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

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Preparation of the river water quality map and analysis of the organic pollution in the region of small precipitation

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Introduction

In the northern part of Shikoku Island, where there is small precipitation, particulate organic substance concentration in the river water is high, because the water is stored in a basin for efficient water use, leading to organic pollution of the river water. In a previous study, it was demonstrated that majority of the particulate organic substances in the Shin river, a major river in the Kagawa Prefecture, were from the basin (Yamada et al. 2010). The other hand, the basins in the Kagawa Prefecture is supplied with the water from the Yoshino river (Kagawa channel water, from central Shikoku Island) during the irrigation period. Since the organic substance concentration of the Yoshino river water is low, it may have dilution effect on the polluted river water in Kagawa Prefecture. In the Kagawa Prefecture, mechanism of ensuring river water quality becomes complicated because of efficient water use. In this study, the relationship between water pollution and water utilization were analyzed under the preparation of the water quality map.

Material and method

The investigation was conducted in the Shin river basin, one of main rivers in the Kagawa Prefecture. The total length of the Shin river is approximately 19 km, and the pond density (over an area of 1 ha) is 0.05 km^2/ km^2 in the middle and lower river basin. To analyze water and the source of organic substances in the Shin river, investigations of temporal variation (in the Shin river) and distribution (in its basin) for organic substances were conducted. Particulate organic carbon (POC), delta^{18}O, and phytoplankton composition in the sample were measured.

Result and discussion

The delta^{18}O of the Shin river decreased in the irrigation period, during which the supply of water from the Kagawa canal was increased (before supply, approximately ?5par-mil; after supply, approximately 7par-mil). The delta^{18}O of water from the Kagawa canal was low, at ?8.5par-mil. Supplying the Kagawa canal water for the irrigation seems to lower the delta^{18}O value of the river water. During the non-irrigation period, it was considered that the irrigation pond was the source of much of the water in the middle and downstream because delta^{18}O values of river and the irrigation pond were similar. The POC of the river water was low, at 2 mg/L, after the supply of Kagawa canal water, whereas it was 8 mg/L before the supply. Because the POC was low for the Kagawa canal water, the inflow of this water could cause the reduction in the POC of the river.

In spatial distribution, the POC and delta^{18}O increased from the upper stream to the middle stream in June and October. This rise was consistent with the rise in pond density in the basin. The proportion of the rise in October was higher than that in June. In October, the POC concentration rose from approximately 0.0?2.0 mg/L to 2.8?6.4 mg/L after the inflow of the largest irrigation pond in the basin. At the same time, delta^{18}O also increased from approximately ?8.2??6.1par-mil to ?4.4??5.1par-mil. It was indicated that POC in the river water rose because of the inflow of water from the irrigation pond. The fact that the POC of the river in June is low, when the water in the irrigation pond is predominantly discharged, was because low POC water, such as Kagawa canal water, flowed into the river during the irrigation period.

The phytoplankton species (*Microcystis aeruginosa* and *Cyclotella meneghiniana*) in both river and irrigation pond were similar, and the composition ratio was also similar.

From these results, it is thus proved that water from the irrigation pond was the source of organic substances in the middle and downstream river. However, during the irrigation period, when considerable water is discharged from the irrigation pond, the river POC was reduced because of dilution of organic substances due to inflow of low POC water from Kagawa canal.

Keywords: Organic pollution, Oxygen isotope ratio, River, Irrigation pond, Water quality map, Irrigation water

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Geochemical and isotopic map of Asahi River, Okayama Prefecture

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The Asahi River, one of the largest rivers in the Okayama Prefecture, has a drainage area of 1800km^2. Because the water from the river supports approximately 1/3 of the population of the Prefecture, understanding the origin and the circulation process of the water through construction of geochemical map is essential. We have undertaken a detailed geochemical and isotopic study of water samples collected from the Asahi River, Okayama Prefecture. A total of 77 samples were collected from the mainstream and tributary of the Asahi River from March to November 2011. All samples were filtered with 0.2 micrometer filter prior to the analyses for major dissolved constituents (F, Cl, NO_3, SO_4, Br, PO_4, Ca, Mg, Na, K), trace elements and O-H-Sr isotopes. The results obtained so far have revealed that there are systematic changes in the deuterium excess (DE), Sr isotope ratio and the concentrations of elements such as Ca, Mg, Sr and Ba from the upstream towards the downstream. Similar but less obvious changes were also observed for elements such as As, Li, Rb, Cs, Ge and Ga. These changes are interpreted to be the result of (1) difference in the air mass contributing to the meteoric water of different locations, (2) interaction with rocks with distinct geochemical characteristics, and (3) various human input. Further discussions including the seasonal changes in the geochemical characteristics of the river water will be given in the presentation.

Keywords: Geochemical map, Asahi River, Okayama Prefecture, Isotope, Trace element

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Water quality map of rivers in the eastern Shimane and western Tottori Prefectures

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This study aims to create maps showing the water quality of rivers in the eastern Shimane and western Tottori Prefectures, in order to provide fundamental information for the sustainable use of the river water. This area is widely composed of granitic rocks with local distributions of Miocene sedimentary rocks in the coastal area and Quaternary volcanic rocks of Mt. Daisen in the eastern area. It is active in agriculture and fishery as well as metal mining from the Edo period including Tatara iron-manufacturing. Further the atmosphere is affected by materials and pollutants from the Sea of Japan and the Asian continent by westerly winds. Human activities in the watershed from the past and recent changes in the atmospheric environment would affect the aquatic ecosystem in this area. To evaluate these effects on the freshwater quality, we determined the compositions of four stable isotopes and fifty-five dissolved components for totally 291 stream water samples, which were collected during base-flow periods of spring to autumn from 2009 to 2011. Analytical results are summarized as follows:

1. Geological contribution: Sr isotope ratios in stream water varied in accordance with the watershed geology; 0.705 - 0.706 in Mt. Daisen area, 0.706 - 0.707 in many areas with the acidic igneous rocks, and 0.707 - 0.709 in the coastal Miocene rock areas. There is a positive correlation between Ca and Sr contents, indicating that both elements are largely derived from Ca-minerals through chemical weathering. Many trace elements such as Ba, Cs and V also displayed a geographical variation dependent on the watershed geology, demonstrating that they are utilized as a hydro-geological tracer.

2. Atmospheric contribution: The concentrations of Cl and Na decreased regularly from the northern coastal area to the southern mountainous area, indicating the inland decrease of sea-salt inputs through the atmosphere. The very high values of seawater component in the stream water of Shimane Peninsula suggest that this peninsula has been acting as a topographic barrier, possibly suppressing the sea-salt impact from the Sea of Japan to Matsue and Izumo Cities. Water isotope ratios also tended to decrease, whereas deuterium-excess value (d-value) to increase, with distances from the Sea of Japan. Stream waters with low water isotope ratios and high d-values (20 - 23) distribute in the mountainous area of southeastern Shimane, where the precipitation of snow is high. Stream waters of Shimane peninsula had high SO_4 concentrations (10 - 30 mg/L) and low $d^{34}S$ values (-2 - 5 per mil), indicating a dominant source of rock sulfur. In contrast, most streams in the Hiigawa watershed had low SO_4 content (2 - 6 mg/L) and high $d^{34}S$ value (8 - 12 per mil), indicating that the Hiigawa sulfur is enriched in marine sulfur and anthropogenic one from the Asian continent rather than granite-derived sulfur. The integrated use of Cl, SO_4, and water and sulfur isotopes are powerful as a hydro-atmospheric tracer.

