

Underground structure and groundwater flow in Saijo plain

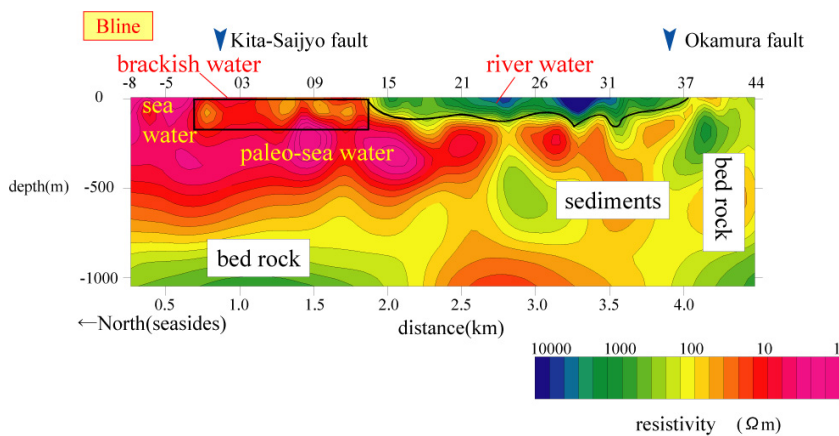
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Many flowing wells are excavated in the Saijo plain, Saijo-shi, Ehime Prefecture, which have been made use for supplying an industrial and agricultural water.

Objectives of the study is to investigate the underground structure and groundwater flow in the Saijo plain and to discuss about the relationship between geological structure and groundwater flow by CSA-MT geophysical exploration and groundwater geochemistry. The study area is composed of the late Cretaceous Izumi Group and Holocene sediments. CSA-MT method was applied to obtain the two dimensional resistivity distribution about 2 km long and 500 m deep along 3 lines with north-south direction in the Saijo Plain. As a result, the Okamura fault that displaces the Holocene and the Izumi Group with east-west strike was detected in the southern part of the area. The newly named Kita-Saijo fault that displaces the Holocene sediments with west-east strike was detected in north of the area, displacing the Kikai-Akahoya tephra (K-Ah) bed erupted at 6 Ka. River waters are penetrated from the Kamo river to the Holocene sediments in the Saijo Plain and flow on the paleo-seawater with low resistivity. Some of them were penetrated under the impermeable layer composed of silt and clay and interrupted by impermeable layer 2 m thick disturbed by the Saijo-Kita fault. Consequently, penetrated groundwater is pressurized by impermeable layer and fault. Then, pressurized groundwater erupts at the flowing wells named Uchinuki.

Keywords: flowing wells, CSA-MT method, groundwater flow, underground structure



(Fig.1). two dimensional resistivity distribution of Bline

The subsurface distribution of saltwater and freshwater in the Nakano-shima island, by electromagnetic exploration

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Groundwater recharged during the last glacial period is revealed to remain in coastal aquifers and sub-seafloor formations, and it has been interpreted that the low-permeability formations have delayed the intrusion of saltwater into sub-seafloor formations (e.g. Groen et al., 2000). Thus, the effects of long-term sea-level change should be taken into account to better understand the groundwater flow system in coastal areas.

The Nakano-shima island, Oki-Dozen, is a volcanic island on a continental shelf. Because the island is situated on the continental shelf, the seafloor around the islands was most likely widely exposed during the last glacial period, and hence the distribution of salt/fresh water in subsurface is estimated to have been affected by the sea-level change after the Last Glacial Maximum. According to a well-drilling report of a hot spring well in the island, groundwater of which Cl concentration corresponds to 20% of sea water was obtained when the well reached to 320 m deep, and groundwater of which Cl concentration corresponds to 5% of sea water was obtained when the construction was completed (screen depth: 560 - 866 m). In addition, the hot spring water taken from the screen depth is suggested to be recharged in colder climate than present based on the stable isotopic ratios of water, dissolved components, and groundwater-age indices (Kusano et al., in press). These results suggest that the groundwater containing higher salinity exists in shallower than 320 m deep, and that the groundwater containing lower salinity and recharged in colder climate exists in deeper formations. In this study, electromagnetic exploration using CSAMT method was conducted to reveal the distribution of salt/fresh water beneath the island.

