Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW023-01 Room:102 Time:May 25 08:30-08:55

Application of stable isotopes to nitrate contaminated groundwater. Review and prospect

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For a last couple of decades, researches on groundwater contamination by nitrogen have been done intensively and knowledge on identification of sources, contamination processes, natural attenuation or denitrification processes has been accumulated. Since nitrate contaminations are closely related to social conditions besides scientific knowledge, measures against the contamination are still left as a big social concern.

The nitrogen stable isotope has played an important role to identify contaminant sources of chemical and organic fertilizers, livestock manure, and domestic waste, and to investigate contamination processes and natural attenuation processes, but combinations of concentrations and isotope ratios cannot necessarily solve problems.

The author will try to review last 20 years research works, including authors case studies in Numata of Gunma Pref., Sugadaira of Nagano Pref., Miyako Island of Okinawa Pref., Kanekodai of Saitama Pref., Nasunogahara of Tochigi Pref., Kagamigahara of Gifu Pref., Sangawa of Kagawa Pref., and Tsukuba of Ibaraki Pref.. Main focuses are on joint or complementary uses of nitrogen isotope with other isotopes and elements such as oxygen, sulfur and carbon isotopes, chloride, sulfate, and bicarbonate ions, and urobilin, in order to analyze groundwater contamination processes and to solve the problems. Some perspectives are referred.

AHW023-02 Room:102 Time:May 25 08:55-09:20

Nitrate sources and processes of rivers in the Lake Biwa watershed: Synoptic surveys using nitrogen and oxygen isotopes

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In order to clarify the pathways and origins of dissolved nitrate (NO3-) in rivers flowing into Lake Biwa, Japan, three types of scale-coordinated surveys of concentrations and isotope compositions of NO3- were conducted: (1) synoptic river sampling of 32 representative inflow rivers, (2) two rivers in catchments with different land uses, and (3) intensive samplings in a headwater catchment. The d15N-NO3 was significantly positively correlated with the population density of each catchment. A mass balance model assuming the d15N-NO3 and the flow rate of sewage effluent was developed. The model simulated the relationship between the population density and the d15N-NO3 reasonably well, suggesting that the dominant source contributing to the increase in d15N-NO3 was the sewage effluent. The spatiotemporal distribution of d18O-NO3 of rivers, especially in the headwater streams, suggested the possibility of the addition of atmospherically derived NO3- through precipitation and snow, although the d18O-NO3 in soil system of forests in the headwater catchment showed the high nitrification potential and replacement of atmospheric NO3- by the microbially produced NO3-. In general, the d18O of NO3- in rainwater is remarkably higher than that produced by nitrifying bacteria in soils. Accordingly, the d18O-NO3 can often be used as an index of the impact of the atmospherically derived NO3-. While soil waters in $<$20cm depth had a strong signal of the atmospheric NO3-, the d18O-NO3 in soil water decreased in the deeper soil horizons, indicating that the dominant source of NO3- in this soil profile was nitrification. The net nitrate production of this soil profile was about 18 kg-N/ha/year, and deposited nitrate was about 6 kg-N/ha/year. Assuming that the annual mean d18O of deposited NO3- was 60 permil, and the mean value of bacterially produced nitrate in soil was about 0 permil, the average value for soil NO3- pool could be ˜15 permil. However, the observed d18O of the soil and groundwater was 0 to 6 permil and remarkably smaller than the above estimation based on annual mass balance. This suggests that the gross nitrification was sufficiently higher than net nitrification rate, and the major portion of NO3- produced in soil was reused by microbes. In forest-dominated catchments with natural drainage systems, a slightly elevated d18O-NO3 signal remained in the stream water even during base flow conditions. This study demonstrated that multi-scale, multi-isotopic investigation is a promising strategy for describing the spatial distribution of NO3- sources synoptically and is useful for evaluating the influences of land use change. The data set used in this paper is the first comprehensive collection of isotopic composition of NO3- in rivers of a large-scale basin in Asia.

Keywords: nitrate, stable isotope, river, Lake Biwa, Forest ecosystem

AHW023-03 Room:102 Time:May 25 09:20-09:45

Environmental analysis of various aquatic ecosystems by using ^{13}C and ^{15}N natural abundances

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Natural abundance measurement techniques of stable isotopes have been utilized as animportant analytical tool to study material cyclings in biogeochemical research. Nowadays, this technique has become a general research tool for ecological and environmental research fields. Because the natural abundance of stable isotopes change corresponding to the basic processes (i.e. mixing, kinetic reaction, chemical equilibrium) that control material flows, we could conduct the following three kinds of research from the isotopic analysis of the inorganic to organic materials:

1) The analysis of the kind of the potential sources and their contribution
2) The analysis of the rate limiting reaction and the factors that control the reaction
3) The verification on whether the status are in chemical equilibrium or not

Especially, in the environmental research field, the primary way in application of stable isotope techniques continued to be for the analysis of the potential sources and their contribution. For example, food source analysis was general done by the measurement of the isotopic composition (^{13}C, ^{15}N, ^{34}S) at the individual level of some organisms, while the food web structure could be analyzed at the community level. As for the analysis of nitrate isotopic composition (^{15}N, ^{18}O), the origin of nitrate could be revealed.

In my presentation, I would like to show you how powerful the isotope analysis is as a tool by reviewing my field isotope data in various aquatic ecosystems. The following five case studies will be introduced: 1) The diversity in N nutrition among wetland plants in Midorogaike, Kyoto, 2) The difference in food web structure between lotic and lentic ecosystems revealed by comparison between an oxbow lake and a main stream in the Shibetsu Basin, Hokkaido, 3) The food webs fueled by methane derived carbon in the Horonai river, Hokkaido, 4) The relationships between watershed characteristics and 15N abundance in stream nitrate and various organic materials in Shiga, 5) The quantitative estimation of irrigation drainage by running a four source mixing model in Ibaraki.

Isotope mixing models analyzing the kind of potential sources and their contribution can be useful to examine whether river ecosystems are supported by material loading from its watershed or by regenerated compounds within river ecosystems. Because the ^{15}N natural abundance in organic and inorganic materials was roughly explained by the isotope mixing models based on the watershed landuse patterns, Japanese river ecosystems are likely to be supported by the material loading from the watershed in terms of N cycling.

Keywords: isotope mixing model, nitrogen loading, methane food web, wetland, oxbow lake

AHW023-04 Room:102 Time:May 25 09:45-10:00

Groundwater recharge and nitrogen contamination in urban area of the Kathmandu Valley, Nepal

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Groundwater is an important water resource in Kathmandu valley, Nepal. It shares about 50% of the total water supply in the valley. In recent years, there has been a marked expansion in water demand due to population and industrial growth. It has led to heavy consequences on the groundwater levels and well yields, which are being declined (JICA, 1990). And the nitrate has recognized as a major pollutants in shallow groundwater. The objective of this study is to identify the nitrate contaminations under the shallow groundwater hydrology of Kathmandu Valley, Nepal.

The 35 shallow groundwater samples were collected public and domestic wells (depth of well are 5-20m). The nitrate-nitrogen and oxygen isotopes were determined by denitrifer method for the pre-treatment and analyzed using mass spectrometry (Sercon, Cryoprep and Hydra 20-20). And the water-oxygen and hydrogen isotope were analyzed by water equilibration system (Sercon, WES and Hydra 20-20).

The water-oxygen and hydrogen isotope values are suggested that annual rain water could be the primary source of shallow groundwater recharge rather than river water. The nitrate-nitrogen and oxygen isotope values suggested that human waste is the major source of nitrate contaminations in shallow groundwater. Furthermore, the existence of a clear slope between the nitrate nitrogen and oxygen isotope values indicated the occurrence of denitrification process in the shallow groundwater.

Reference:

JICA (Japan International Cooperation Agency): Groundwater management project in the Kathmandu Valley, Final Report to Nepal water supply cooperation, 1990.

Keywords: nitrate-oxygen and nitrogen isotope, water-hydrogen and oxygen isotope, shallow groundwater, nitrate contamination, Kathmandu valley

AHW023-05 Room:102 Time:May 25 10:00-10:15

Denitrification and nitrous oxide production and consumption processes in a groundwater at Kathmandu Valley

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We investigated denitrification and its influence on nitrous oxide production and consumption processes by measuring nitrogen and oxygen isotopes ratio of dissolved nitrous oxide and nitrate, dissolved nitrous oxide concentration and other chemicals in the groundwater at Kathmandu Valley, Nepal. Nitrous oxide productions in a groundwater contaminated by nitrogen compounds were often investigated in the agricultural land. However, there are a few studies about that in urban groundwater. Nitrous oxide productions in the urban groundwater may be important as a nitrous oxide emission pathway in the case that groundwater is used as daily life water and heavily extracted.

