

## Stable isotopic ratio of atmospheric vapor in Hiratsuka, Japan

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The origin of water vapor in atmosphere could be variable, for example, the water vapor at a specific point is transported from a distance or the vapor is generated from surface water near the specific point. If there is equilibrium between precipitation and atmospheric vapor, the hydrogen and oxygen isotope ratios ( $\delta D$  and  $\delta^{18}O$ ) of atmospheric vapor are plotted theoretically in meteoric water line. Recently,  $\delta D$  and  $\delta^{18}O$  of atmospheric vapor is used as a tracer for atmospheric water cycle, because the water vapor is much ubiquitous than precipitation (Tsunakawa and Yamanaka, 2005). However, Japan has various water resources. From this aspect,  $\delta D$  and  $\delta^{18}O$  of atmospheric vapor could be disturbed by several factors such as seasonal variation and difference vapor source of supply (Hiyama et al, 2008). In this study, we investigated the seasonal isotopic variation of atmospheric vapor and precipitation. Then, we also examined surface water on ground and transpiration from leaves of plants, as the candidates of atmospheric vapor sources.

Precipitation and atmospheric vapor were collected on the roof of a No.17 building at Shonan campus, Tokai University from May 2013 to Dec. 2014. Precipitation samples were collected based on the method described by Negrel et al. (2011) and Yoshimura (2002). The duration of collection varied from hours to days. Precipitation samples were percolated through 0.2  $\mu m$  filter, and kept into a 100 ml low-density polyethylene bottle. Atmospheric vapor samples were collected by the cryogenic trap cooled with ethanol-dry ice mixture (Tsunakawa and Yamanaka, 2005). The total number of precipitation and atmospheric vapor samples were 142 and 90, respectively. The atmospheric vapor may be supplied by surface water on ground and transpiration from leaves of plants, therefore surface water samples were collected on 4 points (pond or river) near a No.17 building from Apr. to Dec. 2014. Transpiration samples were collected at 6 points near a No.17 building from Aug. to Dec. 2014 by polyethylene bag which covers leaves and twig over 1-4 days. Surface water and transpiration samples were percolated through 0.2  $\mu m$  filter, and kept into a low-density polyethylene bottle. The total number of surface water samples was 6 in each points and the total number of transpiration samples were 16.  $\delta D$  and  $\delta^{18}O$  of samples were measured by a Cavity Ring-Down Spectrometer analyzer (model L2120-i from PICARRO). Some data of rain water, which were sampled several times in a day, were processed to be the weighted average value.

Precipitation showed wide variations in  $\delta D$  and  $\delta^{18}O$  from -124.7 to +9.1 ‰ and -16.6 to -0.6 ‰, respectively. Atmospheric vapor also showed wide variations from -223.5 to -82.2 ‰ and -31.2 to -11.6 ‰, respectively. The  $\delta D$ - $\delta^{18}O$  relationship of precipitation and atmospheric vapor were regressed by  $\delta D=8.5\delta^{18}O+17.4$  ( $R^2=0.95$ ) and  $\delta D=6.6\delta^{18}O-2.6$  ( $R^2=0.92$ ), respectively. The d-excess values ( $d=\delta D-8\delta^{18}O$ ) of precipitation has a variation from -0.7 to 31.4 ‰. The d-excess of atmospheric vapor shows a definite seasonal trend within the range between 5.6 and 35.7 ‰. The isotopic compositions of atmospheric vapor almost agreed to the calculated value from precipitation assuming isotopic equilibrium with the exception in May 2014, where a significant difference between the observed and the calculated isotopic ratios. Such a composition seemed to be generated by the completely evaporated vapor originating in precipitation (= bulk vapor). In Jun. 2014, the d-excess of atmospheric vapor was deviated from the seasonal variation. Such a deviation can be caused by the addition of evaporated vapor from local surface water. The  $\delta D$ - $\delta^{18}O$  plots of all sample suggested that atmospheric vapor was mainly composed by three kinds of vapor, namely, the vapor equilibrated with precipitation, the bulk vapor and the vapor evaporated from the local surface water near the observation point.