A 2.5 km-long measurement section for the electromagnetic exploration was set, along which the hot spring well exists, in east-west direction. Measurement points were placed at about 100 m intervals. Measured apparent resistivity data were used to obtain a two dimensional resistivity structure along the measurement line by two-dimensional inversion scheme developed by Uchida and Ogawa (1993). For better interpreting the resistivity structure in the island, volcanic and sedimentary rock samples obtained from the island were used to measure the bulk resistivity as a function of salinity of the pore water.

The result of two-dimensional inversion showed the higher resistivity zone from the surface to about 100 m depth, a continuous lower resistivity zone throughout the section in between 100 and 200 m depth, higher resistivity zone below, and lower resistivity zone further below, i.e., existence of four distinct resistivity zones. Resistivity values in between 100 and 200 m depth and those in the deepest zone were consistent with bulk rock resistivities saturated with higher salinity water. The results are consistent with the fact that groundwater with higher salinity was obtained when the well reached to 320 m depth and that groundwater with lower salinity was obtained after the well reached to 866 m depth. The obtained resistivity structure might suggest that fresh groundwater recharged in the last glacial period remains in the subsurface of the island, and salt water was intruded into the 100-200 m deep zone after transgression.

References

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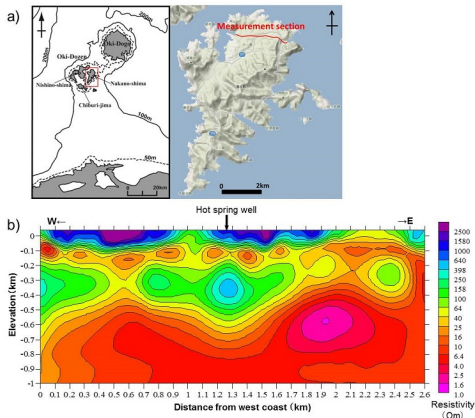


Fig. a) Location of measurement section of CSAMT survey and b) resistivity profile analyzed by 2D inversion of the CSAMT survey in the island.

The method of an estimation of underground parameters of a geyser induced by boiling using the dynamical model

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We have proposed a static model, a dynamical model and a modified dynamical model of a geyser induced by gas inflow based on observation and model experiments of it and have also proposed a combined model combining above two models. And numerical simulations of the modified dynamical model or the combined model reappear spouting dynamics of a geyser induced by gas inflow and it becomes possible that parameters (volume of the underground space, depth of spouting hole and so on) under a geyser are estimated through comparison between results of numerical simulation and those of observation. Moreover we proposed a dynamical model which assumed more than two underground gas supply sources by extension of above-mentioned usual dynamical model. As a result, irregular spouting dynamics of a geyser induced by gas inflow could also be reappeared by the modified model. As a result, spouting mechanism of all kinds of geysers induced by gas inflow has been clarified.

However, in general, geysers are classified into two types dependent on inducer. That is, one is a geyser induced by inflow of gas and the other is a geyser induced by boiling. The latter is more popular and many ones exist all over the world. Though qualitative spouting models of a geyser induced by boiling have been proposed, its dynamics has not been discussed sufficiently. Therefore, then we derived a dynamical model of a geyser induced by boiling applying the above-mentioned dynamical model of a geyser induced by inflow of gas. Then we tried to estimate time derivation of spouting rate of a geyser induced by boiling through numerical simulations. Using the model we can estimate underground parameters of a geyser induced by boiling by comparison of results of numerical simulation of the model and those of observation of a geyser induced by boiling.

In this presentation, after we review above-mentioned models of a geyser induced by gas inflow and one induced by boiling in outline, we explain the method of an estimation of underground parameters of a geyser induced by boiling using the dynamical model.