Groundwater samples were collected from 36 shallow tube wells and dug wells (2.8-21 m) in Aug. 2009 and Aug. 2010. We collected the samples in a glass vials at plastic bucket filled with the groundwater to prevent gas exchange between groundwater and air. mercury chloride was injected to sample to decrease microbe activity in the sample. Nitrogen and oxygen isotopes of nitrous oxide and nitrate data and dissolved molecular nitrogen data showed nitrous oxide in the groundwater at Kathmandu valley was produced by denitrification or denitrification and nitrification. Moreover, dissolved molecular nitrogen data showed nitrous oxide was strongly reduced to molecular nitrogen by denitrification. Nitrous oxide production, consumption and consequent nitrous oxide concentration was considered to be mainly regulated by nitrate pool size. As the one of this reason, denitrification can easily occur in the groundwater at Kathmandu valley because of high dissolved organic carbon and low dissolved oxygen concentrations.

Keywords: denitrification, nitrous oxide, groundwater, Nepal, isotope

AHW023-06 Room:102 Time:May 25 10:15-10:30

Analysis of indicator bacteria presence affected by hydrologic factors in groundwater of Kathmandu Valley, Nepal

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Microbial contamination routinely causes water-borne diseases in Kathmandu Valley, Nepal (WHO 2007), nevertheless, qualitative & quantitative data still remains insufficient in the central area of the valley (Joshi 2003, Pradhan 2004, Prasai 2007, Warner 2007). The present study aims (i) to survey distribution of faecal indicator bacteria in wells and track the sources and (ii) to identify the microbial community structure for development of water quality assessment & control. 12 deep tube wells, 36 shallow tube wells and dug wells, river and rain waters were investigated during dry and wet seasons of 2008-2010. *E. coli* was detected from most of all wells. River waters showed extremely high levels, however, no clear relation was observed between *E. coli* conc. in any type of GW and distance of wells from adjacent rivers. According to stable isotope analyses, nitrate in river & dug wells probably originated from sewerage. These findings indicate that tube wells were rather protected and dug wells were most vulnerable for faecal contamination at very local scale. Genetic analysis of bacterial communities for deep well samples showed the existence of *Enterobacter*, *Acinetobacter* as well as methane & iron-metabolizing groups which provide information of alternative indicators for understanding the pollution system and controlling groundwater quality in the valley.

Keywords: groudwater, Kathmandu, Nepal, indicator bacteria, stable isotope ratio, hydrologic factor, *Escherichia coli*

AHW023-07 Room:102 Time:May 25 10:45-11:00

Geochemical studies on nitrate in the basin of La Paz city, Bolivia, using 15N, 17O and 18O

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Water resources in La Paz, the capital of Bolivia, are highly dependent on runoff from its surrounding glaciers, since the city locates in a semi-arid area in the Altiplano with an annual precipitation of about 500 mm/y. This study aims at determination of nitrate cycles using its stable isotopic compositions in Tuni Lake and its basin, which is one of the important water resources of La Paz.

Samples are collected from downstream rivers of the glaciers during the dry season in September, 2010. The sampling points were allocated from an edge of the glacier to the inflow point to the lake. Samples were filtered through a 0.2 micro meter pore-size membrane filter and stored in a refrigerator until analysis. To determine the stable isotopic compositions of nitrate, the sample nitrate was chemically converted to nitrous oxide using a method originally developed for 15N/14N and 18O/16O isotope ratios of seawater and freshwater nitrate (McIlvin and Altabet, 2005) with slight modification (Tsunogai et al. 2008). The stable isotopic compositions of nitrous oxide were determined using our Continuous-Flow Isotope Ratio Mass Spectrometry system (Komatsu et al. 2008).

Nitrate in glacial melt water had smaller triple oxygen anomalies (+4.1 permil) relative to those in atmospheric nitrate (from +17 to +35 permil), which corresponds to a mixing ratio of atmospheric nitrate to total nitrate of 12-24%, indicating the significance of non-atmospheric origins of nitrate (e.c. microbial oxidation of ammonium) within the glacier. The triple oxygen anomalies of nitrate in downstream river showed systematic variation among three basins ranging from +0.4 to +3.5 permil. The variation may be attributable to the difference in biological activity among the basins.

Keywords: nitrogen cycle, triple oxygen isotopic compositions, nitrogen isotopic composition, nitrate, Glacial melt water, Bolivia

AHW023-08 Room:102 Time:May 25 11:00-11:15

The relationship between nutrients and pH in lakes as an implication for biogeochemical cycles in continental rivers.

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In the perspective of global biogeochemical cycles, rivers are an important path transporting vast amounts of solids and solutes from land to ocean. Chemical reactions of nutrients via biological activities are likely to have a great impact on pH and carbon cycle in terrestrial water. However, previous researches focusing on this perspective were quite few. As rivers in Japan have relatively short residence time than world rivers, it is difficult to simply compare nutrient cycles in small rivers in Japan with those in large continental rivers. Thus, in this study we focused on biogeochemical cycles of lakes, which have longer and comparable residence time to large rivers in the world.

We measured carbonate chemistry of lake water from Lake Kasumigaura , Tega Marsh and Imba Marsh as typical alkaline lake systems in Japan. We also conducted a detailed survey on lake water and input rivers of Lake Inawashiro, as a representative of acidified lake.

Nutrients played an important role in the variation of pH in both alkaline and acidified lakes. In alkaline lakes, nutrients enhance the activity of photosynthesis and as a result elevate pH of surrounding water. In the acidified lake, precipitation of Fe(OH)3 during the mixing of acidified river water and lake water removes phosphorus and limits photosynthesis, remaining the low pH in the lake water. In continental rivers which have longer residence time, nutrients may also affect pH and carbon cycle in river water as found in this study.

Keywords: nutrient, pH, lake, river, limnology, biogeochemical cycle

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AHW023-09 Room:102 Time:May 25 11:15-11:30

Chemical properties of spring water from different lithology and the related carbon cycle

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The earth' s surface environment is determined by the interaction of the atmosphere, the ocean and the land. The river plays an important role on controlling ocean chemistry by chemical weathering. The transportation of dissolved material and particles chemical by the river is one of essential components to the ocean chemistry through the geological time scale. The research field in this study is Fukushima Prefecture, Ibaraki Prefecture, and Shizuoka Prefecture. According to surface geological map, I got spring water samples from the catchment of several lithologies, andesite, basalt, granite, granodiorite, gabbro, mafic metamorphic rock, limestone, and the sedimentary rock. 25 samples were collected. This water quality characteristic of 25 samples could be divided into three groups: Ca-HCO3 type, Na-HCO3 type, and Ca-(SO4+NO3) type. The alkalinity in ground water is an index that shows the level of the progress of chemical weathering. High alkalinity provides a good proxy for the degree of the reaction with more minerals. The alkalinity was associated with high concentration of calcium ion.

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AHW023-10 Room:102 Time:May 25 11:30-11:45

Soil organic carbon redistribution in Japanese cypress (Hinoki) using radionuclides

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The forest cover of Japan (68%) is ranked among the highest of all nations, and its plantations, among the largest, are composed mainly of conifers (41%) dominated by hinoki and sugi tree species located in steep mountainous area. Given the huge carbon stores in this considerable land cover and the significance of the forest soil as a path in global carbon networks, understanding soil organic carbon (SOC) flux in forested areas is essential. We evaluated the potential of {210}ˆPb$_{ex}$ and {137}ˆCs to assess SOC and soil erosion in hillslope forested area. Consequently, findings demonstrated a strong correlation between SOC and both radionuclides. But {210}ˆPb$_{ex}$ showed a superior relation due to its chemical advantage to the cation exchanging sit of the soil fabric. Using DM model, net soil and SOC loss of 0.7 +/- 0.8 (SOC loss: 0.13 +/- 0.16) and 1 +/- 0.4 (SOC loss: 0.2 +/- 0.08) t ha^{-1}y^{-1} have been estimated based on {137}ˆCs and {210}ˆPb$_{ex}$, respectively. In conclusion, due to strong relationship with SOC, natural and continues fallout nature and the presence of considerable concentration in the litter, {210}ˆPb$_{ex}$ could be an alternative independent tracer to study SOC redistribution rate in forested hillslope starting from the very beginning of litter fall than {137}ˆCs. This study contributes to efforts in developing a model to quantify water induced soil and SOC redistribution using {210}ˆPb$_{ex}$ in forested area as a part of endeavor to credit and mitigate carbon-induced climate tribulations.

Keywords: Soil, SOC, radionuclide, redistribution, {137}ˆCs, {210}ˆPb$_{ex}$

AHW023-11 Room:102 Time:May 25 11:45-12:00

Spatial distribution of atmospheric SF6 mixing ratios in Japan: Implications for groundwater dating

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Sulfur hexafluoride (SF6) is a promising transient tracer for young groundwater dating, but elevated levels of atmospheric SF6 may limit application of this dating method in urban areas. To determine the magnitude of this limitation within Japan, we measured the atmospheric SF6 mixing ratios around Nagoya and Tokyo.

