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AHW27-P01 Room:Poster Time:May 1 18:15-19:30

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 are 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

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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 ($^{18}O/^{16}O$) and sulfur ($^{34}S/^{32}S$) 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 ℃, and the pH is between 6.4 and 9.7. The waters were subdivided into a Ca-HCO_3 type, Ca·Mg-HCO_3 type, Na·Ca-HCO_3 type, Na-HCO_3 type, Ca-SO_4 type, Na-Cl·HCO_3 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 δ^{18}O 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 δ^{18}O values of the waters which have high salinity (more than sea water salinity) were low compared with modern seawater values. The Mg/Cl and SO_4/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

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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 Tanegaike 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 Tanegaike 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 Tanegaike. 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