Rapid alkalization in Lake Inawashiro: implications for future changes in the carbonate system of terrestrial waters

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The global carbon cycle, one of the important biogeochemical cycles controlling the surface environment of the Earth, has been greatly affected by human activity. Anthropogenic nutrient loading from urban sewage and agricultural runoff has caused eutrophication of aquatic systems. The impact of this eutrophication and consequent photosynthetic activity on CO₂ exchange between freshwater systems and the atmosphere is unclear. In this study, we focused on how nutrient loading to lakes affects their carbonate system. Here, we report results of surveys of lakes in Japan at different stages of eutrophication. Alkalization due to photosynthetic activity and decreases in PCO₂ had occurred in eutrophic lakes (e.g., Lake Kasumigaura), whereas in an acidotrophic lake (Lake Inawashiro) that was impacted by volcanic hot springs, nutrient loading was changing the pH and carbon cycling. When the influence of volcanic activity was stronger in the past in Lake Inawashiro, precipitation of volcanic-derived iron and aluminum had removed nutrients by co-precipitation. During the last three decades, volcanic activity has weakened and the lake water has become alkalized. We inferred that this rapid alkalization did not result just from the reduction in acid inputs but was also strongly affected by increased photosynthetic activity during this period. Human activities affect many lakes in the world. These lakes may play an important part in the global carbon cycle through their influence on CO₂ exchange between freshwater and the atmosphere. Biogeochemical changes and processes in these systems have important implications for future changes in aquatic carbonate systems on land.

Keywords: the global carbon cycle, lake, alkalization, nutrient, PCO₂

Variation of $\delta^{13}\text{C}$ carbon isotope signatures of particulate organic matter in the Kuzuryu River system in Japan

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Radioactive and stable isotopes of carbon (^{14}C and ^{13}C) can serve as powerful tools for identifying sources and estimating turnover times of organic matter in aquatic systems. This study discussed with the transport of particulate organic matter in the rivers from a river system with different watershed condition using carbon isotopic signatures.

The Kuzuryu River system is located in Fukui Prefecture in the central part of Japan and consists of a main river, Kuzuryu River and a main tributary of the Hino River. River research was conducted at a fixed station in the Hino River (Fukatani site) and the Kuzuryu River (Nakatsuno site) during June-October in 2010. Suspended solid samples were collected from 130-140 L of river waters using continuous centrifugation. Prior to analysis, inorganic carbonates were removed by adding 0.1 M HCl solution, rinsing with Milli-Qwater, and drying again. Stable carbon isotopic ratio of a sample and the VPDB standard used for normalization were made by analyzing sub-samples of CO_2 gas generated during graphite production using a triple collector mass spectrometer with precision of ± 0.2 ‰ as the $\delta^{13}\text{C}$ value. Radiocarbons were determined using accelerator mass spectrometry at the Japan Atomic Energy Agency. Radiocarbon values were reported as $\Delta^{14}\text{C}$ corrected for sample $\delta^{13}\text{C}$ with absolute error of less than 10 ‰.

$\delta^{13}\text{C}$ of organic matter in riverine suspended solids has -26.3 to -24.0 ‰ for the Kuzuryu River and -27.0 to -26.1 ‰ for the Hino River. The $\Delta^{14}\text{C}$ values of the Kuzuryu and Hino samples are -168 to -87 ‰ and -209 to -143 ‰, respectively. The $\Delta^{14}\text{C}$ values of Hino River depleted in $\Delta^{14}\text{C}$ rather than the Kuzuryu River. The averaged TOC/TN ratio is 9.1 ± 1.1 for the Kuzuryu and 8.2 ± 1.1 for the Hino. There is a positive correlation with the $\Delta^{14}\text{C}$ values and water discharge. These results indicate that the differences in POM character may be explained by the differences in watershed conditions and controlled by water discharge.

Keywords: POC, carbon isotopes, river waters, migration, water discharge

Age dating of spring water, groundwater and stream water in mountainous watersheds using multi-tracer approach

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This study aims at estimation of mean residence time (MRT), to reveal the spatial distribution using multi-tracer approach in mountainous catchment, and to make clear relationship between hydrological characteristics and the variation of the residence time. First, we conducted field survey and sampling in Kiryu Experimental Watershed, in southern Shiga, in June, August and October, 2013 and analyze major dissolved inorganic ions, SiO₂, chlorofluorocarbons (CFCs) and stable isotopes (SI). Second, we estimated MRT using CFCs. We also evaluate MRT using seasonal variation of SI of rainfall, groundwater and stream water that collected monthly from 2008 to 2012.