Keywords: Sulfur hexafluoride, atmospheric mixing ratio, urban area, Japan, groundwater age

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AHW023-12 Room:102 Time:May 25 12:00-12:15

Study on the origin of He and non-anthropogenic sulfur hexafluoride in groundwater in the Nakano-shima Island, Oki Dozen

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1. Introduction

Sulfur hexafluoride (SF_6) has been produced industrially since 1950s, and used as a tracer for dating young groundwater. In addition, $SF_6$is known to be trapped in silicic igneous rocks with high concentration, and is also estimated to be contained in deep fluid (Busenberg and Plummer, 2000). High concentrations of SF_6 in groundwater in the Nakano-shima Island, Oki-dozen, were observed, and it was suggested that the geogenic SF_6 could be the reason for the high SF_6 concentration. In this paper, we discuss the origin of water, dissolved 3He and SF_6 in groundwater.

2. Method

Water samples were collected from twelve wellsprings and a hot spring well in June 2009, February and September 2010. All samples were analyzed for major dissolved components (Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, $HCO_3{}^-$, $SO_4{}^{2-}$, $NO_3{}^-$), CFCs, ^3H, SF_6, and stable isotopic ratios of water. Samples from four wellsprings and the hot spring were analyzed for isotopic ratios of He.

3. Results and discussion

3-1. Concentrations of CFCs, ^3H, and SF_6

Concentrations of major dissolved components of water samples from deep wells tend to increase, and those of CFCs and ^3H tend to decrease. These trends suggest that groundwater of deeper part has longer residence times. CFCs and ^3H concentrations of groundwater from two wellsprings, W4 and W7, were much lower than those of other samples. SF_6 concentrations of these samples were higher than that of pond water which is assumed to be saturated with modern air. Considering that CFCs concentrations of these samples were lower, high SF_6 concentrations should be geogenic. It should be noted that the sample obtained from the hot spring showed lower concentrations of both CFCs and SF_6.

3-2. Stable isotopic ratios of water

Delta D and delta ^{18}O values of groundwater were plotted parallel to the meteoric water line. These of the hot spring and W7 were smaller than other groundwater samples.

3-3. Isotopic ratio of He

Groundwater samples from W4 and W7, containing high concentrations of SF_6, and those from two wellsprings and the hot spring, containing low concentrations of SF_6, were analyzed for He isotopic ratios. $^3He/^4He$ values of the hot spring and W7 were higher than that of air, suggesting that mantle-derived ^3He is added. Other three samples showed $^3He/^4He$ values close to that of air.

3-4. Origin of groundwater and dissolved gases

Because delta D and delta ^{18}O values of groundwater were plotted parallel to the meteoric water line, groundwater is considered to be mainly meteoric water origin. Higher $^3He/^4He$ values of the hot spring and W7 samples indicated that the mantle-derived ^3He are added to these samples. delta D and delta ^{18}O values of magmatic water are estimated to be in the range between -80 and -50 per mill, and +6 and +10 per mill, respectively (Hoefs, 2007). These values are much different from those of groundwater in the island. Therefore, the contribution of magmatic water is considered to be quite small. The hot spring water contains little SF_6 and shows higher $^3He/^4He$ value than that of air, while groundwater at W4 contains higher concentrations of SF_6 and shows $^3He/^4He$ value close to that of air. These results suggest that SF_6 added to groundwater of W4 and W7 are not originated from mantle.

4. Summary

Delta D and delta ^{18}O values of groundwater suggest that groundwater is mainly originated from meteoric water. Higher $^3He/^4He$ values of the hot spring and W7 indicated that mantle-derived ^3He is added to groundwater. As the hot spring water contains low concentration of SF6, and W4 shows low ^{3}He/^{4}He value and high concentrations of SF_6, SF_6 added to groundwater in W4 and W7 is considered not to be originated from mantle. Identifying the origin of added SF_6 also needs further consideration by analyzing concentration of SF_6 trapped in rocks in the island.

AHW023-13 Room:102 Time:May 25 12:15-12:30

Using tritium (3H) and sulfur hexafluoride (SF6) to estimate groundwater residence times around the Angkor's ruins

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Tritium (3H) and sulfur hexafluoride (SF6) provide a technique for dating young groundwater with a residence times less than 60 y. We applied these traces to estimate groundwater dating around the Angkor ruins. The tritium and SF6 based groundwater ages showed clear areal variations in which residence times are relatively short ($<$20 y) in north area (Angkor ruins area) and long (20 to 40 y) in south area (Tonle Sap area). The increase of groundwater age from the north to the south is congruent with the distribution of the water table. However, the water chemistry of groundwater was quite different between the north and the south areas, suggesting that the groundwaters of both areas are maintained from the different groundwater flow system.

Keywords: Tritium, Sulfur hexafluoride, Groundwater age, Angkor's ruins

AHW023-14 Room:102 Time:May 25 12:30-12:45

Age dating of spring and groundwater and its modeling in Mt. Tsukuba, central Japan

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To estimate the spring and groundwater residence time and to understand the surrounding groundwater flow system, the multi-tracer approaches using CFCs and stable isotope, and numerical modeling were applied to Mt. Tsukuba. From September 2009 to June 2010, field survey was conducted every 3 months, for spring and groundwater. Residence time and recharge elevation were respectively estimated from dissolved CFCs concentration and oxygen stable isotope. Using Visual MODFLOW, distribution of groundwater potential was estimated and particle tracing method computed the flow line and residence time. These values were compared with the estimated results derived from tracers. Parameters such as hydraulic conductivity were calibrated by trial and error, thus we tried to make clear the groundwater flow system.

Water chemistry was almost constant during one year: it means that there is no seasonal change of flow path and residence time. Modeling results show that groundwater level is up to 500 m and altitude where topography intersects the water table is between 300 m and 400 m. The springs located at an altitude more than 300 m show a residence time ranging from 1 to 10 years, whereas springs and groundwater located at the altitude less than 300 m show an estimated residence time, ranging from 20 to 40 years. In the gabbro catchment at the upper part of the mountain, groundwater is characterized by an almost vertical flow type. However, in granite catchment at the lower part of the mountain, groundwater is characterized by a horizontal flow type; that may explain its longer residence time. In the foot of the hillslope, an upward flow is dominant.

Keywords: Mt. Tsukuba, groundwater flow system, residence time, CFCs, numerical model

Japan Geoscience Union Meeting 2011
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AHW023-15 Room:102 Time:May 25 14:15-14:30

The characteristics of stable isotopes in precipitation at Japan

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Characteristics of Stable Isotopes in Precipitation over Japan

Spatial distribution and seasonal variabilities of stable isotopes in precipitation over Japan were considered.

The distribution of annual weighted average Oxygen-18 was considered. The Pacific Ocean side (Hachijo, Miyake, Tsukuba, Ryori) were recognized latitude effect. These of d-excess was also considered. D-excess of the Japanese sea side (Toyama, Tottori) were larger than those of Pacific sea side (Ryori, Kanto Plain, Kumamoto etc). This trend is same as previous studies. It is interesting that d-excess of Hachijo and Miyake (located in the Pacific Ocean) were almost same values in the Japanese sea side (Toyama, Tottori).

Seasonal variabilities of Oxygen-18 over Japan were recognized (increasing April and decreasing June). Seasonal variabilities of Oxygen-18 were classified into three types. The first type is summer type; high in summer (from July to August) and low in winter (from December to February). The distribution of summer type was in the Pacific Ocean side (Ryori, Kanto Plain, Kagoshima) and slope and intercept of Local Meteoric Water Line (LMWL) were less than 8 and less than 13, respectively. The second type is winter type; high in winter (from December to February) and low in summer (from June to August). The distribution of winter type was in the Japanese sea side (Toyama, Tottori). Slope and intercept of LMWL in winter type were more than 8, and more than 13, respectively. The third type is unclear seasonal variabilities. Seasonal variabilities of d-excess over Japan were recognized high in winter (from December to January), low in summer (from June to August).

Further study, the distribution of stable isotopes in precipitation will be compared with in shallow groundwater.

Keywords: stable isotopes in precipitation, seasonal variabilities, annual weighted average, LMWL

AHW023-16 Room:102 Time:May 25 14:30-14:45

Proposal method for estimating evaporation rates of water using characteristic of change of oxygen isotopic ratio

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Recently, water shortage is caused by climate change such as Global warming. Therefore, estimation of amount of evaporation for dam, reservoir and irrigation water is important for preservation of water resources.