3. Anthropogenic contribution: The concentration of NO_3 tended to be high in the lower reaches where the anthropogenic effect is expected to be large. The distribution of Fe was similar to those of Cr, As and Se, but they did not show any meaningful relationship with areas where the Tatara mining took place.

Keywords: Riverine water quality map, Strontium isotope ratio, Hiikawa River System, Hinogawa River System

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Water quality map in the southern part of Mt. Fuji

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We summarized the quality of spring waters in the southern part of Mt. Fuji in map for the purpose of estimating the origin and recharge area of these springs. The study area is the foot of Mt. Fuji in Shizuoka Prefecture, including surrounding mountains (e.g. Mt. Ashitaka, Mt. Hakone, Tenshu Mountains). This area is an important industrial region, expected as a greenfield site for companies using high-quality groundwater. On the other hand, the problem of saline groundwater in coastal area arose in 1960s due to excess-pumping, not being solved completely today. Moreover, recently the amounts of spring waters tend to decrease at the foot of Mt. Fuji. The stable use of groundwater is important for the sustainable development of this area, and it is necessary for developing strategy for groundwater conservation and use to elucidate the mechanism of groundwater flow in the basin.

We collected 133 spring water samples from the study site in early winter (November to December 2009). Water samples were analyzed for major ions, trace elements and hydrogen, oxygen, and strontium isotopes. Geographic Information System was used to make the water quality map, which also contains information of e.g. geology, vegetation, land use and social conditions, in the study area.

The isotopic composition of oxygen and hydrogen in spring waters shows a linear relationship between d^{18}O values and dD values. The d-values in Mt. Ashitaka area, facing Suruga bay, and in the southwestern foot which altitudes are between 300 and 500 meters above sea level, are relatively low ($<$12). The low values indicate that the precipitation in both areas would be strongly affected by water vapor from the Pacific Ocean. The isotopic composition of oxygen in spring waters shows that low d^{18}O values between -8 and 10 permil are observed in the foot of Mt. Fuji except for spring waters in the southwestern foot, which represent -8 permil or less. The isotopic enrichment of these springs is probably caused by the superficial aquifer recharged by precipitation in the vicinity.

The spring waters in the basaltic rock area (Mt. Fuji, Mt Ashitaka and Mt. Hakone) display low ^{87}Sr/^{86}Sr values under 0.7040. In contrast, the ^{87}Sr/^{86}Sr values of spring waters in sedimentary rock area (Tenshu Mountains) are much higher (over 0.7055). The high Sr isotopic signature in the western foot of Mt. Fuji (Inokashira springs) suggests that the groundwater recharged in Tenshu Mountains would partly flow into the area.

The principal component analysis of the 19 components dissolved in the spring water was conducted. The first principal component can be regarded as an index of human activity, because its scores were low for springs in the southern foot of Mt. Ashitaka and the southwestern foot of Mt. Fuji, where tea plantation predominates. We consider the high concentrations of NO_3 observed in these areas to be of agricultural origin. The concentration of Cl is also high in the areas, probably caused mainly by airborne salt. We can also separate oxyanion-forming elements (e.g. V, P, As, Mo) from other dissolved components on the basis of their distribution on the second principal components. The concentrations of these elements are negatively correlated with d^{18}O values. The high concentrations are interpreted as resulting from the elution of the elements by long-term interaction between rock and groundwater recharged at high altitude of Mt. Fuji. The third principal component separates trace elements (e.g. Cs, Ba, Rb) from the other components, relatively low in the eastern foot and high in the western foot of Mt. Fuji.

As described above, we can clarify the regional characteristics of spring water through the analysis of stable isotopes and dissolved elements. Mapping the information of water quality with GIS made it possible to analyze factors which contribute to the regional variations and, in addition, to form a basis for building a groundwater governance in the study area.

Keywords: water quality, spring, stable isotopes, principal component analysis, GIS, Mt. Fuji

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Mapping of water quality in the Obitsu and Kamo rivers on the Boso Peninsula, Japan.

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This study investigated downstream variation in the chemical composition of river waters in terms of the interaction between hydrologic cycles, human activity, and geologic composition in a drainage area. We used the Obitsu and Kamo rivers and their tributaries in the central part of the Boso Peninsula, as a case-study field of this research. We analyzed 50 dissolved elements and stable isotopes of hydrogen, oxygen, sulfur, and strontium using 150 water samples taken form the two river systems during three summer seasons from 2009 to 2011. On the basis of spatial variations in the concentration of dissolved elements and stable isotopic ratios of the four elements, we discriminated the following three major factors, which seem to have controlled the water quality in the two river systems.

(1) Air-water cycles: The deuterium-excess shows local decreases as a response to the construction of some reservoirs and also shows higher values in the upstream areas, as having already been observed in other areas. In contrast, the hydrogen isotopic ratio shows spatial variation opposite to the altitude and continental effects in the upstream areas. Thus, we need to clarify spatial variation in the isotopic composition of rainfall for the better understanding of a major process of air-water cycles in a small drainage area.

(2) Artificial contribution: The concentration of nitric acid increases in lowlands and also at the foot of small mountains as a response to the increase in population, housing, and agricultural fields in local association with stock raising. The concentration of Cl and Na, together with K, Rb, and Cs, show local increase in some tributaries in the upstream areas. These areas are also characterized by a higher $^{87}Sr/^{86}Sr$ ratio in river waters, and the water quality is interpreted to be polluted locally by water drained from chloride mineral springs. Furthermore, the sulfur isotopic data suggest that the chloride mineral springs have seeped after fossil brine had been affected by sulfate reduction, mixing with rainwater, and reacting with the host sedimentary successions in a subsurface environment.

(3) Geological effects: The southern tributaries of the Kamo River flows out from the Mineoka Mountains, which consists mainly of mafic and ultramafic rocks, and are characterized by a higher concentration of Mg, Ni, and Cr, and by a lower concentration of Si, K, Rb. Cs, together with a lower $^{87}Sr/^{86}Sr$ ratio. A lower $^{87}Sr/^{86}Sr$ ratio also characterizes upper reaches of both the Obitsu and Kamo rivers, where volcaniclastc sediments are developed. The drainage basin of the Obitsu River consists mainly of siliciclastic sedimentary rocks and is also characterized by the Kanto Loam in the uppermost sedimentary successions in the lower reaches. Thus, the water quality of the lower reaches is characterized by a higher concentration of Mg, Si, V, in association with a lower $^{87}Sr/^{86}Sr$ ratio. In contrast, the middle reaches of the Obitsu River are represented by turbidite successions and the river water is represented by a higher concentration of Mo and by a higher $^{87}Sr/^{86}Sr$ ratio. Locally, the upper reaches of the Kamo River are also characterized by a higher concentration of Cl and Na, in association with a higher $^{87}Sr/^{86}Sr$ ratio. This locally observed higher signal is interpreted to represent an effect of fossil brine from the sedimentary successions. Although the $^{87}Sr/^{86}Sr$ ratio in river waters is sensitive to the geologic composition in the drainage basins, we have not found any distinct spatial variation in the $^{87}Sr/^{86}Sr$ ratio of channel-floor sediments of both the Obitsu and Kamo rivers. Thus, we should separately analyze chemical composition of primary and secondary minerals of the channel-floor sediments for the better understanding of the interaction between the river waters and channel-floor sediments.