The MRT of stream water and groundwater were estimated to be ranging from approximately 2.8 to 4.4 years by using SI as tracers. The MRT of spring water and groundwater were estimated to be ranging from 1.5 to 8.5 years and 15 to 23 years, given a water temperature as recharge temperature using CFCs. The relationship between Na⁺ concentration and MRT based on CFCs suggested that short MRT that provided from decrease trend in atmospheric CFCs concentration is appropriate.

The MRT of water by CFCs ranged from 1.5 to 8.5 years, whereas that by SI ranged from 2.8 to 4.4 years in this catchment. This result conforms that of previous studies using SI, however the MRT by CFCs shows larger value range because CFCs represent time resolution information. In addition, the MRT varies in time and space due to mixing of different subsurface flow with different MRT and flow path.

Keywords: multi-tracer approach, mean residence time, stable isotope, chlorofluorocarbons

Sources and recharge process of groundwater in sub-urban area of Hanoi city, Viet Nam

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Water demand in Hanoi city, the capital of Viet Nam, has been increased with recent rapid urbanization. Although high concentration of Arsenic is contained, groundwater is one of important water resources in this city. Groundwater abstraction has induced depletion of groundwater levels in major aquifers (Holocene shallower aquifer and Pleistocene deeper aquifer) not only in the central area but also sub-urban areas. On the other hand, urbanization reduces the surface water areas such as ponds, rivers and canals, and paddy fields. We focus on the interaction between surface water and groundwater to clarify water cycle and solute transport process in Hanoi area for sustainable water resource management. We are carrying out regular measurement of geochemical properties of surface water and groundwater, monitoring of groundwater levels in the major aquifers, and evaluation of groundwater age in some sub-urban villages.

The result of our previous study shows the surface water with evaporation process is a major source of groundwater in the study area. From the result of the regular measurement of surface and ground water and monitoring of groundwater levels in the shallower aquifer (unconfined condition), we found seasonal change of groundwater levels and geochemical properties of groundwater related with fluctuation of rainfall between rainy season and dry season. Also, seasonal change of geochemical properties was delayed several months to that of groundwater levels. This difference suggested the relatively slow infiltration of surface water with evaporation process into the shallower aquifer. On the other hand, result of CFCs and SF₆ measurement showed apparent groundwater age in the shallower aquifer of the study area is several decades. These results may suggest groundwater abstractions enhance water cycle in the study area.

Keywords: Hanoi city, groundwater recharge process, fluctuation of groundwater level, isotopes, groundwater age

Long-term trends of climate variability in upper Dong Nai river basin in Vietnam

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According to a report of the Intergovernmental Panel on Climate Change (IPCC) and last studies, Vietnam is considered as one of the most countries affected by climate change. That are in the sea level rises (SLR) 1 m scenarios, about 10-12% of Vietnam's population are directly impacted and the country will lose up to 10% of GDP. With the combination of SLR and an increase in precipitation in the rainy season, there is a possibility of a serious impact on low-lying coastal area and leads to flooding of up to 40,000 km² of the coastal delta and 90% of the Mekong River delta. It is also expected that temperatures will rise more significantly in the plateau region. Dong Nai river basin is located in the Southern Vietnam along with the Mekong River, that have supplied the major water resources of southern. Dong Nai river originates from the plateau of the Southeastern, through the Tri An reservoir, a major power generating dam of southern Vietnam, in the lower area it mixed with the tributaries of the Mekong Delta downstream and after that flows to East sea.

In the state which continues of changes on water resources Mekong river due to climate change, controversy about the potential impact of sediment transport and river flows downstream due to the cascade hydroelectric power plant system or dam construction on the upper Mekong basin, because of Dong Nai river basin is a water resources that can controlled by Vietnam, it is considered that is necessary to analyses change in hydrological regime due to climate variability and adaptation to that changes. The purpose of this study is detecting long-term changes in the climate data and runoff due to climate change in the Dong Nai river basin.

As hydrological information of the target basin, the Dong Nai river basin, last 20 years (form 1992 to 2011) data which observed by National Center for Hydro-Meteorological Forecasting (NCHMF), Department of Natural Resources and Environment (DONRE) of each region, Tri An hydroelectric power plant management office were analyzed by Empirical Mode Decomposition (EMD) to detected a long-term change in rainfall, temperature, potential evapotranspiration and runoff at the basin outlet (inflow of Tri An reservoir). EMD has recently been pioneered by Huang et al. for adaptively representing nonstationary time-series data as sums of zero-mean amplitude modulation frequency modulation components. The components, called intrinsic mode functions (IMFs), allow the calculation of a meaningful multicomponent instantaneous frequency.