There are various methods to calculation of the amount of evaporation such as Thornthwaite method (Thornthwaite, 1948), the Penman method (Penman, 1948), etc. The estimation method of evaporation rate using isotopic ratio was made by Allison et al. 1) or Gibson et al. 2) , etc. from before. However the method included many parameters such as humidity, partition coefficient, oxygen isotopic ratio of vapor, kinetic isotope effect, resistance of diffusion, and so on and then the some parameter is very difficult to estimate. Therefore, estimation method of evaporation rate to calculate from isotope is very difficult because evaporation rate is controlled by many parameters.

The purpose of this study is to develop simple method for estimating evaporation rates of water using oxygen isotopic ratio and to verify which parameter affects isotope ratio change and isotopic separation effectively. Then, we can estimate the isotopic ratio of the residual water when the evaporation rate of water reaches 1%.

In laboratory test, amount of average evaporation of day, temperature, humidity, and saturation deficit were measured and then the relation of isotopic ratio of water and their parameters was analyzed. From the test, negative correlation (R= -0.84) between the average humidity and the amount of change of the *delta* ^{18}O per rate of unit evaporation was clarified and then the humidity change accompanying seasonal change was clarified to affect apparently the *delta* ^{18}O per rate of unit evaporation. With the increase in an evaporation rate, the amount of change of the *delta* ^{18}O per rate of unit evaporation with humid change was clarified to decrease.

The amount of evaporation in the Inawashiro lake in Fukushima was estimated from the relation of the amount of change of the *delta* ^{18}O per rate of unit evaporation and humidity and the estimated values, 595 mm/year was good agreement with the calculation result of previous research. Therefore, the simple estimation method of this research is effective for estimation of evaporation rate of an actual lake or a pond.

Keywords: water resources, evaporation rates, oxygen isotopic ratio, humidity, lake

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(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW023-17 Room:102 Time:May 25 14:45-15:00

Estimation of the springwater origin of Kushiro-moor using oxygen and hydrogen stable isotopic ratios

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Kushiro-moor is the greatest important moor in Japan with a valuable living thing such as endangered plant and inhabits. The Kushiro-moor has some springs, and then even cold winter, river water does not froze around the spring and Grus japonensis can pass the winter. It is reported that the great portion of moor water derived from spring water. Therefore, in order to preserve moor, a wide water cycle including the catchment of spring was necessary.

The purpose of this study was grasping the water cycle of the Kushiro-moor using oxygen and a hydrogen stable isotope ratio. Flow analysis of the groundwater at the Kushiro area was performed using the 3-dimensional advection diffusion analysis software ,G-TRAN/3D for Dtransu-3D.

There are some catchment areas for springs in the Kushiro-moor from the analyzed results. The springs with -10.0 permil for delta-^{18}O along the upper stream of Chiruwatunai river was thought to de derived from areas at the north of 10~20km of the Kushiro-moor estimating from the delta-^{18}O distribution. The springs with -8.0 permil for delta-^{18}O along the upper stream of Chiruwatunai river was thought to de derived from areas at the southeast of the Kushiro-moor estimating from the delta-^{18}O distribution. The springs with -8.5 permil for delta-^{18}O near the Kirakotan cape was thought to de derived from the Taro lake area at the east of the Kushiro-moor estimating from the delta-^{18}O distribution.

On the other hand, the spring with -7.0 permil for delta-^{18}O along the down stream of Chiruwatunai river was found but water with with -7.0 permil for delta-^{18}O out side of the Kushiro-moor was not found. However, river water at the south area of the Kushiro-moor does not reach -7.0 permil but show high delta-^{18}O values. The groundwater around the Kushiro-moor was estimated to flow into the center of the Kushiro-moor by flow analysis and then west, north and east areas surrounding the Kushiro-moor were thought to be all catchment area for springs. Therefore, the high delta-^{18}O spring in the Kushiro-moor also was thought to be derived from area at the south of the Kushiro-moor.

Keywords: Oxygen isotopic ratio, Kushiro-moor, Springwater, Flow analysis

AHW023-18 Room:102 Time:May 25 15:00-15:15

Characteristics of water quality at Shiojiri Area, southern part of Matsumoto basin

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Matsumoto basin is located to slightly northward from the center of the Nagano Prefecture and surrounded the mountains (Hida-mountains and Tsukuma mountains). The complex alluvial fan is formed by the Metoba and Susuki river in the east part of the Matsumoto basin. The Matsumoto basin is from 500 to 700 m above sea level. There is some aquifer in the Matsumoto basin and large quantity of groundwater is stored in the basin. The people who live in Matsumoto city have been used the groundwater water or spring water for long period, and now that the water supply facilities is completed people use the groundwater or spring water for drinking water. In this presentation, the objective of this study is make clear the characteristics of water quality and stable isotopes in groundwater and spring water at Shiojiri City which is located to southern part of Matsumoto basin.

The water samples of groundwater and spring water have been samples at 14 sites. The EC value is from 30 to 413 *u*S/cm. The EC value is relatively low in the mountainous area and relatively high around the Shiojiri station (urban area). And the spring water of the limestone area also shows the high EC value. The pH is from 5.69 to 8.10. The pH is low in the urban area and high in the limestone area. The groundwater or spring water temperature is from 11 to 12 degree, this water temperature is almost corresponding to the annual air temperature in this area.

The water quality compositions of groundwater and spring water show mainly Ca-HCO_3 type. However, Na-HCO_3 type is also shown at deep groundwater samples, it is assumed that the residence time of this groundwater is relatively long. The NO_3 concentration is relatively high in the urban area, so it is considered that the water quality is affected by artificial influence. The stable isotope of oxygen ranges from -11.7 per mill to -11.4 per mill and hydrogen ranges from -84 per mill to -80 per mill. The isotope values in groundwater of Shiojiri area are almost corresponding to those of Matsumoto urban area (yabusaki, 2010). In the future, the investigation and sampling of groundwater and spring water at Shiojiri area will be continued, and finally the groundwater flow system of Matsumoto basin will be clarified.

Keywords: Matsumoto basin, Shiojiri area, water quality, stable isotope

AHW023-19 Room:102 Time:May 25 15:15-15:30

Fundamental study of Understanding the water cycle using oxygen and hydrogen isotopes in the region Shirahama Spring

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1.Introduction

The Shirahama Hot Spring is a famous hot spring at the west coast of the Kii Peninsula and there are many types of hot spring for water chemistry such as bicarbonic acid, chlorine and hydrogen sulfide. Hot springs temperature ranges 40 degrees to 80 degrees. Past, there were artesian flowing wells and at present, most of source of hot spring needs pumping. Although near the Shirahama Hot Spring there is neither volcano nor volcanic activity at present, the temperature of hot spring is high and heat source is not clarified.

A present problem of the Shirahama Hot Spring is decrease of flow rate and flowing pressure of the hot spring and water chemistry changes such as contamination of sea water caused by excess pumping up.

It is important to understand the source and migration of hot spring water in the Shirahama Hot Spring area in order to preserve stable supply of hot spring water. Therefore, in this study, the source and migration of hot spring water were analyzed by oxygen and hydrogen isotopes and water chemistry.

2.Experimental Methodology

Hot spring water was sampled from the Shirahama Hot Spring and the Tsubaki Hot Spring with the type of hydrogen sulfide next to the Shirahama Hot spring along the coast. River water, cold well water and sea water was sampled from the Shirahama area and the Tonda River in side of the Shirahama Hot Spring.

Oxygen and Hydrogen isotope ratios of the sampled water were analyzed by mass spectrometer with equilibrium method between sample water and hydrogen and carbon dioxide gas. In field, EC, pH, ORP and temperature were measured. Soluble substance such as Cl^-, Br^-, $SO_4{}^{2-}$, $NO_3{}^-$, Na^+, K^+, Ca^{2+}, and Mg^{2+} was measured by ion exchange chromatograph. $HCO_3{}^-$ concentration was titrated by acid.

3.Results

The relationship between the Oxygen and Hydrogen isotopes for the sampled water shows that all sampled waters were on the Meteoric Water Line.

Hydrogen and oxygen isotope ratios of hot spring water near the shoreline sites were slightly higher than those in the mountains at the Shirahama Hot Spring area.

Chloride ion concentrations in the Hot Spring water, sea water and cold well water increase with hydrogen and oxygen isotope ratios although under the condition of low chloride ion concentration, hydrogen and oxygen isotope ratios were variable. The relation between Chloride ion concentration and hydrogen and oxygen isotope ratios were as follows;

deltaD = $0.0019*Cl^-$ - 49.11

delta^{18}O = $0.0003*Cl^-$ - 8.4634

As both end points were sea water and cold well water, hot spring water was thought to be mixed water by sea water and cold well water and sea water ratios for the hot spring water in the Shirahama Hot Spring were 1 to 50 %.