Keywords: Precipitation, Atmospheric vapor, Stable isotope

## Characteristics of water quality in groundwater near the coastal area at northern part of Fukushima Prefecture

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The coastal area at northern part of Fukushima Prefecture suffered big damage by a tsunami generated in 11 March, 2011. The groundwater around these areas was affected by the tsunami. These areas were greatly affected by the accident of the nuclear power plant, and the radioactive contamination of a plant, soil and farm products became serious problem. It is important to make clear the groundwater flow in these areas because of considering the solution to the serious problem. The objective in this study is to uncover the groundwater flow system and residence time of spring water and groundwater in the coastal area at northern part of Fukushima Prefecture.

As a result of field survey, EC values of spring water and groundwater were under 30 mS/m in most sites. Almost site shows lower than 7 of pH values, however, in several sites show higher than 7.5 of pH. The water temperature is from 13 to 18 degree Celsius in almost site, but some site shows the lower than 12 degree Celsius. So, it is considered that the groundwater and spring water which show lower than 12 degree Celsius were recharged in the relative high altitude area. Water quality of shallow groundwater is Ca-HCO<sub>3</sub> type, but that of spring water and deep groundwater is Na-HCO<sub>3</sub> type. Since the SiO<sub>2</sub> concentration of these spring water and deep groundwater is relatively high, it is expected that the residence time of these water are relatively long.

The  $\delta^{18}\text{O}$  values show from -10 to -6 ‰ and  $\delta\text{D}$  values show from -65 to -35 ‰. The altitude effect in this area is -0.16 ‰/100 m of  $\delta^{18}\text{O}$  and -0.6 ‰/100 m of  $\delta\text{D}$ .

In future, we will analyze the <sup>3</sup>H, CFCs and SF<sub>6</sub>, and will consider the residence time and groundwater flow system.

Keywords: Minamisoma City, Soma City, Namie City, water quality, stable isotopes, recharge area

## Effects of mountainous water recharge to groundwater quality of alluvial fan

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In this study, the hydrogen and oxygen stable isotopes (dD and d18O) and chemical compositions of environmental water were employed to identify the effects of mountainous water recharge for groundwater quality on alluvial fan.

The study area is Midaigawa alluvial fan, located in western Kofu basin on central Japan, which is formed by Raised-bed River discharged from the mountain watershed.

The groundwater samples were collected from 25 deep wells (100~300m) in June-2010, November-2011 and November-2012. Those wells were located on Midaigawa alluvial fan and adjacent mountain. Four End-member mixing analysis using isotope value and chemical compositions revealed spatial variation in the contribution ratios for various groundwater sources. This presentation focused on groundwater recharge from mountain area to alluvial fan. It also found the relationship between contributions of mountainous water on groundwater and chemical composition.

### Acknowledgment

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Keywords: Groundwater recharge, Alluvial fan, Isotopes, End-member mixing analysis, Mountainous water resource

## Change of rainfall runoff processes with the erosion of the volcano body: a case study of Mt. Ontake

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To clarify the change of rainfall-runoff processes with the erosion, long-term monitoring of stream-runoff and EC were conducted on two basins in Mt. Ontake.

Keywords: rainfall-runoff, Mt. Ontake, erosion, hydrograph separation, direct runoff, recharge rate

## Helium isotopes in groundwaters from the middle and lower reaches of the Tone River, Japan.

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There exist three regions in the Kanto plain, central Japan, whose groundwater is characterized by a high Cl<sup>-</sup> concentration: (1) floodplains and deluvial uplands along the lower reaches of the Tone rivers (Ibaraki and Chiba Prefectures), (2) south-east parts of the Gunma Prefecture along the middle reaches of the Tone rivers, (3) central parts of the Kanto plain, south east of the Area (2).