The results show that trend of rainfall and temperature slightly increase, but the trend of potential evapotranspiration and runoff decrease in the last two decades within the basin. In the comparison with the results of Mekong River Commission or World Bank research on Climate change in Vietnam, we similarly conclude that rainfall and temperature tend to increase. It is considered change in land cover and land use within the basin is one of the causes of the downward trend of runoff. This is planning on the next study.

Keywords: Dong Nai river basin, climate variability, empirical mode decomposition, EMD

A consideration of sustainable grazing over Mongolia, as point of view of recent climate change and vegetation responses

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We will present two topics. One is winter extreme-cold-events (ECE) detected by JRA-25/JCDAS reanalysis object dataset over Mongolia. Since 2000's ECE frequently occurred rather than 1990's, closely linking with synoptic scale circulation change in mid-high latitude. Such synoptic scale circulation change triggered by changing area of sea-ice over Barents Sea. Second topic is vegetation reaction process revealed by satellites observation. We used MODIS spectral reflectance dataset boarded on Terra/Aqua platform. Also we used two vegetation indices: One is major vegetation index, NDVI, the other is Green-Red ratio Vegetation Index (GRVI). NDVI is applied as proxy index of biomass, GRVI is regarded as proxy of biodiversity index. Based on matrix field of NDVI and GRVI, we define the recover status (2012) from herbaceous degradation in 2009. We found that faster recovered areas were located in the foot-fill. More detailed (e.g. degradation process period) analysis will be show in presentation.

Keywords: Mongolia, grazing, extreme colod events, NDVI, GRVI

Effect of snow depth on hydrology of highland marshes - Analysis of PALSAR/ALOS data at Kiritappu, Sarobetsu and Oze -

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It is basically very difficult to monitor the hydrological environment of highland marsh with snow in winter. We lastly reported that the most famous highland marshes Oze keeps a largest amount of liquid water body under the thick snow layer (more than 2 m) in midwinter based on our analysis of PALSAR/ALOS data, a kind of L-band radar. We concluded that such liquid water would be squeezed out from peat layers by the load of heavy snow and not the meltwater. In this presentation, we show our new analysis results at Kiritappu and Sarobetsu, both of which are highland marshes locating in Hokkaido, where it snows a lot but not as much as Oze in winter. The PALSAR/ALOS data is used again. This time we find almost no liquid water body in midwinter and recognize the singularity of Oze. We try to evaluate the effect of snow depth, peat depth on hydrology of highland marshes in winter.

Keywords: highland marsh, hydrology, PALSAR, remote sensing, snow, peat

Modeling of hydrological temporal-spatial data by a universal model

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We propose "the universal model" which generates hydrological temporal or spatial data. First a white noise is generated, then the white noise is filtered by a specific filter and data are generated. If a field is fractal, log-log-linear-filter (ω vs. $P(\omega)$) is used (Lavallée, 2008). If a field is modeled by e-model (Gomi and Kuzuha, 2013), an exponential filter is used. We examined rainfall time series, spatial rainfall fields, time series of ion concentration in river water, and ion concentration in tap water. As a result, those data were modeled by the universal model.

Gomi, C. and Y. Kuzuha(2013), Simulation of a Daily Precipitation Time Series Using a Stochastic Model with Filtering, Open Journal of Modern Hydrology, DOI: 10.4236/ojmh.2013.34025

Lavallée, D.(2008), On the Random Nature of Earthquake Sources and Ground Motions: A United Theory, Advances in Geophysics, Vol. 50, 2008, pp. 427-461.

Keywords: fractal, hydrological temporal-spatial data, filtering, universal model, e-model

Characteristics on groundwater salinization in a downstream area of dam reservoir, a coastal region of NorthEast Tunisia

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This study tried to characterize salinization processes of coastal shallow groundwater in a downstream area of dam reservoir, based on field investigation and chemical water analyses in order to indicate positive effects of dam reservoir on prevention of the groundwater salinization or seawater intrusion. Thus, focusing on two neighboring watersheds: Lebna and Chiba watersheds located in Korba aquifer (North-East Tunisia), the field investigation was carried out at 72 locations in June 2013, then water samples were collected at the 63 locations.