Reference list
1) URBAN KUBOTA NO.38, pp.42-56, 1999, 9

Keywords: oxygen and hydrogen isotopes, Spring

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AHW023-20 Room:102 Time:May 25 15:30-15:45

Role of deep-seated fluid in formation of CO2-rich springs in the central part of San'in district

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Many CO_2-rich springs are distributed in the central part of San'in district, southwest Japan. It has been assumed that they are affected by volcanic fluid owing to existence of a small-scale Quaternary active volcano (Sambe volcano) at the center of the distribution area. It is expected, however, that deep-seated fluid derived from lower crust contributes to the formation of CO_2-rich springs, because the discharge points of them exist more than 10km away from the Quaternary volcanos. For investigate of the above mentioned details, the geochemical feature and formation process of CO_2-rich ($>$ 250mg/L) thermomineral spring and well waters were discussed.

From the chemical composition of major dissolved solids, CO_2-rich springs are divided into Na-Cl and Na-HCO_3 types. The former is located around the Quaternary volcanos (Mt. Sambe and Oe-Takayama volcanic group) and the latter is located in the Chugoku mauntains composed of Paleozoic basement rocks and many granite intrusions. Isotopically, we could not found influence of deep-seated water except for Yodani hot spring (Na-Cl type) slightly shifted for magmatic water on delta-diagram.

To detect the deep-seated fluid contained in CO_2-rich spring waters, a ternary diagram (proposed by Ohsawa et. al., 2010) plotted on relative ratio of chlorine (Cl), lithium (Li) and boron (B), which are conservative components in fluid, were used in this study. All of Water samples were plotted along the B-Li axis between inter-layer dehydrated water of clay minerals (B-rich) and Arima-type brine (Li-rich), which is likely originated from dehydrated water from altered basalts in the Philippine Sea slab. Na-Cl type waters were clustered close to Arima-type brine, while Na-HCO_3 type waters were plotted nearer part of the B-enrichment inter layer water. Difference of Li/B ratio between Na-Cl and Na-HCO_3 types may be related to the originated depth of fluid (Hrajima et. al., 2010). Therefore, Na-Cl type waters with higher Li/B ratio are originated from deeper part of crust (probably lower crust).

Carbon isotope composition of dissolved inorganic carbon in water samples were ranging from -8.7 to -2.4 per mil indicating that deep source CO_2 play a important role for the formation of CO_2-rich springs. The contribution rate of deep source CO_2 in Na-Cl type waters was high compared with that in Na-HCO_3 type ones.

Deep low frequency earthquakes are occurring at about 30km depth beneath the Sambe volcano, where Na-Cl type waters are distributed, and northern part of the Miyoshi city, where Na-HCO_3 type waters are found, indicating that aqueous fluid exist in the lower crust. The fluid in lower crust might be dehydrated (degassed) from solidifying basaltic magma (Kazhaya, 2010). Difference of the geochemical feature of Na-Cl and Na-HCO_3 type waters may be related to the different geological structures which influence the rise of deep-seated fluid in both Quaternary volcanic and non-volcanic area.

Keywords: CO2-rich spring, isotopes, Cl-B-Li composition, deep source CO2, deep-seated fluid

AHW023-21 Room:102 Time:May 25 15:45-16:00

Lithium isotopic variation of spring water in the vicinity of Suma fault after 1995 Kobe Earthquake in Japan

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It has been proposed that the island arc deep-crustal fluid has played important role in intra-arc earthquakes (e.g., Iio et al., 2002), although many things, incluing the relationships between the island arc deep-crustal fluid and slab-derived fluid, have been still unresolved. It has been difficult to identify the nature of deep-crustal fluid based on the geochemical researches using underground water recovered from spring and well, because the deep-crustal fluid is very diluted by surface water during ascending. Lithium (Li), the lightest alkali metal, is a fluid-mobile element having two stable isotopes, ^{7}Li/^{6}Li, with abundances of 92.5% and 7.5%, respectively. Amount of Li leached from rock to fluid drastically increases with the temperature, and once leached Li is kept in fluid while decreasing temperature (cooling). These features indicate that non-traditional Li isotopic tracer has a great potential to provide new insight on the origin of nature of island arc deep-crustal fluid.

The 1995 Kobe earthquake (M7.2) is one of destructive intra-arc earthquake in the past 100 years. Seismic tomography revealed that deep-crustal fluid was contributed to the initiation of this Kobe earthquake (Zhao et al., 1996). The geochemical results have also demonstrated that chlorine contents of underground water in Kobe area increased from August 1994 to just before the earthquake, January 1995 (Tsunogai and Wakita, 1996). This means that the degree of discharge of the chlorine enriched deep-crustal fluid to the surface was increased with the time before the earthquake. The nature of the deep-crustal fluid involving the earthquake has never been revealed. Then, we have analyzed Li isotopic variation of spring water from Suma Reisen since March 1995. The spring, Suma Reisen, is located in the vicinity of Suma fault in the Rokko-Awaji fault zone, of which southern part moved in 1995 Kobe earthquake. We have also researched the Li isotopic compositions of spring water and river water that were recovered from the area around the Suma fault. Based on these results, we will present the nature of the deep-crustal fluid involving the 1995 Kobe earthquake.

References:
Iio et al., 2002, EPSL 203, 245-253.
Tsunogai and Wakita, 1995, Science 269, 61-63.
Zhao et al.,1996, Science 274, 1891-1894.

Keywords: lithium isotope, geofluid, deep-crustal fluid, Suma fault, Southern Hyogo Earthquake, fault-fluid

AHW023-22 Room:102 Time:May 25 16:00-16:15

Helium isotopes and 36Cl in saline deep groundwater from the Osaka Basin, Southwest Japan

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Isotopic composition and concentration of helium and chlorine in groundwater are a useful indicator for identifying groundwater flow path and estimating a very old groundwater age. Morikawa et al. (2008) investigated the He isotopes in deep groundwater from the Osaka Basin, southwest Japan, in which unusual saline water containing upper mantle-like helium welled out (Especially in Arima and Ishibotoke area). Observed ^{3}He/^{4}He variation in deep groundwater was clearly related with the geological structure. The ^{3}He/^{4}He ratios decrease with increasing distance from the faults. It has been proposed a model that spatial distribution of ^{3}He/^{4}He ratio reflects the movement of fluids through the fault and following dissolution of crustal ^{3}He/^{4}He during groundwater flow. The amount of accumulated ^{3}He/^{4}He corresponds to the age for hundreds of thousands of years.

Chlorine-36 is a radioactive nuclide, which decays with a half-life of 301,000 years and is thus applicable to dating very old groundwater. Another possible application of this isotope is a method using subsurface produced ^{36}Cl to investigate the origin and evolution of saline water.

In this study, we investigated the distribution of ^{36}Cl/Cl ratio to examine the saline groundwater flow model inferred from the He results. Most of ^{36}Cl/Cl ratios in the deep groundwaters from the Osaka Basin (4.1-25.6 x 10^{-15}) are higher than those in Arima-type thermal water and sea water. These high ratios are not due to mixing of modern surface water which contains bomb-^{36}Cl, but an incorporation of subsurface products of nucleogenic ^{36}Cl during deep groundwater flow, since the data points are significantly plotted above the mixing line between modern meteoric water and Arima-type water. Spatial distribution of these data shows that the ^{36}Cl/Cl ratios increase straightforward towards the middle part of the basin. This trend is consistent with observed decreasing ^{3}He/^{4}He ratio toward the middle part of the basin. Considering a concurrent change in ^{36}Cl/Cl and He concentration, increasing ^{36}Cl/Cl ratio reflects increase of groundwater residence time towards the basin and thus shows groundwater flow direction.

Keywords: groundwater, helium, chlorine-36, groundwater age, Osaka Basin

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AHW023-P01 Room:Convention Hall Time:May 25 16:15-18:45

Relationship between nitrate in river waters and land use in a hilly and mountainous area: stable isotope-based analyses

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Declining quality of waters arises from an imbalance of the inflow of pollutant loads such as nutrient versus the self-purification of waters. For urbanized areas where the population density is high, the sewage effluent can be a dominant source contributing to the increased nitrate concentration in rivers and often leads to the increased eutrophic levels in downstream waters. Also, for hilly and mountainous areas where the population is declining, the nitrate concentration in rivers can be increasing every year even though its cause remains unclear. One such example is Hii River, which is the largest river flowing into Lake Shinji and Lake Nakaumi in Shimane prefecture. The nitrate concentration in the Hii River tends to be increasing every year despite depopulation, an increased percentage sewered population and improved sewage disposal in the basin. That could cause algal blooms in Lake Shinji and Lake Nakaumi and thus immediate countermeasures are required.

