amount effect. However, the relationship of stable isotopes of modern precipitation against meteorological variables has not yet been understood well. In this study, precipitation was collected at 6 locations in Hokkaido during the period from March 2010 to February 2013 to investigate relationship between isotope ratios of precipitation and meteorological condition and to clarify the underlying processes. Relatively low $\delta^{18}O$ with high d-excess for annual averages were observed at three sites in the region along Sea of Japan (Teshio, Nakagawa and Sapporo), compared to the other three sites on Pacific side (Tomakomai, Shibecha and Akkeshi). Seasonally, winter precipitation showed the lowest $\delta^{18}O$ and highest d-excess among seasons. Weekly $\delta^{18}O$ was positively correlated with temperature and negatively with the amount of precipitation in most season and regions. To investigate the relationship between meteorological condition and $\delta^{18}O$ values, 264 precipitation events were identified. Precipitation events from low pressure systems were classified into three groups (northwest, southeast and middle) according to their trajectories. Precipitation events with trajectory of southeast of Hokkaido showed relatively lower $\delta^{18}O$ than those in northwest, although the amount of precipitation in Hokkaido area was not different between them. Lower $\delta^{18}O$ values observed in earlier case was attributed to lower $\delta^{18}O$ values of water vapor due to heavy rainfall in the upstream region of the trajectories of low pressure systems on Pacific Ocean. Observed isotopic composition of water vapor also supports this.

Keywords: stable water isotopes, precipitation, Hokkaido

Sources and flow system of groundwater in and around eastern Fukushima Prefecture

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Great East Japan Earthquake on the 11th March 2011 impacted on the hydrosphere. Salinization by Tsunami and radiogenic isotopes caused by the Fukushima Daiichi nuclear disaster were the most serious for the groundwater of affected area. Tritium originated from the disaster was detected in the shallow groundwater near the nuclear power plant in Fukushima (Yabuzaki, 2015).
In this study, major and minor chemistry, radiogenic Cs, stable hydrogen and oxygen isotopes of water, and SF_6 and CFCs were analyzed to trace the groundwater flowing paths from the recharging zone to the sampling site. The samples were taken from the eastern half of Fukushima, southernmost part of Miyagi and northernmost part of Tochigi Prefectures; 37 riverwaters, 46 springwaters, 71 well waters <10 m depth (shallow groundwater hereafter), and 21 well waters >10 m depth (deep groundwater hereafter).
Dissolved components are generally low, i. e., EC<200 mS/cm. The most diluted waters were found in the mountainous area (Abukuma Mountains) and at foot of the high mountains (Ohu and Echigo Mountains) in the west, and the major chemistry were Na-Ca-HCO_3 type, reflecting silicic igneous rock compositions. The water chemistry changes through Ca-HCO_3 to Ca-Na-SO_4(+NO_3) types. Especially, the latter water chemistry was found in the low land and villages in the mountains, indicating vertical infiltration of surface water, plausibly containing wastewaters with anthropogenic origin of these anions. Na-Cl type water groundwater was found in the Tsunami affected area, however, the Cl concentrations are as low as 40 ppm, and the seawater rapidly removed from the reservoirs. Riverwaters collected from the foot of the high mountains occasionally gave Ca-SO_4 type water chemistry due to the large contribution of hot spring waters flew out from the volcanoes.
The relationship between d^{18}O and d ^{2}H gave the two different sources of precipitation; one was from Pacific Ocean Air masses and the other was from Sea of Japan Air masses. The former was plotted on the global meteoric water line, and the all of the waters from coastal plain and foot and inside of the Abukuma Mountains. Also, these waters were observed in the groundwaters from Fukushima basin and northernmost part of Kanto Plain (northernmost Tochigi). The latter was found in and foot of eastern Abukuma and western Ohu and Tochigi Mountains and low land intercalated by those mountains (Naka-dori). The smallest isotope values were observed for the waters originated from Ohu and Tochigi Mountains, and those were plotted on the local meteoric line of precipitation originated from Sea of Japan side. Most of the waters of this group were plotted between the two meteoric water lines, indicating mixing of two differently originated precipitations.
Recharging age of the groundwaters were from 7 to 51 years, and the many were between 20 and 30 years. The groundwaters recharged in these 10 years mainly distributed in the low land around the foot of mountains. Also, the recharging periods were shorter in the southern area than in the northern area, suggesting shorter paths of groundwater flow.
Cs of all analyzed waters was below detection limit (same as standard value 10 Bq/L). Five years passed after the earthquake, and tritium and/or soluble radiogenic isotopes would be found in the groundwaters having shorter recharging period widely in the studied area. We have to monitor the water to trace the fate of radiogenic isotopes in the whole hydrosphere.

Carbon isotope composition of riverine particulate organic matter in the Kumaki River system with forest and paddy field in Noto Peninsula, Japan

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River systems play an important role on geochemical processes in watershed and the source of nutrient and organic matter to coastal marine environment. Land-use pattern in river watershed reflects water quality and bioavailable chemical compounds in river waters. Rain and snow events also influence water quality, transport flux and migration behavior of organic matter in river systems. To understand the transport processes and sources of organic matter, researchers have been applied tracers such as C/N ratio, delta^{13}C, radiocarbon and biomarkers. Carbon isotopic compositions, delta^{13}C and capitaldelta^{14}C, are useful tools because of identification of plant types (C3 and C4) and apparent age of organic matter. The purpose of this study is to understand the transport behavior of particulate organic matter (POM) in rivers, which have watershed with abandonment of forest and paddy field in present Japanese watershed condition. The river research was carried out at the Kumaki River system, the Kumaki River and Nishiyachi River during 2009-2011, in the Noto Peninsula, Japan. We set up at three sites (headwater, upper and middle reaches) of the Kumaki River and at three sites in the Nishiyachi River of the main tributary. Riverine suspended solids were separated from 60-90 L river waters using continuous flow centrifugation method. delta^{13}C values range from -28.5 to -24.8‰ for the organic matter in riverine suspended solids and river bottom sediments. The capitaldelta^{14}C values are 86 to 97‰ at the headwater site, -5 to 34‰ at the upper site and -18 to -64‰ at the middle site. The capitaldelta^{14}C of POC decreases from the headwater to the middle sites at the Kumaki River. POC content is 3.9 to 21%, and C/N ratio ranges from 9 to 19. These parameters also show downward decreasing trend in the river line. Similar downward variations were found in the Nishiyachi River but little bit different correlation with delta13C and capitaldelta14C. Land-use pattern in the Kumaki River watershed is occupied by forest in the upper area and by paddy field along the middle and lower river area. These results indicate that paddy field in the middle and lower watershed area in the Kumaki River system has main sources of POM exported to the coastal marine environments.

Keywords: Radiocarbon, stable carbon isotope, suspended solids, terrestrial organic matter