Keywords: Water quality, Obitsu River, Kamo River, Boso Peninsula

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Water-quality diagnosis of Sabanakett district in central Laos

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ater cycle in the Indochinese peninsula is strongly affected by Asian monsoon, and people strongly depend on the water in rainy season. Rain in this tropical area accelerates chemical weathering to have formed lateritic soil, which is deficient of base cations and is enriched in iron and aluminum. Lao People's Democratic Republic is a landlocked country in the peninsula and its water resource receives high demands as electric power from the surrounding countries. Development of industrial system and growth of population in Laos, although they are not so rapid, become concerned with pollution and other human impacts on the aquatic ecosystemr. Nevertheless, there is few geochemical study on the fresh water in Laos. Water stable isotopes and dissolved components in surface water and shallow groundwater, as they are of meteoric water origin, provide basic information on the water cycle, material behavior in ecosystem, and human health. In RIHN, project focusing on infectious disease such as Malariya and Clonorchis sinensis disease have been implemented at Xepon and Lahanam areas in Savannakhet district of southern Laos. These areas are located in the watershed of the Banhyang River, which is one large tributary of the Mekong River. Here we report the compositions of stable isotopes and dissolved components for surface and ground waters at about 200 sites in this area. All analyses were done for water using 0.2 um acetate-cellulose filter.

The d18O values and dD values of all waters are plotted along the meteoric water line. It is notable that the water isotope ratios of surface waters show a large areal variation (d18O values; -11.4 - -7.4 permill) and dD values, whereas those of most ground water (<50m from the surface) fall in a relatively narrow range (d18O; -8.1 - -6.5 permill). This isotope value of groundwater is close to the annual average of rain water at Luang Phabang in northern Laos (d18O; -7.4 permil), suggesting that the groundwater and surface water in small streams are derived largely from precipitation in Lao Heights. In contrast, the Banhyang River and some tributaries had low water isotope ratios. This result is also consistent with that this river flows from the Annamite Mountains where the precipitation would have low isotope ratios due to elevation effect.

Dissolved components are divided into three groups (A, B, and C) based on the water type and the water isotope ratio. Regardless of the water type, the concentration of dissolved component in the water with high d18O value (-8.1 - -6.5 permil) showed a large variation. On the other hand, for waters with d18O values less than -8.1 permill, Group-A and Group-B components are characterized by low concentrations and high ones, respectively. Component of Group-C is intermediate between the two groups. Cl, SO4, and alkali and alkali-earth elements are classified into the Group-A, and are considered to be dissolved as ions in the water. The Group-A components are very high in the groundwater of Lahanam area, which is derived from the dissolution of evaporate minerals. In contrast, Group-B is composed of Al, Ti, Fe, Mn, Y, and REEs, which are the major constituent of minerals resistant to chemical weathering. It is likely that the Group-B elements are present as small mineral and/or colloidal particles in the water. The widespread distribution of surface water with high Fe and Mn contents suggest a contribution of lateritic soil. This result is also consistent with the comparison of Sr isotope data between water and rock, suggesting that the water is affected by rainwater input rather than the dissolution of primary minerals. Group-C is composed of NO3, Zn, and K. These components are affected by human activities in addition to atmospheric precipitation and mineral dissolution, which are the major source of group-A and ?B components. Indeed, NO3 tended to be high in populated area. Zn was also high in groundwater pumped through Zn-coated steel pipe.

Keywords: Laos, water circulation, water isotope, material behavior, strontium isotope, trace element

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Water quality maps of Laguna de Bay Basin, Philippines

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This study, conducted in Laguna de Bay Basin, aims at creating water quality maps for the Basin and its watersheds. The Laguna de Bay is the largest lake in the Philippines, with a surface area of 900 km^2 and its watershed area of 2920 km^2 (Santos-Borja, 2005). It is located on the southwest part of the Luzon Island and its watershed contains 5 provinces, 49 municipalities and 12 cities, including parts of Metropolitan Manila. The water quality in Laguna de Bay has significantly deteriorated due to pollution from soil erosion, effluents from chemical industries, and household discharges. Recent studies have suggested that concentration of heavy metals in the edible fishes and aquatic plants in the Laguna de Bay are high and likely to have health risks to eating them (e.g., Molina 2011). In this study, we performed multiple element analysis of water samples in the lake and its watersheds for chemical mapping, which allows us to evaluate the regional distribution of elements including toxic heavy metals.

We collected water samples from 24 locations in Laguna de Bay and 160 locations from rivers in the watersheds. The sampling sites of river are mainly downstreams around the lake, covering urbanized and rural areas. We also collected well water samples from 17 locations, spring water samples from 10 locations, and tap water samples from 21 locations in order to compare their characteristics with the river and lake samples and to assess the quality of household use water. The samples were collected in dry season (March and May in 2011) as well as wet season (October and November in 2011) of the study area in order to evaluate seasonal differences. Water samples were filtered through a cellulose acetate disposable filter (0.2 micrometer pore size), then brought to the Research Institute for Humanity and Nature (RIHN), where the analysis was performed. The concentrations of the major components (F, Cl, NO_3, SO_4, NO_2, Br, PO_4, Ca, Mg, Na, and K) dissolved in the samples were determined with Ion Chromatography System (Dionex Corporation ICS-3000). We also analyzed major and trace elements (Li, B, Na, Mg, Al, Si, P, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn Ga, Ge, As, Se, Rb, Sr, Y, Zr, Mo, Ag, Cd, Sn, Sb, Cs, Ba, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, W, Pb and U) with Inductively Coupled Plasma-Mass Spectrometry (ICP-MS, Agilent Technologies 7500cx). We used Geographic Information System (GIS) to create water quality maps for each components.

At most sampling locations, concentration of dissolved components in the wet season samples are lower than those in the dry season samples which can be attributed to dilution effect of rain water during wet season. The element concentrations of rivers are characterized by remarkable regional variations. For example, heavy metals such as Ni, Cd and Pb are markedly high in the western region as compared to the eastern region implying that the chemical variation reflects the urbanization in the western region. On the other hand, As contents is relatively high in the south of the lake and some inflowing rivers in the area. The higher concentration of As is also observed in the spring water samples in the area. Therefore, the source of As in the area is probably natural origin rather than anthropogenic.