Land use within a river basin is one of the most important factors influencing the nitrate concentration in the river water. However, little information is available about how land use affects river nitrate concentration in hilly and mountainous areas. This may be because the nitrate concentration varies within a relatively narrow range and thus appears to differ little among river basins with different land uses. Also, there is not always a constant relationship between the nitrate concentration and percentage of land use in the river basin because the nitrate concentration varies according to river discharge. In this study, to examine the effects of land use on river nitrate concentration in a hilly and mountainous area, river water samples were collected at the end of nine subbasins in the Hii River basin and concentrations and isotopic compositions of nitrate were analyzed. We are going to report those results.

Keywords: diffuse pollution, forest, hydrological condition, agricultural land, enclosed waters

Japan Geoscience Union Meeting 2011
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AHW023-P02 Room:Convention Hall Time:May 25 16:15-18:45

Understand seasonal variation of the stalagmite growth rate with the hydrochemical parameters of dripwater

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Carbon dioxide (CO_2) degassing is given for a main factor to control the stalagmite growth recently. The seasonal variation (high pCO_2 in summer and low pCO_2 in winter) of the CO_2 partial pressure (pCO_2) of the cave air by ventilation of the cave air which occurred with a temperature difference between the cave outside and the cave air was observed. Because a change of this pCO2 changes easiness (difference ($dpCO_2$) cave air pCO_2 and dripwater equilibrium pCO_2) of the CO_2 degassing, the seasonal variation of the stalagmite growth rate is supposed (Spotl et al., 2005; Baldini et al., 2008). In addition, there is the study (Genty et al., 2001) that was going to see the cyclic variation of the stalagmite growth rate by the theory equation found from an annual growth thickness and chemical kinetics of the dripwater, and stalagmite growth rate increase is supposed regardless of a season when the Ca^{2+} concentration of dripwater is high in this study. The common understanding of the mechanism of the short-term variation of the stalagmite growth rate is not provided in this way. Therefore we built technique to estimate the stalagmite growth rate from the hydrochemical parameter of the dripwater and observed a stalagmite growth rate (Calcite deposition rate) monthly in Inazumi limestone cave in mie-machi, bungo-ono-shi, Oita-ken, Japan. As a result, we report that we got the seasonal variation and the control factor of the growth rate.

As Spotl et al. (2005) and Baldini et al. (2008) guessed, the stalagmite growth rate of the Inazumi limestone cave showed a slow tendency in the summertime and fast tendency in the wintertime, but we got that growth became slow in winter by taking it finely. Genty et al. (2001) insisted that the Ca^{2+} concentration of dripwater controlled stalagmite growth, but there was not the correlation between Ca^{2+} concentration and the stalagmite growth rate, and this observation result did not support the claim. Many researchers believe (e.g. Spotl et al. (2005) and Baldini et al. (2008)) that a difference between cave air pCO_2 and dripwater equilibrium pCO_2 controls stalagmite growth but the variation is not seasonal variation. Furthermore, dripwater dissolves a stalagmite at the time of plus pCO_2 value if equilibrium is concluded in a chemical reaction of the stalagmite growth but a stalagmite grows up even at the time of plus pCO_2 value of the summertime. The observation result of the Inazumi limestone cave does not support the claim of Spotl et al. (2005) and Baldini et al. (2008).The control factor of the stalagmite growth has calcite saturation index (CSI) and dripwater quantity besides $dpCO_2$. Because CSI value of the dripwater always shows pluses (supersaturation for calcite), stalagmite is going to always grow up. Furthermore, the variation of CSI resembles the variation pattern of the stalagmite growth rate closely. However, the variation of the stalagmite growth rate in the Inazumi limestone cave cannot explain a variation of the winter only by CSI. The fall of this growth rate is caused by the decrease of the dripwater quantity, and this observation result support a claim of Genty et al. (2001) that the dripwater quantity controls the stalagmite growth most when the dripwater quantity is very few.

A key result is that a stalagmite grew up because dripwater is always a supersaturation condition, and the seasonal variation of the stalagmite growth rate is controlled by the seasonal variation of CSI. In the Inazumi limestone cave, there is the peculiarity that quantity of the dripping water decreases in winter and tends to depend on dripping quantity of water than CSI in the time. We are conscious of contribution to the study of the paleoclimate reconstruction that used the striped pattern to appear in the growth direction of the stalagmite and want to clarify the reason of seasonal variation of CSI of the dripwater and the variation of the drip rate of the dripwater in future.

Keywords: Stalagmite growth rate, Hydrochemical parameters of dripwater, Seasonal variation of growth rate

Japan Geoscience Union Meeting 2011
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AHW023-P03 Room:Convention Hall Time:May 25 16:15-18:45

Altitude effect of precipitation samples at Kusatsu area, Gunma Prefecture

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The stable isotopes of oxygen and hydrogen in precipitation are formed with complex factors, i.e. precipitation amount, elevation, altitude and air mass, and the change pattern of isotopes is different in various sites. There is a lot of study about isotopes in precipitation, but many of them target the isotopes at one-slope. Thus the investigation of the isotopes in precipitation at the mountainous area which has a complex topography is few, there are uncertain points for the mechanism of isotopes in precipitation. The isotopes in precipitation are useful tool to understand the recharge area of spring water and groundwater. In this study, the study site is Kusatsu area which is located to northwest at Gunma Prefecture and spread out the mountainous region. The objective of this study is to male clear the characteristics of isotopes in precipitation around Kusatsu area.

An annual mean air temperature is 7.4 degree and annual precipitation amount is about 1700 mm at Kusatsu area. The precipitation sampler is settled at 6 points with 3 different slopes. The monthly precipitation samples have been sampled since March 2010. The pH, EC, water quality and stable isotopes of oxygen and hydrogen were analyzed for all precipitation samples.

The stable isotopes of oxygen and hydrogen in precipitation show a similar change. The isotope values are relatively high in June and relatively low in August 2010. Thus the isotope values are relatively low with the high elevation and relatively high with the low elevation, the altitude effect is confirmed in this area. The d-excess values are high at the high elevation and low at the low elevation. And there is the obvious seasonal variation of d-excess in precipitation; that the d-excess are relatively low in summer period and relatively high in winter period. It is cause of the air mass which is source of the precipitation. The altitude effect using the data of 6 observation sites is -0.26 per mill / 100 m for d^{18}O (r^2=0.980) and -1.9 per mill / 100 m for dD (r^2=0.988). The altitude effect is slightly different on three slopes and also different according to the month. It is assumed that the reason of the difference of altitude effect is cause of the difference of precipitation amount and transportation process of the water vapor which is source of the precipitation. The local meteoric water line in Kusatsu is $d\mathrm{D} = 8.0d^{18}\mathrm{O} + 9.6$, which is almost same the Craig's meteoric water line. In future, the observation and sampling of the precipitation will be continued, and the characteristics of isotopes in precipitation will be clarified in detail.

Keywords: Kusatsu, precipitation, stable isotope, altitude effect

AHW023-P04 Room:Convention Hall Time:May 25 16:15-18:45

Elevation effects for hydrogen and oxygen isotope values of rainwater within the Kofu Basin

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To elucidate the factor controlling elevation effects in hydrogen and oxygen isotope values, 150 rain water samples were collected from 6 points in different altitude from 250m to 1300m of 25 rainfall events. The water oxygen and hydrogen isotope values were analyzed with these samples. And the rainfall feature in each event was investigated by the observation of the X-band multi-parameter radar of University of Yamanashi.

The elevation effects were not well understood on windward side. Hence, these results were different from the previously reports of Friedman and Smith (1970). Elevation effects are well defined on the rainfall amount. Hence, to clarify the factor of elevation effects, it must identify the distribution of rainfall amount. In this presentation, we examine the relationship between rainfall amount and the rainfall distribution in rain clouds advected to the Kofu Basin.

Keywords: water hydrogen and oxygen isotope, elevation effects, rainfall, X-band multi-parameter radar

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AHW023-P05 Room:Convention Hall Time:May 25 16:15-18:45

Stable isotopic composition of rainwater and soil water of Kathmandu Valley, Nepal

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The present study examined the hydrogen and oxygen stable isotopic composition of rainwater and soil water and of Kathmandu Valley, Nepal.Ten stations were selected for rainwater sampling and two sites were selected for soil water samplings. Bulk rainwater samples were collected in biweekly basis whereas soil water samples were collected in a weekly basis during monsoon season (June - September) of 2010. Soil water samples were collected from 4 different depths (50, 70, 120 and 150cm) using tension lysimeter. Both the rainwater samples and soil water samples were analyzed water oxygen and hydrogen isotope values using Cavity Ring-Down Spectroscoyy (Picarro, L1102-1).