The high-chloride groundwaters from the central parts of the Kanto plain are characterized by the following features; (a) helium isotopic ratios (<sup>3</sup>He/<sup>4</sup>He) are relatively homogeneous with an end member of 0.8-1.1 x 10<sup>-6</sup>, (b) helium-4 concentration show positive correlation with chloride concentration (Morikawa et al., 2006). Morikawa et al (2014a) investigated the noble gases in the deeper groundwaters (hot springs) in the central parts of the Kanto plain and the high-chloride groundwaters from south-east parts of the Gunma Prefecture to elucidate the origin of water and chloride component. Low <sup>3</sup>He/<sup>4</sup>He ratios in the hot springs indicate that there is almost no interconnectivity between the high chloride groundwater and hot spring water around these regions. In contrast, both <sup>3</sup>He/<sup>4</sup>He ratio and correlative <sup>4</sup>He and Cl<sup>-</sup> concentration in the high-chloride groundwaters from south-east parts of the Gunma Prefecture are similar to those in the groundwaters in the central part of the Kanto Plain. They suggest that these groundwaters and their constituents are closely related to each other in their origin. Although there is no hydrogeological connectivity, groundwaters from some part of the lower reaches of the Tone river also show similar helium isotopic ratios (<sup>3</sup>He/<sup>4</sup>He) and positive <sup>4</sup>He-Cl correlation (Morikawa et al., 2014b).

In this study, we further conducted complementary investigation for the groundwaters between the region of middle reach and lower one of the Tone River. Low Cl<sup>-</sup> with low <sup>4</sup>He groundwaters exist in this region. Combined with previous and present results, the groundwaters along the Tone River implies a mixture of young meteoric water and high chloride saline water bearing with high <sup>4</sup>He which seems to be stagnant nature.

References: Morikawa et al. (2006) JPGU 2006, H121-004, Morikawa et al. (2014a) JPGU 2014, AHW25-12, Morikawa et al. (2014b) JAHS 2014, P18.

Keywords: Helium, Groundwater, Tone River, Kanto Plain, Chloride Ion, Noble Gas

## Visualization of the deep-seated fluid ascending along the fault

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### 1. Introduction

It is known that deep-seated fluid is highly saline water and includes gas. In addition, it is thought that fluid rises from the deep part under the ground. Therefore it is thought that the deep-seated fluid has a big influence on environment of deep part groundwater.

It is known that the groundwater mix deep-seated fluid derived from the slab, based on the result of geochemical analysis at the inland from Northeast Yamaguchi to Southwest Shimane (Murakami and Tanaka, 2009). The most of these fluids spout out at the surface of the ground. However, the fluid erupted from only the flowing borehole in Tokusa basin, Yamaguchi. We cannot identify the deep-seated fluid if we don't play drilling operation. Therefore, we cannot identify the fluid if we play field investigation. And, distribution and flow of the deep-seated fluid is not known in underground.

I used the CSAMT method in this study in Tokusa Basin and tried visualization of the distribution of the deep-seated fluid underlying underground.

### 2. Geological setting

The bedrock consisted of Late Cretaceous welded tuff and rhyolitic lava of Abu group in Tokusa Basin. Sediments of the Quaternary period cover the bedrock in the basin. Based on the result of gravity survey, thickness of the sediments are up to about 200 m. The point of the fluid spout out from the borehole is three places in total and is distributed along Tokusa-Jifuku fault dislocation estimated by NE-SW direction.

### 3. Results

**Groundwater from the borehole :** Electric conductivity of the groundwater is higher than general groundwater (211 mS/m, 426mS/m and 1,310 mS/m). Water quality type are NaCl type or NaHCO<sub>3</sub> type. Though the groundwater is an inland, it is highly saline water.

**The surface groundwater :** Electric conductivity of the groundwater varied considerably ranging from 5.80 to 22.8 mS/m. The water quality type of most surface groundwater is CaSO<sub>4</sub> type. However, the groundwater of the north side of the fault tends to be slightly higher Na<sup>+</sup> and Cl<sup>-</sup> than the groundwater of the south side of the fault. Based on the result of groundwater level survey, the surface groundwater flows to the river of the northwest direction across the fault from the southeastern direction.

**Distribution of resistivity :** Fig-1B shows the resistivity profile line X-X'. As a result, H1 was a high resistivity zone more than 1,000 Ωm and caught distribution of the bedrock. And, L1 and L2 were low resistivity zone less than 100 Ωm and 30 Ωm. These low resistivity zone is the area where the deep-seated fluid gets mixed with.