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Keywords: Water quality map, Laguna de Bay, Philippines

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The influence of the Ganges, Brahmaputra river, and Meghna river on global carbon cycle

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In the perspective of global biogeochemical cycles, continental rivers are important paths transporting vast amounts of solids and solutes from land to ocean. However these rivers are not just pathways to ocean. There are various chemical reactions occurring in river water, e.g. respiration and photosynthesis. These reactions can alter chemical character of rive water and play some parts in global carbon cycle. In this study, we investigated three continental rivers in Bangladesh: the Ganges, Brahmaputra river, and Meghna river. We measured pH, total alkalinity, pCO_2, nutrients, and major ions in the river water. In these rivers, pCO_2 values were higher than the atmospheric level, which indicates that the river water works as a source of CO_2 to the atmosphere. Respiration and photosynthesis rather than weathering may play an important part in the river flow. We evaluated how continental rivers themselves affect global carbon cycle.

Keywords: respiration, photosynthesis, pCO2, river, limnology, carbon cycle

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Distribution of oxygen-18 and deuterium across the Tunisia

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Groundwater use in Tunisia

In their fourth report, the Intergovernmental Panel on Climate Change (IPCC) warns that temperature will increase and rainfall will decrease especially in the Mediterranean coastal areas of North Africa with a global warming increase. People in Tunisia located in north Africa largely depends on groundwater use for irrigation, which caused the drawdown of groundwater.

For sustainable groundwater use, it is essential to understand the groundwater system.

Isotopic Mapping

Kendall (2010) pointed that large scale spatial isotope studies of water cycle can provide important insights into the groundwater recharge process. Kendall (2001) also showed the effectiveness of isotopic mapping by taking surface water samples over large areas, because surface water can be representative value of rainfall water of whole basin.

High resolution isotopic mapping also can help us to identify the important sites such as recharge area in the surface and groundwater flow system.

Objective and Methodology

The objective of this research is showing isotopic map and clarifying the groundwater recharge process across the Tunisia.

Sampling survey was conducted form from July 7th to11thand, from Nov 12th to 20th in 2011. Water samples were taken mainly from river across the whole of Tunisia. We measured electrical conductivity, ORP, and pH in situ. We also analyzed the stable isotopes (D, 18O) in laboratory.

However, in southern area, wadi river were dry up even in rainy season. Then we took water from some Magels (traditional water tank to collect rainfall during rainy season). Magel is covered by concrete and prevent evaporation effect. Then the water in Magel can be integrated value of rainfall during rainy season.

Results and Discussion

Stable isotopic values were plotted on river system map and compared with topographic map. Generally, isotopic values in eastern coastal area tended to be relatively high (delta D = -27.6 ˜ -6.9 per mill, delta 18O = -4.4 ˜ 0.1 per mill). Meanwhile, values in western inland area were relatively low (delta D = -41.9 ˜ -27.7 per mill, delta 18O = -7.9 ˜ -4.5 per mill). This tendency is remarkable especially in Mejerda River watershed located in northern Tunisia. Isotopic values along the mainstream increased with distance from coat to inland (inland effect).

However isotopic values at some points located in northern coastal area were low. These values were lower than average precipitation value at nearest observation point of IAEA. There is possibility that these low value come from not base flow but short time rain event.

More sampling are planned in gap area on the map and, in same points to see seasonal change.

Keywords: groundwater, stable isotope, tracer, isotopic mapping

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Temporal variation of stable isotope ratio in precipitation on Chubu-mountainous areas: case study of Mt. Ontake in cent

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In order to clarify the temporal variation of the stable isotope ratio in precipitation on the mountainous area in Japan, monthly precipitation was collected at 11 sites on Mt.Ontake from Jan 2003 to Dec 2005, and determined their delta-values. d-excess values ranged from 5 to 34 per mil, and showed clear seasonal variations in which values are low in rainy season from spring to fall and high in snow season (winter), reflecting the change of monsoon. The isotope ratios showed high delta-values in spring, low delta-values in winter and intermediate delta-values in summer to fall throughout the observation period, and these seasonal variations can not be accounted for the amount effect and the temperature effect. Rain-bearing weather condition and spatial variation of rainfall amount around Mt. Ontake were investigated, and discussed a factor controlling the seasonal variation of delta-values. In the warm rainy season, the low delta-value in precipitation were observed in the period at which the rainfall amount of windward (south-east) area of Mt. Ontake was high, suggesting that delta-values variation on Mt. Ontake during the warm rainy season depend on the rainfall amount during the vapor mass transpiration from Pacific coast to Mt. Ontake. Moreover, it is indicated that the low delta-values of snow cover in winter was caused by the inland effect, considering the existence of heavy snowfall area in windward. These variations of delta-value associated with the rainfall amount on surrounding area is considered to be reflect the geographical location of Chubu-mountainous area which is away from the ocean generating a vapor mass.

Keywords: Chubu-mountains areas, Mt. Ontake, precipitation, stable isotope, vapor mass transpiration,, inland effect

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

AHW26-P11 Room:Convention Hall Time:May 24 17:15-18:30

Stable isotope distribution of Springwater in Kanagawa Prefecture.

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It is necessary to clarify the altitude effect of precipitation in the object region to presume the altitude of recharge area of the spring and the stream using the hydrogen and oxygen stable isotopes. However, it is known that the altitude effect of precipitation changes with altitude, latitude, slope direction, seasons and others. For this reason, it is very difficult to extract the rain sample which covered these. In such a case, the recharge altitude is presumed with the groundwater occurrence curve drawn from an isotopic ratio in the small-scale springwater which gushes from mountainous watershed and altitude. However, this method is mainly used in the comparatively narrow ranges, such as mountain land. On the other hand, examination in the wide area containing a plain and a plateau part is seldom performed.

In this study, areal distribution of the stable isotope ratio of springwater in Kanagawa prefecture was clarified and the broad-based groundwater recharge isotopic ratio was examined.

Summary of investigation

The springwater was sampled at 163 point in Kanagawa Prefecture and a neighboring area. The investigation went from April, 2009 to August, 2010. Measurement of the water temperature, pH, and electrical conductivity in springwater was performed, and analysis of dissolved ion, and hydrogen and an oxygen isotopic ratio was conducted. Moreover, the amount of springwater was measured as much as possible. As a result of investigating with the springwater of 163 points, the gush part from underground has been checked at 119 points. However, it is fixed as a springwater institution and 40 points were not able to check a gush place, and 4 points were springwater ponds. From the point which has checked the gush point, the isotopic distribution figure was created using the isotopic ratio in the springwater of 114 points which excepted five points which showed the unusual isotopic ratio.

Oxygen isotopic ratio distribution in springwater

The minimum values of oxygen stable isotope ratio in springwater of Kanagawa Prefecture was -9.3permil and the highest was -6.8permil and arithmetic mean value was -7.9permil. The areal distribution of the oxygen isotopic ratio in springwater was low in Hakone in western Kanagawa, and the Tanzawa area, and the tendency which becomes high in an area along the shore and an eastern part of prefecture was seen. The altitude effect of oxygen stable isotope in the springwater calculated using all the points is -0.104permil/100m and coefficient of determination was 0.375.