The preliminary results of stable isotopic composition are used to construct the Local Meteoric Water Line (LMWL), and found to be delta D (permil) = 8.17 delta18O + 10.8 (r2= 0.98). This meteoric line was then compared with the Global Meteoric Water Line (GMWL), where the slope and intercept of LMWL are close to that of GMWL ((i.e. delta D (permil) = 8delta18O+10) as described by Craig (1961).

The isotopic composition of soil water varies according the depth of soil. In upper surface (50cm and 70cm depth), most of the soil water samples contain lighter delta18O composition where the heavier values are observed in the greater depth (120 and 150cm). However some of the samples showed the similar isotopic composition of in all depths.

The variations and differences in isotopic composition of rainwater and soil water of Kathmandu Valley could provide the estimates of evaporation, infiltration processes which are very useful for the groundwater management perspective.

Reference

Craig (1961)

Keywords: rainwater, soil water, stable isotopes, Kathmandu

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AHW023-P06 Room:Convention Hall Time:May 25 16:15-18:45

Isotopic composition of throughfall in coniferous forest plantation

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A few studies reported the changes of isotopic composition of rainwater during its passage through the vegetation canopy (Brodersen et al., 2000; Liu et al, 2008). The selection processes, the forest canopy structure and resulting evaporation processes seemed to be the main factors influencing the isotopic composition of open rainfall while passing the canopy, however the effect of rainfall redistribution by the vegetation canopy on the isotopic composition of rainfall has often been neglected. In this study, we conducted field measurement of throughfall using 10m long and 10m wide interception plots and a set of 20 tipping bucket rain gauges and throughfall collectors for isotopic analysis in Japanese cypress and Japanese cedar plantations.

Keywords: Coniferous forest plantation, Throughfall, Isotopic composition

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AHW023-P07 Room:Convention Hall Time:May 25 16:15-18:45

Recharge and flow processes of groundwater on the outer rim slope of Hakone caldera

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The purpose of this study is to understand recharge and flow processes of groundwater on the slope of outer rim of Hakone caldera, central Japan from using environmental tracer methods. 99 stream and 38 spring water samples were collected from study area in middle of August to early September 2010, and analyzed for oxygen isotopic composition (d^{18}O).

The stream and spring waters in the western slope of study area have higher d^{18}O value compared with that in other slopes as well as precipitation data presented by Miyashita (2009). The isotopic difference between western and other slopes are probably caused by a rain shadow effect of mountain, because the dominant wind directions during summer period, when intensive groundwater recharge occurs, is from SW to NE. In other words the precipitation of northeastern slope, which is leeward side, is more isotopically depleted than that of western slope, which is windward side. A comparison of spring water samples at the same elevation (about 1000m a.s.l., near the top of outer rim) indicate that d^{18}O of those on the leeward northeastern slope are more isotopically depleted and about 1.0 per mil less than those from the windward west slope.

Therefore, it is necessary to evaluate the altitude effect of water samples in each slope (west, southeast and northeast), dividing from the spatial distribution patter of d^{18}O. Based on the relationship between d^{18}O values and mean elevations of catchment for several selected springs, recharge-water lines were obtained in each slope. Altitude effect of recharge water in each slope was different: -0.2 per mil/100m for the western slope, -0.18 per mil/100m for the southeastern slope and -0.14 per mil/100m for the northeastern slope. CFCs (chlorofluorocarbon) and SF6 (sulfur hexafluoride) have been used to determine the average residence time for two spring waters, located on the middle (360m a.s.l.) and lower (45m a.s.l.) part of the northeastern slope. Consequently, the residence times of both spring waters were < 20 years (probably about 10 years). On the basis of mean recharge elevation obtained by recharge-water line and distribution pattern of springs and result of the CFCs and SF6 datings, conceptual model of groundwater flow system in the outer rim slope of Hakone caldera are proposed.

Miyashita (2009) reported that the d^{18}O of stream and spring waters was about 2 per mil higher than weighted mean d^{18}O of precipitation at the same elevation. It has also been found that the difference in d^{18}O between recharge water and precipitation was 1.5˜2.0 per mil in this study. The difference may be responsible for the evaporation of precipitation in the recharge process, and we calculated annual evaporation rate using the Rayleigh-type equation. The evaporation rates are about 15 percent of the annual precipitation in each slope.

Keywords: Hakone volcano, Oxygen isotope composition, Rain shadow effect, Altitude effect, Groundwater flow system, Evaporation rate

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Groundwater flow system of the Yiluo River Basin from the tritium and stable isotopes ratios

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Groundwater flow system and the water quality in Yiluo River Basin, China
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The author has carried out the analysis of tritium and stable isotopes of surface water and groundwater to evaluate the groundwater flow system in the Yiluo River basin, China.

1) Tritium concentrations of the groundwater in the slope of the southern and northwestern mountain range were higher than 10 T.U. and suggested that the residence time of these groundwater was younger than 50 years. On the other hand, tritium concentrations of the deep groundwater along the Yiluo River and in the lower area of the basin were very low. Therefore, the residence time were estimated to be longer than 60 years.

2) The stable isotopic ratios of hydrogen and oxygen of the groundwater showed relatively low value in the southern peripheral part of the basin and showed relatively high value in the central part. In the eastern part, down-stream part, and the southeastern part of the basin, groundwater with low dD and d^{18}O flows toward the lower area of the basin.

Keywords: tritium concentration, stable isotopic ratios, groundwater flow system, The Yiluo River Basin

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Water quality, environmental isotopes and subsurface temperature of high Cl groundwater area in the northern Kanto plain

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Previous studies point out that there are some areas of groundwater with high Cl^- concentration (dozens to about 200 mg/l) in the inland part of Kanto plain that is the largest sedimentary plain in Japan (i.e. Ikeda, 1984; METI, 1975). As for the high Cl^- groundwater area in the central part of the plain, from the view point of isotopic characteristics, residence time of the groundwater is probably longer than the groundwater in the surroundings (i.e. Yasuhara et al., 2008; Hayashi et al., 2003). However, origin of Cl^- in this area has not been revealed yet. With regard to the high Cl^- groundwater areas in the northern part and northeastern part of the plain, Miyakoshi et al. (2003) estimates that subsurface temperature in these areas are higher than the surroundings. However, information about groundwater quality, environmental isotopes and relation of distributions between the high Cl^- groundwater and subsurface temperature are quite limited. Therefore, we collected groundwater samples from these two areas and measured major dissolved ions and environmental isotopes. Also, we measured subsurface temperature profiles to reveal subsurface temperature distribution.

For Cl^- concentration, the highest value was 538 mg/l in the northern area and was 221 mg/l in the northeastern area. However, in the northeastern area, only one sample showed high Cl^- concentration higher than 20 mg/l. For delta^{13}C, these two areas showed relatively high values than surroundings: -8.5 to 0.3 permil in northern area and -7.3 to 2.0 permil in northeastern area. However, correlations between Cl^- concentration and delta^{13}C were not clear. As for the subsurface temperature distribution, subsurface temperatures of the two areas were higher than the surroundings. Especially, the northern area was one of the highest temperature areas in the Kanto plain. In a larger sense, distribution patterns of Cl^-,delta^{13}C and subsurface temperature were consistent.

Keywords: kanto plain, high Cl groundwater, environmental isotopes, subsurface temperature

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An isotopic study on the origins of water and chloride ion in artesian groundwater of the Kanto plain, central Japan

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There exist three regions in the Kanto plain, central Japan, whose artesian groundwater is characterized by a high Cl^- concentration: 1) central parts of the Kanto plain (Saitama Prefecture), 2) floodplains and deluvial uplands along the lower reaches of Kokai and Tone rivers (Ibaraki and Chiba Prefectures), and 3) south-east parts of Gunnma Prefecture). An isotopic study has been under way to make it clear the origins of both water and Cl^- of these Cl^--rich artesian groundwaters. As for that in the central parts of the Kanto plain, confined groundwater with a high Cl^- concentration of up to 216 mg/l is obtained from the productive bores of 200-430 m depth. The area of Cl^--rich groundwater, spreading from the northwest to southeast, corresponds with the so-called Motoarakawa tectonic zone (ca. 10 km wide by 35 km long) bounded by the faults on its longer sides. Taking all isotopic data (delta-D, delta-^{18}O, ^{13}C, ^{14}C, ^{4}He, ^{36}Cl/Cl) obtained so far into account, with regard to the origin of groundwater in the Motoarakawa tectonic zone, a potential source is assumed to be precipitation of low stable isotopic composition in the Last Glacial Maximum when the sea level of the Tokyo Bay was lower than the present by more than 100 m. Admixture of sea water in the period of and/or after the Shimosueyoshi transgression (peak period at around 125,000 yrs. BP) is likely to account for its elevated Cl^- concentration. The Ayasegawa and Kuki faults, and other unknown faults could act as a geologic barrier to the modern regional groundwater flow system, preventing mixing of groundwater between in and out of the tectonic zone. The results from the similar isotopic study now in progress on the other two Cl^--rich groundwater regions will help an overall understanding of the long-term groundwater system development in the Kanto plain in these 500,000 yrs.