At first groundwater table contour map was drawn using investigated groundwater level data, and the groundwater flow was estimated. From the chemical analyses, spatial distributions of dissolved inorganic ions' concentrations, and stable hydrogen and oxygen isotopic compositions were obtained. Then, the seawater ratio in the groundwater samples were calculated using mass balance equation of chloride concentration under assumption chloride was derived from seawater. Using the seawater ratio, a theoretical concentration of each parameter were estimated, and differences between the analytical and theoretical concentrations were obtained. Additionally saturation indices were calculated based on chemical equilibration theory. Moreover, multivariable analyses: Cluster Analysis (CA) and Principal Component Analysis (PCA), were conducted to classify the groundwater salinization process and to determine the important parameters associated with the process.

As a result, the groundwater level (GWL) in the downstream of Lebna dam reservoir was higher than the sea level, while the GWL in Chiba watershed was lower than the sea level. The lowest point is about -10 m above sea level. According to seawater ratios and stable isotopic compositions, the study area were categorized into the following three types: (i) high seawater ratio, (ii) low seawater ratio and low isotopic compositions, and (iii) low seawater ratio and high isotopic compositions. On the other hand, CA results showed the study area were categorized into 5 clusters, and the PCA showed the following three phenomena were main reasons for the 5 clusters: (a) seawater ratio in groundwater, (b) inverse cation exchange by reaction between seawater and clay minerals, and (c) directly or indirectly groundwater recharge from Lebna dam reservoir. Moreover, considering totally the three types (i), (ii), (iii), three phenomena (a), (b), (c), and groundwater level, the study area could finally be divided into 3 areas A, B, C which have different characteristics on groundwater salinization

Area A is located around Lebna dam reservoir, in which groundwater level is higher than sea level and the stable isotopic compositions are relatively higher. High groundwater level is probably sustained by the direct recharge from the reservoir, or by infiltration of the irrigation water from the reservoir in the farm land. Area B is located near shoreline, in which groundwater level ranges 0 to -4 m above sea level, and high seawater ratio and high concentration of each dissolved ion are observed. The groundwater in this area has high concentrations of sodium and chloride (derived from seawater) and calcium (derived from inverse cation exchange) due to seawater intrusion. Area C is located in inland area of Chiba watershed, in which groundwater level is lower than -4 m above sea level. There should be three groundwater flows: from Area A, and the upstream of Chiba watershed with fresh groundwater derived from precipitation, and from Area B with saline water, especially high concentration of calcium. Therefore, the groundwater in this area probably consists of the three different origin waters.

Keywords: seawater intrusion, dam reservoir, dissolved inorganic ions, stable hydrogen and oxygen isotopic compositions, mass balance, multivariable analyses

Geochemical features of groundwaters around the southern Itoigawa-Shizuoka tectonic line, western Kofu Basin

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Over the last few decades, drilling of thermal wells for hot spring bathing purposes were performed extensively on a deep aquifer at the depths more than 1000m in the non-volcanic area of Japan. Around the southern part of Itoigawa-Shizuoka Tectonic Line (ISTL), western Kofu Basin of central Honshu, many numbers of ground waters from drilled wells have been used for hot spring bathing. Some of these waters have high salinity, up to more than sea water salinity level, but their genesis and the formation mechanism of water quality have not been clarified previously. In this study, chemical and isotopic compositions of hydrogen (D/H), oxygen (¹⁸O/¹⁶O) and sulfur (³⁴S/³²S) of several ground water samples from, such as, natural spring and drilled wells around the southern part of ISTL, western Kofu Basin were analyzed in order to discuss the origin of waters and the formation mechanisms of water quality.

Temperature of the samples was up to 48.8 °C, and the pH is between 6.4 and 9.7. The waters were subdivided into a Ca-HCO₃ type, Ca·Mg-HCO₃ type, Na·Ca-HCO₃ type, Na-HCO₃ type, Ca-SO₄ type, Na-Cl·HCO₃ type, and Na-Cl type. Among these, Na-Cl type was the most dominant water quality and maximum Cl concentration of the samples was up to about 23000 mg/L.