Then, the west of the west longitude of 139.15 degrees was classified with the western prefecture. Moreover, the longitude between 139.15 to 139.45 degree was classified with the central prefecture, and the east of 139.45 degree were classified into the eastern prefecture, respectively. And it analyzed for every area about the relation between altitude and an oxygen isotopic ratio, latitude and an oxygen isotopic ratio. As a result, the altitude effect of oxygen stable isotope in the western prefecture is -0.086permil/100m and coefficient of determination was 0.474, in the central prefecture is -0.278permil/100m and coefficient of determination was 0.287, and in the eastern prefecture is -0.275permil/100m and coefficient of determination was 0.016, respectively. On the other hand, it is about the relation between latitude and an oxygen isotopic ratio in the western prefecture is -0.032permil/min and coefficient of determination was 0.146, in the central prefecture is -0.064permil/100m and coefficient of determination was 0.582, and in the eastern prefecture is -0.017permil/100m and coefficient of determination was 0.134, respectively. As a result, the central prefecture showed the value with inclination and the highest correlation coefficient. Since a central prefecture has the Tanzawa place in a northern part, this is considered because the direction of high latitude and the high altitude direction overlapped.

Keywords: Springwater, Hydrogen and Oxygen stable isotopic ratio, areal distribuion

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Stable isotopic composition of river and spring waters in the Shirakami Mountains, Japan

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The Shirakami Mountains is the general name given to an extensive mountainous region of 130,000 hectares ranging from the southwest of Aomori to the northwest of Akita prefecture. Within this area are 16,971 hectares of land, enclosing virgin forests of Japanese beech, which were registered as a world heritage region in December 1993. However, environmental impact by acid rain at the Shirakami Mountains is becoming an issue these days. Acid rain deposits nitrates that can lead to increases in nitrogen in forests. So we have studied about the chemical and isotopic compositions of river and spring waters in the Shirakami Mountains area, to clarify origin and geochemical characteristics.

Delta-18O and delta-D of groundwater samples mainly showed -8.8 to -10.6 permil and -50.7 to -62.7 permil, respectively. The hydrogen and oxygen isotopic ratios of water collected at inland side are higher than shoreline side samples.

Keywords: Shirakami Mountains, hydrogen and oxygen isotopes

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Characteristics of stable isotopes of oxygen and hydrogen in precipitation at Saku City

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Stable isotopes of oxygen and hydrogen in precipitation have several characteristics e.g., amount effect, temperature effect, altitude effect, latitude effect and longitude effect. For the altitude effect, however, there is little investigation about precipitation samples which are taken at different slopes. The objective of this study is to make clear the temporally variation and altitude effect of stable isotopes in precipitation which are sampled at different slope in Saku City, eastern part of Nagano prefecture. The precipitation samples were taken in September 21 and 22, 2011 that is before and after the typhoon No.15 for the three points in northeast slope (elevation is 800m, 1,000m and 1,200m) and at the eight points in southwest slope (elevation is 800m, 1,000m, 1,200m, 1,400m, 1,600m, 1,800m, 2,000m and 2,100m).

The stable isotopes of oxygen (d^{18}O) and hydrogen (dD) are relatively light for the precipitation samples which are taken after the typhoon had passed through. The reason of this may be estimated that the influence of the amount effect appears. The altitude effect is existed both northeast slope and southwest slope. The altitude effect for d^{18}O at southwest slope is -0.25 permil/100m which is before the typhoon and -0.39 permil/100m which is after the typhoon. The altitude effect for dD at southwest slope is -2.1 permil/100m which is before the typhoon and -2.6 permil/100m which is after the typhoon. The altitude effect is high for the precipitation samples which were taken after typhoon had passed through. The local meteoric water line is $d\mathrm{D} = 7.95 d^{18}\mathrm{O} + 9.30$, it is almost the same as Craig's meteoric water line. The d-excess values in precipitation samples which were taken after the typhoon passed through are relatively higher rather than those in precipitation samples which were taken before the typhoon passed through. This cause may be considered that the difference in source of water vapor affects. In future, it will be make clear the factor of d-excess variation by performing the detailed and regularly investigation of rainfall or typhoon event.

Keywords: precipitation, typhoon, stable isotope, altitude effect, d-excess

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AHW26-P14 Room:Convention Hall Time:May 24 17:15-18:30

Characteristics of stable isotopes for precipitation at the mountainous region in the eastern part of Matsumoto

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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. 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 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.

For estimating the recharge area of groundwater or spring water in Matsumoto basin by using the stable isotopes of oxygen and hydrogen, precipitation samples have been taken at four points on the east side of Matsumoto basin since June, 2009. The water samplers which have the parts to prevent the evaporation of water are settled at P-1 to P-4. The elevation of P-1 is 592m, P-2 is 1,000m, P-3 is 1,300m and P-4 is 1,900m. The monthly precipitation samples are taken at four points from May to November and taken at only two points (P-1 and P-2) from December to April.

Thus the stable isotopes of oxygen (d^{18}O) and hydrogen (dD) in precipitation are relatively low in the place of high elevation, the altitude effect is existed. The altitude effect is Matsumoto is -0.17 permil/100m (r^2=0.998) for d^{18}O and -1.0 permil/100m (r^2=0.994) for dD. Since the precipitation amount is large with increasing the elevation, the amount effect also will probably exist. Usually the d^{18}O and dD in precipitation have no seasonal variation in Japan, however those in Matsumoto are relatively low in winter season (from November to February). As a result of calculation by using the stable isotopes of precipitation and groundwater samples, it is estimated that the average recharge are of groundwater in Matsumoto basin are estimated at the area from 1,300m to 1,600m above the sea.

The d-excess values have a seasonal variation which is relatively low at summer period and relatively high at winter period. However, the d-excess values in Matsumoto is relatively low than other area (e.g. Niigata prefecture, southern part of Nagano prefecture and western part of Yamanashi prefecture).

The local meteoric water line (LMWL) is dD = 7.16d^{18}O + 2.58 (r^2=0.928) for P-1, dD = 7.12d^{18}O + 2.26 (r^2=0.902) for P-2, dD = 6.18d^{18}O + 7.00 (r^2=0.681) for P-3 and dD = 8.00d^{18}O + 13.3 (r^2=0.976) for P-4. The slopes of LMWL at P-1, P-2 and P-3 are relatively gentler than that of Craig's meteoric water line (dD = 8d^{18}O +10). On the other hand, the slope of LMWL at P-4 is relatively steeper than that of other points and almost same the slope of Craig's meteoric water line. Thus there is almost no the observation in the mountainous region where the elevation about 2,000 meter, it is important to continue the observation of this study.