Keywords: Kanto plain, artesian groundwater, chloride ion, delta-18O & delta-D, 14C, 36Cl/Cl ratio

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A multiple-isotope apporach to reveal the coastal hydrogeological system and its temporal changes.

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Multiple-isotope data and the results of the diffusion-sedimentation model were used to reveal the coastal hydrogeological system and its temporal change at a small catchment and its offshore extension, the Uto Peninsula, Kumamoto, Japan. Chloride concentration decreases gradually downwards, and the profile of the stable chlorine isotopic ratio showed the typical pattern formed by diffusion-controlled mass transport process. One-dimensional diffusion/sedimentation model explained the measured chloride profile and the fractionation of chlorine isotopes sufficiently well. The apparent residence time of groundwater below inter-tidal zone is on the order of 100 years while that below sea bottom is about 2000 years, suggesting that groundwater situated below the inter-tidal zone constitutes a part of present-day groundwater flow system while the fresh groundwater below sea bottom was separated from the present-day flow system. The coincidence among the apparent residence time of groundwater below sea-bottom, the age of the start of the deposition of marine clay, and the age of the start of the diffusion process strongly suggests that the deposition of marine clay controlled the hydrogeological system and resulted in the reduction of the extent of the groundwater discharge.

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Occurrence and formation mechanism of Harazuru hot spring, Fukuoka, Japan

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Harazuru hot spring is located to the eastern part of Chikugo Plain in Fukuoka-ken, Kyushu, Japan, where is just beside of the Chikugo River, the longest river in Kyushu. There two types of hot springs, chemically; One is Na-HCO3 type, and the other Na-Cl/HCO3. The former is located in the central part of Harazuru extending to the NE-SW direction, and the latter distributing to the northwestern and southeastern part of the former type. The delta D of the Na-HCO3 and Na-Cl/HCO3 types are delta D =-49 to -51 per mill and -54 to-57 per mill, respectively. The delta D of the Chikugo River shows -50 per mill. Such chemical relations suggests Na-HCO3 type of water is formed by mixing of Na-Cl/HCO3 with meteoric water. However, the delta D is so small compared to that of Chikugo-gawa river nearby, the water is probably migrated through a big geological structures extending EW direction from the upper part of the Chikuko-gawa river.

Keywords: hot spring, chemistry, idotope, formation mechanism, Harazuru, Fukuoka

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AHW023-P13 Room:Convention Hall Time:May 25 16:15-18:45

Origin of dissolved inorganic carbon of hot spring waters discharged from the non-volcanic region of central Kyusyu

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For elucidation of carbon sources of dissolved inorganic carbon (DIC) in the hot spring waters discharged from the non-volcanic region between Aso and Kirishima volcanoes of Kyusyu District, Japan, and also in order to search a deep-seated aqueous fluid derived from subducting oceanic plate in the region, we analyzed major chemical components, dD and d^{18}O of water and d^{13}C and concentration of DIC, rare gas isotope concentrations of dissolved gases of the hot spring waters. Although water of every hot spring is originated from meteoric water shown by water isotopic data (dD and d^{18}O), relationships between d^{13}C and concentration of DIC suggests that the DIC should be formed by mixing of soil and two kinds of deep-originated CO_2. This idea is supported by isotopic date of rare gases (^{3}He/^{4}He vs. ^{4}He/^{20}Ne) and relation between concentrations of Ca and HCO_3 ions, and it is confirmed that the two kinds of deep-originated CO_2 are mantle-derived CO_2 and CO_2 originated from subducted marine carbonate by a calculation of contributions of source carbons of selected hot spring waters. Moreover, we calculated respective contribution ratios of deep-originated CO_2 to DIC of all the hot spring waters on the basis of the linear relation observed between contribution ratios of deep-originated CO_2 and d^{13}C values of DIC of selected hot spring waters, and expressed hot springs showing high contribution ratios (more55percent) on a published map showing crustal resistivity structure of this studied area, thereby it appears that hot springs rich in DIC derived from the subducted marine carbonate are roughly concentrated on low electrical resistivity zone extending NE direction from Kirishima volcano. This result seems to suggest the possibility that an associated aqueous fluid of dehydrated fluid from subducting oceanic plate forms the low electrical resistivity zone. On the other hand, distributions of high contributions of mantle-originated $CO_2$of hot spring waters are concentrated in the Hitoyoshi Basin which is thought to be a tectonic basin formed by fault movement, and this result may suggest that a passageway for rising of mantle-derived CO_2 must be formed in the crust under this area.

Keywords: non-volcanic region, dissolved inorganic carbon, mantle, deep-originated CO_2, low electrical resistivity zone, dehydrated fluid from subducting plate

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Distribution of the helium isotope ratios in Kyusyu district

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Kyusyu island is located at the intersection of the SW Japan arc and the Ryukyu arc. The Philippine Sea plate is subducting beneath the Eurasian plate at the Ryukyu trench and the Nankai Trough along these arcs. The subduction angle of the Ryukyu trench is larger than that of the Nankai Trough. The former angle is almost orthogonal and the subduction of the Philippine Sea plate is seismically detected to the depth of 150-180 km (Nakajima and Hasegawa, 2007). The Okinawa Trough is to the west of the Ryukyu trench and extends as a back-arc basin of the Ryukyu arc. The Beppu-Shimabara Graben in central Kyusyu is regarded as an extension of Okinawa Trough. Strong low-velocity anomalies are distributed extensively along the volcanic front and extend to the back-arc side in the crust and upper mantle. Volcanisms are supposed to result from the fluid supplied by the dehydration processes of the descending Philippine Sea plate. In addition, the hot upwelling materials related to the back-arc opening have contributed to the Unzen volcanism in Beppu-Shimabara Graben (Wang and Zhao, 2006). Thus two different mechanisms for volcanism exist in north Kyusyu.

In this study, we measured the helium isotope ratios (^{3}He/^{4}He ratios) of hot springs around the area of the prefectural boundary of south Fukuoka and north Kumamoto in order to study the precise geographical distribution of helium isotope ratios in this region and to compare them with tectonic data. This area covers the Beppu-Shimabara Graben and its northern and southern areas. We collected 13 samples of hot spring waters in the above area. High ^{3}He/^{4}He ratios were observed at the Beppu-Shimabara Graben, and low ^{3}He/^{4}He ratios were observed in the northern and southern area of the Beppu-Shimabara Graben. It is very peculiar since the observed area belongs to the back-arc region where ^{3}He/^{4}He ratios are generally higher than the atmospheric value as commonly seen in NE Japan. We indicated that the high ^{3}He/^{4}He ratios simply reflected a high velocity region of about 25-30 km in depth under the sampling region (Xia et al., 2008), and was not due to the addition of fossil pore water drawn from impermeable marine clay layers as suggested by Mahara and Kitaoka (2009). Thus, ^{3}He/^{4}He ratios could be closely related with the presence of deep fluid at the basement of the crust.

Keywords: helium isotope ratio, Kyusyu, Beppu-Shimabara Graben

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Application of ^{36}Cl to deep fluid systems in Japan: Implications for the sources and residence time of chlorine

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This study applied the long-lived radionuclide ^{36}Cl to better elucidate the sources of chlorine in deep fluids in Japan. Several regions with different tectonic/geological settings were selected for the collection of deep fluid samples from hot spring wells: e.g., a coastal sedimentary basin in Aomori, surroundings of volcanic calderas in Hokkaido, and vicinity of tectonic faults in western Japan. Concerning the samples obtained from a coastal sedimentary basin, the ^{36}Cl/Cl ratios mostly fall on the seawater-shallow groundwater mixing trend line, with a few samples deviating upward possibly due to the build-up of nucleogenic ^{36}Cl in the subsurface. The calculated ^{36}Cl/Cl ratios of assumed seawater fractions were positively correlated with crustal ^{4}He concentrations, associated with increasing residence time of the fluids in the subsurface. This trend suggests that the source of deep fluids in this area is probably old seawater. In the case of the samples nearby major tectonic faults, the delta ^{18}O-delta D relationship depicts a shift to Arima-type thermal brine (Matsubaya et al., 1973) or magmatic water (Giggenbach, 1992). These samples tend to show low ^{36}Cl/Cl ratios close to the seawater value (1-2 x 10^{-15}) especially for the samples with high ^{3}He/^{4}He ratios similar to that of the upper mantle. It implies a deep-seated source of these fluids, such as mantle- or magma-derived components, and also suggests a relatively short residence time in the crust without significant production of nucleogenic ^{36}Cl.

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Keywords: deep fluid, chlorine, origin, residence time, chlorine-36