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Aquifer structures and flow systems of groundwater in the Osaka sedimentary basin

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Withdrawal of groundwater in urban areas of Japan has been strictly controlled for the mitigation of disasters caused by groundwater such as subsidence and salinitization, which were serious social problems until 1970s. However, the withdrawal of groundwater increases as a cheap water resource recently and the groundwater attracts the attention as an emergent water resource when the natural disaster occurs and water supply lines are damaged. We should evaluate accurately the potential of groundwater, including scale and structure of the aquifers and the flow rates of each aquifer, as a water resource to use effectively without the groundwater disasters. We have studied to visualize groundwater flow beneath the Osaka Plain, where is one of the largest urbanized area. The Osaka sedimentary basin, which is one of the largest groundwater aquifers of this country, has rather simple structure than the other sedimentary basins of this country, and it is easy to trace the groundwater flows. In this report, the groundwater aquifers and those structure and flow systems are documented, and the recharging paths will be discussed mainly based on the data of oxygen and hydrogen stable isotopes of the groundwaters.

Groundwater aquifers beneath the center of the Osaka Plain can be roughly divided into three categories; the unconfined and uppermost confined aquifers <50 m depth, confined aquifers in Tanaka Formation of Osaka Group, and confined groundwater in Miyakojima Formation of Osaka Group and basement rocks. The Tanaka formation comprises freshwater sandy sediments as groundwater aquifers and intercalated less permeable marine clay layers. The Miyakojima Formation is composed of freshwater sediments and the aquifer is not separated by less permeable layer. The depths of boundary between Tanaka and Miyakojima Formations are commonly 600 to 700 m depth and the basement rock underlies at 800 m depth beneath the Uemachi Daichi at the center of the plain and 1000 to 1500 m beneath the lowland of the plain.

Uppermost groundwaters are recharged by the local precipitation. The groundwater has high quality, and is used as the washing water for temples and shrines at the Uemachi Daichi and gardening for the residences in the suburban area. While, the groundwaters of lowland contain present seawater in the western part and are stagnant in the eastern part from Uemachi Daichi. Thus, the groundwaters of this area are not used and give high hydropressure to be a potential cause of liquification.

The confined groundwaters in the Tanaka Formation are recharged at the Uemachi Daichi and surrounding hills of lowland of Osaka Plain. This formation contains unconsolidated marine clay layers, which was subsided due to excess uptake of groundwater, thus, the groundwaters have not been used after 1970s. Recently, the groundwaters at 100 to 300 m depths are used for supplied water for each buildings and prepare for emergency. Since the groundwaters of this level at the location apart from recharging area occasionally gives the light oxygen isotope shift, squeeze of porewater from the clay layers may occur. The groundwater at 300 to 500 m depths are not used, and probably at the stagnant condition.

Deep groundwaters from Miyakojima Formation and basement rocks are used for bathing purpose. Those from upper part of Miyakojima Formation are diluted Na-HCO3 type chemistry, and highly saline waters are occasionally found in the deeper portion. Temperature of the groundwaters are 50 degreeC at the highest. Active faults works as recharging paths for the groundwater in Tanaka Formation, however, the groundwaters in the Miyakojima Formation and the deeper are fossil water. Some of the saline waters, probably originated from seawater judged by Br/Cl ratio, give the heavy oxygen shift for those oxygen isotope ratios, suggesting that those are formed at low water/rock ratio.

Keywords: Osaka Plain, groundwater, oxygen hydrogen stable isotopes, saline water