Keywords: Matsumoto basin, Utsukushigahara plateau, precipitation, groundwater, stable isotope

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AHW26-P15 Room:Convention Hall Time:May 24 17:15-18:30

Clarification of recharge source and emergence/disappearance mechanism of an oasis in Tottori Sand Dune

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1. Introduction

The Tottori sand dunes, located in the Sanin Kaigan national park, are the most famous sightseeing sand dunes in Japan. In this sand dune, there is an oasis which repeats emergence and disappearance. There is a perpetual spring near the oasis. It has been considered that the spring is the recharge source of the oasis. The emergence/disappearance mechanism of the oasis and the recharge source of the spring are longtime academic concerns. In addition, because the Tottori sand dunes were registered in the global geoparks network in 2010, clarification of the emergence/disappearance mechanism of the oasis has been strongly expected. Although some local researchers have advocated that the water in the spring comes from the Tanegaike pond which located on the south side of the sand dunes, this hypothesis has not been confirmed due to limitation of investigations in the national park. The objectives of this study were to clarify (i) emergence/disappearance mechanism of the oasis, (ii) the recharge source of the spring and (iii) elapsed time from rainfall events to discharges from the spring, through hydrological observation and water stable isotope ratio analysis.

2. Material and Methods

2.1 Water level observation in the oasis

Pressure type water level loggers were buried into the ground at the oasis emergence area. The inside and around area of the oasis were surveyed and three-dimensional shape of the oasis was determined. The shape was used to estimate contribution rate of evaporation to reduction of the oasis volume by combining water level data and pan evaporation data.

2.2 Water stable isotope ratio analysis

Precipitation water for all daily precipitation events was collected from Nov. 2010 - Dec. 2011. Also the oasis and Tanegaike pond water was collected every one-three days. Oxygen (delta^{18}O) and hydrogen (deltaD) stable isotope ratio of the water samples were analyzed by an isotope ratio mass spectrometry. The d-excess value was calculated using of the delta^{18}O and deltaD values for each sample.

3. Results and Discussion

The emergences of the oasis were strongly affected by the precipitation within a few hours. The contribution rate of evaporation to reduction of the oasis volume was about 10%, meaning that the most of the oasis water was lost by infiltration to the ground. The values of delta^{18}O of the spring and Tanegaike pond did not cross through the whole year, indicating low probability of water flow from the Tanegaike pond to the spring. The annual variation of the d-excess values in the precipitation and spring water suggested that the source of the spring water was reserved and averaged precipitation for long period. However, after very heavy rainfall events, the rainfall water discharged from the spring within about 10 days.

Keywords: oasis, hydrological observation, water stable isotope ratio analysis, d-excess

Japan Geoscience Union Meeting 2012
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AHW26-P16 Room:Convention Hall Time:May 24 17:15-18:30

Tracing the source and fate of nitrate in groundwater using ^{15}N, ^{17}O and ^{18}O

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The stable isotopic compositions of nitrate in precipitation (wet deposition) and groundwater were determined for Toyama prefecture, Japan, so as to use the ^{17}O anomalies ($D^{17}O$) to trace the fate of atmospheric nitrate that had deposited onto the groundwater catchments. Both $d^{15}N$ and $d^{18}O$ of nitrate were also used together with $D^{17}O$ to trace the non-atmospheric sources of nitrate in the groundwater. Wet deposition (precipitation) samples were taken every week at the Kosugi Station of Toyama Prefectural Environmental Science Research Center from April 2010 to March 2011. Groundwater samples were collected at 47 sites, mostly located on Kurobe, Joganji or Shougawa alluvial fan, in Toyama prefecture. 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 $^{15}N/^{14}N$ and $^{18}O/^{16}O$ 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). Concentration of nitrate in ground water samples varied widely from less than 0.1uM to more than 100uM due to the difference in biological activity among the groundwater catchments. All the groundwater samples in this study had small but positive $D^{17}O$ values in nitrate ranging from +0.4 to +4.0 permil as compared to those in atmospheric nitrate; the annually averaged $D^{17}O$ value of atmospheric nitrate was determined to be +26.8 permil at Kosugi Station. We conclude that only less than 15% of the nitrate in groundwater originates directly from the atmosphere being processed in the soil, and substantial portion of nitrate is remineralized origins that undergo biologic processing in soil before being exported from the ecosystem.

Acknowledgements
The authors would like to thank H. Miyakoshi and the staff members of the Toyama Prefectural Environmental Science Research Center (TESC) for their kind assistance in collecting groundwater samples. Part of the groundwater samples were provided by the Japan Society of Kurobe Area Studies.

Keywords: triple oxygen isotopes, nitrogen isotope, nitrate, groundwater, nitrogen cycle

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AHW26-P17 Room:Convention Hall Time:May 24 17:15-18:30

Sources and processes of nitrate in forest soils: a case study at sites with heavy nitrogen deposition using nitrogen an

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Nitrogen is one of the indispensable nutrients for plant growth and microbial activities. The nitrogen cycle is an important part of the forest ecosystems. Atmospheric nitrogen deposition remains elevated in industrial regions of the world and is accelerating in many developing regions. Chronically elevated atmospheric N inputs to forest can lead to changes in tree growth, mortality, and species composition and to possible declines in soil fertility and drainage water quality. Combined oxygen (O) and nitrogen (N) stable isotope analyses are recently used in the source determination of NO3-. The source of NO3- can be determined based on distinct O and N isotopic signatures (d18O and d15N) of various sources and isotopic effects during NO3- transformation processes. There two major sources in forest soil nitrate (NO3-): atmospheric deposition and microbial production. In Tanashi where have a high amount of nitrogen deposition, we analyzed d18O and d15N of NO3- in the samples consisted of the rainfall, though fall, stew fall , litter layer water and the soil water.

The results were: 1) the d18O of NO3- had a decreasing trend from rainfall, though fall, stem flow to soil water. It indicates that NO3- derived from the atmosphere is absorbed by plants and/or microbes when the rain through forest vegetation. 2) the d18O of NO3- values was 0˜20 permil while d15N of NO3- values was -5˜5 permil in the soil water. This suggests that the major potion of NO3- of the soil water is comes from the nitrification in soil by microbes, meaning that most of atmospheric NO3- was replaced by NO3- produced by microbes. 3) A large range of d18O values 12˜95 permil and d15N values -9.2˜6.6 permil in the litter layer water what shows that nitrate in the litter layer water has complex sources including nitrification and atmosphere , and those change temporarily.

Keywords: nitrate, oxygen and nitrogen stable isotope, Tanashi, temperate forest

Keywords: nitrate, oxygen and nitrogen stable isotope, Tanashi, temperate forest

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Analysis of nitrate variation by source and hydrologic factors in spring water of Mt.Ytsugatake

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Concerns regarding ground-water contamination in the Mt. Yatsugatake on the west slope have arisen due to a steady increase in averaged nitrate concentrations (from1.2 to 3.5 NO3-mg/l) during t

he past 15 years (from 1987 to 2002) in spring waters (Shimizu et al. 2007). Mt. Yatsugatake is volcano in central Japan having elevations of 2899m. The artificial and local resort towns are locating blow 1100m elevation. The stock farms are expanding from upper 1100m until 1400m elevation.

