Estimated groundwater flow system in the Osaka basin based on the data base of groundwater chemistry

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Groundwater flow in shallower than a few hundred meters depth of Osaka basin is argued using two approaches based on the water quality data sets; i.e., VOC (mainly tetrachloroethilene (PCE) and its biproducts) as anthropogenic contaminants and fluoride and arsenic mainly as natural contaminants, in the open data base of groundwater quality cared by Osaka Prefecture and newly analyzed groundwater chemistry in Osaka City area, where the monitored data were limited. The former was used for tracing the time-series variation of VOC, and the latter was used to document the present situation of groundwater pollution. The groundwater is conveniently categorized into three groups as 50 m, 50˜100 m and 100 m depths of wells.

PCE was presumed not been wasted since legally prohibited to dump into the environment in 1988. The PCE containing groundwater has been distributed widely in Osaka Prefecture during the observation period between 1989 and 2006. The well waters containing excess PCE than the environmental standard value are concentrated in the following five areas; Ikeda City near the border to Hyogo Prefecture, Takatsuki and Hirakata Cities in the northeastern part of the Prefecture, Uemachi upland and its surroundings at Osaka City, Yao and Kashiwara Cities at the eastern part of the Prefecture, and Izumi-Otsu and Izumi Cities in the southern part of the Prefecture. The PCE contaminated groundwaters are abundantly found in the 50 m depth wells. Thus, the anthropogenic contamination occurred in large scale in the above five areas, and the shallow groundwater above 50 m depth was abundantly polluted by those contaminants.

Distribution of PCE contaminated wells is controlled primary by the geographical distribution of the source areas but not geology and/or aquifer structure. It meant that the anthropogenic contaminants migrated vertically into the deep aquifer. In the south of Yamato River, detectable PCE were found in the wells installed at 50 m and 100 m depths but not in 50 to 100 m depth, where the contaminant must be washed out by groundwater flow.

Distributions of trichloroethilene, cis 1,2-dichloroethilene and 1,1-dichloroethilene as biproducts of PCE are similar to that of PCE. However, those biproducts, especially cis 1,2-dicholoroethilene, were occasionally found from the well waters free from PCE, indicating that the time was not enough to completely decompose those materials.

PCE has disappeared from the well waters 100 m depth in the southern part of Uemachi upland since 2000, and it has not been detected in the low land west from the Uemachi upland since 2005. All of the groundwaters taken from Osaka City and analyzed in this study did not contain VOC. The groundwaters from the low land west of Uemachi upland were affected by present seawater. Rate of seawater to fresh water is higher in the shallower wells (50 m) than in the deeper wells (50-100 m) at the same site. Thus, the seawater intrudes into the groundwater aquifers, which are beneath the sea level, from the surface. Seawater did not intrude into the groundwaters below 100 m depth, and those groundwaters would be recharged from river. Anthropogenic contaminatnts, VOC, would have been flushed out from the shallow aquifers in association with tidal movement of seawater intruded into the aquifers in the area at and below sea level.

The anthropogenic contaminants moved vertically into the groundwater aquifer 100 m depth. The contaminants have been flushed out where the groundwater flows along the aquifer, while those stay in stagnant environment of the aquifer in the Osaka basin.