Effects of surface warming and groundwater flow on subsurface thermal regime in Osaka, Tokyo and Nagoya.

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Inversions in temperature-depth profiles (T-D profiles) due to surface warming are found in subsurface thermal regime of many areas in over the world. T-D profiles have been used as signature to evaluate the past climate change. However, subsurface thermal regime is affected not only by the past climate change but also heat advection due to groundwater flow. Therefore, attention has been paid to both effects of heat conduction and convection caused by groundwater flow on the T-D profiles under the condition of surface warming. The objectives of this study are to evaluate the effects of surface climate-change and groundwater flow on the subsurface thermal regime in Osaka Plain, Japan and to compare with them in Tokyo (Dapaah-Siakwan et al.,1995) and Nagoya (Uchida and Sakura, 1999).

In the Osaka Plain, groundwater flow system evaluated from observed hydraulic potentials agree well with that estimated from subsurface temperature, though the influence of a local groundwater flow system is observed. In comparisons between calculation results using heat conduction-advection equation and actual measurements, the effect of surface warming on the subsurface temperature is larger in the center of the Osaka than that in the suburban area. From the calculation results, it was found that surface warming affected the depth of inversions from time to need for surface warming.

According to the comparisons of T-D profiles in Osaka, Tokyo and Nagoya (Nobi Plain), followings were found. Subsurface thermal regime in Nagoya is most influenced by groundwater flow and there is no influence of surface warming. Inversion depth is deeper in recharge area, and is not observed in a discharge and intermediate areas. Subsurface thermal regime in Tokyo is most influenced by surface warming in addition to the advection effect due to groundwater flow. Inversion depth is observed in both areas, and depth of inversion is deepest among three cities. The surface warming is the main effect on subsurface thermal regime in Osaka, and there is a little influence of groundwater flow. Surface warming evaluated from T-D profiles become large in order of Tokyo, Osaka, and Nagoya, and agree with the order of increased air temperature.