Due to plot of Na and Cl concentration of groundwaters were distributed along with mixing line between rain water and sea water, Na-Cl type water, which is dominant water quality type in the study area were appears to be derived from mixing of rain water and sea water end-members. δD and δ¹⁸O plot of the low salinity waters were distributed along with the Global Meteoric Water Line, supporting that the low salinity end-member is originated from rain water. However, δD and δ¹⁸O values of the waters which have high salinity (more than sea water salinity) were low compared with modern seawater values. The Mg/Cl and SO₄/Cl ratio of these high salinity waters were very low compared with modern sea water, whereas the Ca/Cl ratio is higher than modern sea water. These chemical and isotopic characteristics of the sample waters indicate that the high salinity end-member of the study area is altered sea water.

Keywords: Itoigawa-Shizuoka tectonic line, deep fluid, water quality, formation mechanism

A Study on the Origin of a Spring in Tottori Sand Dunes using various geophysical and hydrological methods

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There is an oasis that changes its appearance depending on the season in the depression south of Umanose (horseback), which is a symbol of the undulations of Tottori Sand Dunes. This oasis is not always visible. It disappears during the summer. The influent that constantly flows over the ground surface into the oasis depression forms Shirinashigawa River when oasis is gone, as the inflow water permeates into the sand or evaporates. By what mechanism does this oasis appear and disappear? That is, where does this influent come from and where does it go? This question about the oasis spring has been a scientific interest for a long time. For example, there have been a proposal that the rainwater from rain in the sand dunes became groundwater, some of which formed a spring and appeared on ground surface again(Akagi, 1991), a proposal that the rainwater permeating into the sand dunes with low water-holding property accumulated as groundwater near the impermeable stratum of the bedrock or volcanic ash layer with low water permeability and formed spring (Natural Parks Beautification and Management Foundation, 1995), and a recent study that investigated the relevance of oasis formation and the changes in water level in Tanegaiké which is located south of the sand dunes (Hoshimi, 2009).

To answer this question, that is, to search for the origin of the spring in sand dunes (oasis), this study was conducted on the subsurface structure and circulation of groundwater in Tottori Sand Dunes. We estimated the subsurface structure of Sand Dunes and obtained basic data on groundwater existence, mode of its flow, the base structure of sand dunes using various nondestructive geophysical exploration methods, and tried to elucidate the origin of the oasis spring and the quantitative rise and fall mechanism also incorporating hydrological methods. While the specific methodologies used here will be described in a later section, we applied electrical resistivity imaging method, 1 m-depth geothermal prospecting, self-potential method, tremor probing and gravity probing to estimate the former subsurface structure and introduced continuous water level observation on oasis and analysis of evaporation quantity, groundwater level survey in oasis and its proximity, and analysis on stable isotope ratio of oasis spring water and water sampled from Tanegaiké for the latter. For the former application, we conducted a GPS survey using a differential method so that we could understand the positions of observation points and grasp the overall topography of the sand dune area. For the latter application, we conducted a survey using total station to grasp the microtopography of the oasis area and its proximity.

As a result, we reached a conclusion as described below regarding the subsurface structure of Tottori Sand Dunes and the origin of the spring in sand dunes (oasis). “ Rainwater permeates into the sand dunes and form groundwater. A part of it is lead to the aquifer mainly formed on the volcanic ash layer (as perched water) and flows into the oasis spring. Then, the oasis spring flows into the sea through underground of Umanose. There is no simultaneous or direct relevance between oasis spring and the water in Tanegaiké. We found association between the overall groundwater distribution in Tottori Sand Dunes area (sand dunes for sightseeing) and the undulations of the bedrock structure estimated by the subsurface structure analysis.” It is surmised that this study verified these things from quantitative observation values including subsurface structure, changes in water level, changes in isotopes and so forth of sand dunes had significance of its own. This article will report on the basic scientific background, an outline of the study, the results of multiple surveys and their interpretation, and an overall summary of them.

Keywords: Tottori sand dunes, underground water, geophysical exploration methods