Twenty-nine water samples were collected from 750m to 2380m elevation. Multiple isotopic tracers were used to identify the sources and extent of nitrate dynamics in groundwater under the recharging systems.

The ranges of nitrate-N concentration were from <0.05 to 17.8mg/l. Few samples of high nitrate-N concentrations (5.8 and 17.8 mg/l) were located in locally concentrated of agricultural and local resort town. And 80% of collected samples were <0.9 mg/l. Although delta 15N-NO3 values (from -0.4 to 10.5permil) were highly variable both spatially and vertically. The high delta 15N-NO3 values are decreasing with the averaged recharge elevation of springs which was estimated by elevation effects of water hydrogen isotope values on Mt.Yatsugatake reason. Relatively high isotope value samples (4.4-10.1permil) were detected blow 2000m elevation indicated that nitrate in springs mixed from human/animal wastes consistent with landuses. The relationship between NO3-N concentration and delta 15N values was insignificant. However the high NO3-N concentration (>0.9 mg/l) springs having relatively small amount of discharges (850 m3/day) indicated the effects for the distribution of NO3-N concentration is nitrogen sources rather than quantity of the groundwater.

Keywords: Spring water, Mt. Yatsugatake, Nitrate, Nitrate nitrogen and oxygen isotopes, Water hydrogen and oxygen

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AHW26-P19 Room:Convention Hall Time:May 24 17:15-18:30

Source and residence time of groundwater around Battambang region in Kingdom of Cambodia

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Management of groundwater is vital for maintaining social systems under Asian monsoon climate. At Battambang, which is situated west of the Lake Tonle Sap, hydrological system is strongly related to the lake level changes. The river water level of the Sangkae River, the main river running Battambang, fluctuates up to 7 m and the water level almost drops to riverbed in dry season. Groundwater level also fluctuates seasonally. Thus, it is very important to study the relationship between surface water, i.e., river water and lake water, and groundwater for understanding the hydrological system of the area, and to propose appropriate management system. For achieving the objective, we conducted field survey on November 2011 at around Battambang. Groundwater samples were collected from 15 wells, and stable isotopes of oxygen and hydrogen, water chemistry, tritium and sulfur hexafluoride were analyzed for all samples. Based on the results, we discuss source and residence time of the groundwater around Battambang region.

Keywords: Kingdom of Cambodia, Battambang, Groudwater age, Sulfur hexafluoride, Tritium, Stable isotopes

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AHW26-P20 Room:Convention Hall Time:May 24 17:15-18:30

Existence of the long-term groundwater flow system in the Nakano-shima Island, Oki-Dozen, Japan -A preliminary study-

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It is known that groundwater flow system in the coastal area is affected by sea level changes. We have been attempting to reveal the groundwater flow system in the Nakano-shima Island, which is situated in the Sea of Japan, using several indices of the residence time of groundwater (CFCs, ^{3}H, SF_6, and ^{14}C). In this paper, end-member waters with different residence times are clarified, and the formation of groundwater and hot spring water in the Nakano-shima Island are discussed.

The Nakano-shima Island was formed by volcanic activities which erupted alkali basalt lava c.a. 6Ma (Tiba et al., 2000). Thickness of the lava is about 300 to 400m. The lava overlies the sedimentary rocks of which deposition ages were Lower to Middle Miocene (Tiba et al., 2000).

Groundwater samples were collected from five springs, thirteen water-supply wells (screen depth: GL-10 to -100m) and a hot spring well (screen depth: GL-560 to -870m). All samples were analyzed for CFCs, ^{3}H, SF_6, and stable isotopes of oxygen and hydrogen. Samples from four water-supply wells and the hot spring were analyzed for ^{14}C and isotopic ratios of helium.

Stable isotopic ratios of oxygen and hydrogen of all samples were plotted on or near the meteoric water line. Those values of the hot spring were lower than other samples. Samples from two water-supply wells and the hot spring well showed much lower CFCs and ^{3}H concentrations than other wells, and their ^{3}H concentrations were close to detection limit (0.2 TU). ^{14}C concentrations were analyzed for samples from the hot spring, two water-supply wells containing lower CFCs and ^{3}H, and a water-supply well containing higher CFCs and ^{3}H concentration. ^{14}C concentrations of theses samples were 17pMC, 57 to 77pMC, and 96pMC, respectively. The samples analyzed for ^{14}C were also analyzed for $^{3}He/^{4}He$ and $^{4}He/^{20}Ne$. Those values of all samples were plotted in the zone which can be explained by the mixing of air, mantle, and crust components, suggesting that mantle-derived fluid is added to groundwater. Thus, pMC values are considered to be higher than those measured by subtracting the addition of ^{14}C -free fluid derived from mantle. In addition, groundwater containing lower CFCs and ^{3}H and the hot spring water are considered to be the mixture of young groundwater containing CFCs and ^{3}H and old groundwater free of CFCs and ^{3}H, and hence, it is necessary to consider the mixing effect to estimate the pMC values. This analysis is under progress.

Lower delta D and delta ^{18}O values of the hot spring suggest that the hot spring water might be recharged in colder climate, and this result is consistent with lower pMC value of the hot spring water. It is considered that fresh groundwater recharged during the last glacial period still remains in the aquifers. Further consideration is needed for understanding the formation process of such long-term groundwater flow system in the island, with the focus on the effect of sea level changes and the paleo-topography of the island and its surroundings.

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Japan Geoscience Union Meeting 2012
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AHW26-P21 Room:Convention Hall Time:May 24 17:15-18:30

Preliminary results of groundwater age-related isotopic tracers for shallow groundwaters in the Eastern Osaka Basin

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High chloride groundwaters are often found in the coastal regions, possibly due to intrusion of sea water, squeezing pore water from clay layers by excessive pumping of the wells and/or infiltration of sea water during the sea level rise period. Groundwater age is a key factor for investigating the nature of high chloride component. However, the ages measured by isotopic and chemical methods give only 'mean age' if mixing of groundwater has occurred. This 'mean age' has no meaning when we consider the nature of high Cl water. It is important to know the age for the timing of the high Cl water infiltration into the fresh water.

Since the 1950s, the groundwaters with high Cl concentrations as high as 800mg/L were found in the Eastern Osaka Basin (Kawachi Plain), especially in the region around Yodo River (e.g., Tsurumaki, 1967). The high Cl groundwaters are still found in this area (Nakaya et al., 2009). In this study, we preliminary investigated the mixing condition between the high Cl water and the freshwater and inferred the age of high Cl water using tritium, helium, carbon-14 and chloride-36.