### 4. Discussion

The area of L1 where low resistivity is distributed in Fig.1B is known that distribution Tokusa-Jifuku fault and the highly saline groundwater is identified in the direct top. As a result, L1 that low resistivity zone catches the rise of the deep-seated fluid along the fault. It is thought that the deep-seated fluid ascending along the fault penetrates in sediment, because low resistivity zone L2 distributes the north side of the fault and the shallow groundwater of the NaCl type distributes. Namely, the deep-seated fluid ascending Tokusa-Jifuku fault (L1) mixes the shallow groundwater in sediments, but the flow is regulated by the shallow groundwater system which flows from the south of the Tokusa Basin to the north (L2). The plural ratio resistivity distribution across Tokusa-Jifuku fault shows similar tendency to Fig.1B. Therefore, the deep-seated fluid distributes not only the place where the fluid spouts out from the borehole but also in the range of at least 1.5km along the fault in the underground of the Tokusa Basin.

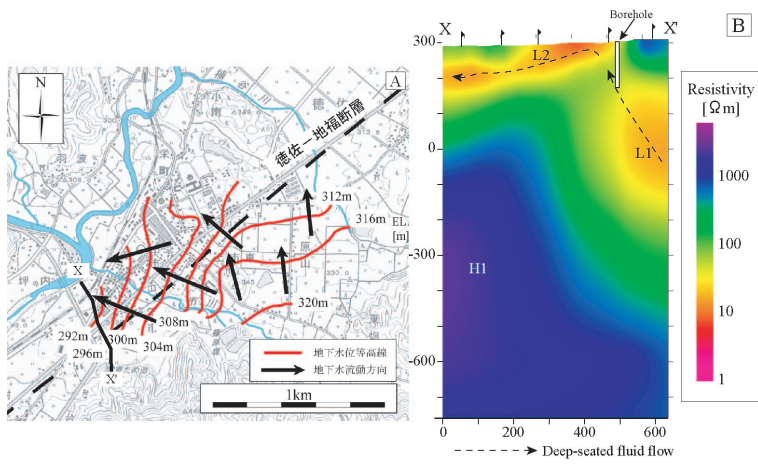
When the fluid spouts out from the borehole in the place where the sediments distributes, it is necessary to considerate that the fluid may be widely distributed along fracture zone such as faults in the underground.

Keywords: Deep-seated fluid, CSAMT method, Tokusa-Jifuku fault

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## Secular change of stable carbon isotopic ratio in groundwater samples during their storage in laboratory

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Carbon isotope is a useful tracer in order to identify carbon sources and behavior in the fields of biogenic and geochemical processes. However, the isotopic change during the storage in sample bottles until the measurement sometimes occurs owing to carbon exchange between DIC and atmospheric CO<sub>2</sub>, biogenic activity and/or carbonate mineral reactions (deposition and dissolution). The present study examined the secular change of carbon isotopic compositions, <sup>13</sup>C/<sup>12</sup>C and <sup>14</sup>C/<sup>12</sup>C, of DIC in water samples.

The water samples examined are surface seawater (RICE-W01), hot spring water (RICE-W03: high salinity and high DIC, W04: high salinity and low DIC), shallow groundwater (RICE-W05: low salinity and low DIC), deep groundwater (RICE-W06: low salinity and low DIC), and RO water prepared by dissolving chemical reagent (RICE-W07: low DIC, W08: high DIC). The carbon isotopic measurements were carried out on the samples which storage periods were 860 days for W01, 560 days for W03-W06, and 480 days for W07 and W08.

Secular changes of  $\delta^{13}\text{C}$  ranged from -5.4 ‰ to -0.2 ‰. The large isotopic change might be caused by decomposition of biogenic carbon in water samples, since the Keeling Plot showed the biogenic features of  $\delta^{13}\text{C}$  of added carbon. The storage examination suggested that some water samples did not change the  $\delta^{13}\text{C}$  values widely for years. The biogenic activity is prevented by reagent addition to water samples. Commonly HgCl<sub>2</sub> or NaN<sub>3</sub> is used, but it is hard to use them for groundwater samples because sampling field is not situated in the chemical controlled site. The present study confirmed that isotopic change reduced by NaOH instead of poisonous materials.

The materials of storage bottles are also influenced the secular isotopic change. The present study compared the  $\delta^{13}\text{C}$  value and <sup>14</sup>C concentration among the glass, PAN plastic and PP plastic bottles. The  $\delta^{13}\text{C}$  value was relatively constant for all bottles, while the <sup>14</sup>C concentration was clearly different. The contamination of modern carbon was detected for PP plastic bottle.

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