Both He concentration and isotope ratio in shallow groundwaters in the studied area are almost identical to those in air saturated water, indicating these groundwaters are very young sufficient to accumulate little amount of crustal (and mantle) He. It is not contradict with tritium results. Significant amounts of tritium (up to 3.4 T.U.) are detected from most of selected samples analyzed in this study. The $^{14}C/^{12}C$ ratios show various values ranging from -33 to -809 permil, but these values are significantly high relative to the deep groundwaters in this region which is mostly composed of dead carbon. Four analyses of the $^{36}Cl/Cl$ ratios also show various values (2.8 - 52.4x10^{-15}). Considering with the relatively low Cl concentration (55 - 230mg/L) and the detection of significant amount of tritium, the samples with the high $^{36}Cl/Cl$ ratio may be due to the contribution of cosmogenic ^{36}Cl dissolution during recharge. After subtracting the contribution of cosmogenic ^{36}Cl, the $^{36}Cl/Cl$ ratios in these groundwaters are in the range of those in seawater. High Cl shallow groundwater in the Eastern Osaka Basin may originate from mixing with relatively modern sea water and fresh water, although both the He and ^{36}Cl results for saline groundwaters in the deeper region of this area show the characteristics of nearly stagnant saline water (Morikawa et al., 2011).

References: Tsurumaki (1967) Journal of Groundwater Hydrology, 9, 11-23. Nakaya et al. (2009) Journal of Groundwater Hydrology, 51, 15-41. Morikawa et al. (2011) Japan Geoscience Union Meeting 2011, AHW023-22 (Abstract)

Keywords: Groundwater, Osaka Basin, Tritium, Helium, Carbon 14, Chroline 36

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Comparison between volcanic and non-volcanic thermal waters using the chloride type thermal waters in Kanagawa Pref.

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The sodium-chloride type thermal waters which are discharged in the Hakone volcano, located in the west margin of Kanagawa Prefecture, central Japane, are widely known as the typical volcanic thermal water originated from magma, that is, slab-derived fluid (Oki and Hirano, 1970). Recently, the sodium or calcium-chloride type saline waters and brines have been obtained from deep wells installed in the Kanto sedimentary basin of the eastern Kanagawa Prefecture. Itadera et al. (2011) suggests that these deep well saline waters are probably originated from modern or fossil seawaters. The purpose of this study is to understand the difference of the geochemical features between volcanic and non-volcanic chloride type thermal waters discharged in adjacent regions.

The sources of the deep well waters in Kanagawa Prefecture were divided into three groups, (1) modern seawater, (2) fossil seawater and (3) meteoric water, on the basis of the relationship between Cl^- and $SO_4{}^{2-}$ concentrations (Itadera et al., 2011). On delta-diagram the saline waters of group 1 are plotted along the mixing line between meteoric water (group 3) and V-SMOW (modern seawater), while those of group 2 are plotted below the mixing line (type A) or on the meteoric water line (type B). Almost all the saline waters of type A are discharging from Kazusa formation (Pliocene to Pleistocene), having higher Br/Cl ratio ($4.0x10^{-3}$) than that of modern seawater with natural gas as well as the natural gas brine in the Minami-kanto natural gas field (Maekawa et al., 2006). The source water of type A seems to be interstatial water of marine deposits, since the depletion of ^{18}O and Mg^{2+} perhaps produced by alternation of volcanic materials in sediments are found as well as pore water from sediments in oceanic crust (Lawrence and Gieskes, 1981). The saline waters of type B are discharging from Hayama formation (Miocene) which is lower than Kazusa one. On the figure of $d^{18}O$ vs. Cl^- concentration, the most saline waters of type B are plotted on the left-hand side of mixing line between meteoric water and modern seawater, namely the chloride ion is depleted and ^{18}O enriched in seawater. Similar saline water samples are produced from deep wells drilled in Miocene sedimentary rocks at Niigata and Miyazaki Plain. These saline waters seem to be diagenetic water originated from dehydrated interlayer water in smectite. (Ito et al., 2004 and Ohsawa et al., 2010).

The sodium-chloride thermal waters in Hakone volcano are discharging in Gora area, located on the flank of central cones in the caldera, and Hakone-Yumoto, located in the eastern margin of the caldera along valleys which is deeply dissected by Hayakawa and Sukumogawa rivers. Chloride concentration (below 3500m/L) of thermal waters is less than that of the deep well saline waters in the Kanto sedimentary basin. Though the isotopic shift is a little, the thermal waters in Hakone volcano are linearly plotted form meteoric water and high temperature volcanic steam (Matsuo et al., 1985). However, the Li/Cl ratios of thermal waters, which are useful value when seawater and slab-derived fluid are distinguished, differ between Gora and Hakone-Yumoto areas. Most thermal waters of Gora area have higher value ($0.5\tilde{}1.0x10^{-3}$) than those of Hakone-Yumoto ($0.25\tilde{}0.1x10^{-3}$) with closer value of seawater. The Br/Cl ratio of Gora area is inversely lower value ($1.5\tilde{}2.5x10^{-3}$) than that of Hakone-Yumoto area (around $3.0x10^{-3}$) in relation to the Br/Cl ratio of seawater is $3.46x10^{-3}$. These characteristics of thermal water in both areas seem to be attributed to the effect of the common source water (provably high temperature volcanic steam) and different geological settings and sources of dissolved components.

Keywords: deep hot spring water, Hakone hot springs, interstitial water, diagenetic fluid, volcanic fluid

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An isotopic study on Cl-rich groundwater in the lower reaches of the Tone River, Japan

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In the Kanto plain, Japan, there are three regions whose groundwater is characterized by a high Cl concentration: 1) central Kanto plain (eastern parts of Saitama Prefecture), 2) lower reaches of the Tone River (southern parts of Ibaraki Prefecture and northwestern parts of Chiba Prefecture), and 3) northwestern Kanto plain (southeastern parts of Gunnma Prefecture and southern parts of Tochigi Prefecture). A study based on water chemistry, delta-18O, delta-D, 3H, 13C, 14C, 3He/4He and 36Cl/Cl has been in progress to elucidate groundwater system of the respective regions with special reference to origins and residence times of both water and Cl. As a part of the study, eighty water samples from the depth interval between 30 and 250m were analyzed in this paper to have a clear grasp of the geochemical status quo of groundwater in the lower reaches of the Tone River.

As a result, groundwater in the Pleistocene sediments in the depth of 80-150m along the Tone River course proved to be characterized by a high Cl concentration of 62-173mg/L as well as highly depleted delta-18O and delta-D values. With regard to the origin of this groundwater, a potential source is assumed to be the precipitation of low stable isotopic composition in the Last Glacial Maximum (peak period at around 20,000 yrs. BP) when the sea level of the Tokyo Bay was lower than the present by more than 100 m. The 36Cl/Cl analyses indicate admixture of 'fossil' sea water trapped in the sediments during the Shimosueyoshi transgression (peak period at around 125,000 yrs. BP) or even earlier transgressions is likely to account for its elevated Cl? concentration. On the other hand, groundwater in the overlying Holocene sediments in the depth 30-40m, which is also have a high Cl concentration of 768mg/L, is assumed to have its origins of Cl and water in sea water of the Jyomon transgression period starting around 10,000 yrs. BP and precipitation of the same period, respectively.

Keywords: Kanto plain, Cl-rich groundwater, water chemistry, multi-isotope study, residence time, origins of water and Cl