Stable Isotope of Groundwater in the Yellow River Basin, China

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Ministry of Education, Culture, Sports, Science and Technology (MEXT) named entrustment undertaking on national priority fields Research Revolution 2002 (RR2002) Project. On the environmental sciences field among the RR2002 Project, the proposal of the Development of Water Resources Prediction Model Associated with Artificial and Natural Changes in Asian Monsoon Regions was adopted. This project basically consists of two objective areas: the Mekong River and Yellow River (Huanghe), and is implemented by nearly 20 organizations such as universities and institutes. Among the project, AIST is responsible for the Modeling of Water Balance, Circulation, and Utilization of Groundwater in the Yellow River Basin and Future Prediction in China. This paper briefly describes the results of this AIST project, simply referred as the Yellow River Groundwater Project hereinafter.

A main stream of the Yellow River reaches about 5,500 km long and about 750,000 km2 wide. This river flows from the high mountain areas as high as 4,500 m in Qinghai, eastward from Gansu, Ningxia Hui, Neimenggu, Shanxi, Shaanxi, Henan, Hebei and Shandong, and into the Bohai Sea. The average flow rate of this river is 58 billion tons a year. As the name of this river itself, one ton of yellowish river water contains voluminous mud and sand as high as 35 kg in average. A quarter of mud and sand tends to deposit along the river levee, easily resulting in the raised bed river 4 or 6 m higher than the surrounding plain as typically seen from Henan to the east. The Yellow River caused 1,500 times of flooding during the past 2,000 years, because of such the instability of the raised bed river. An amount of surface river water is used for agriculture in the Yinchuan Plain in Ningxia Hui and the Hetao Graben in Neimenggu at the middle reaches of the Yellow River, whereas the desertification is spreading in the Ordos Plateau and its vicinity. An amount of groundwater is recently consumed by a number of wells in the North China Basin at the lower reaches of the Yellow River due to the rapidly growing agriculture and industry, and rapidly increasing population. This gives rise to serious drawdown of water tables in the area. Surface river water was dried and stream was stopped in part of the Yellow River in 1981 that was the first serious experience during the past 2,000 years. In the 1990s, however, stream was often stopped and it has been stopped for 200 days in the worst year.

The water budget and water circulation are closely related to the surface streaming water, atmospheric water and artificial water consumption where we need climate data such as the rain precipitation and artificial water consumption data. Thus, we have collected variety of data. To achieve these targets, this project have performed periodical and down-hole measurements on water tables and borehole temperatures from about 100 observation wells, multi-tracer analyses on chemical and isotopic compositions of water samples from some of these wells, literature investigations in Chinese researches and construction of a groundwater circulation model.

The most important objective of field survey is to measure hydraulic head in the borehole, borehole temperature and groundwater sampling as many as possible. Oxygen and hydrogen stable isotopic compositions of water samples are classified with regions in the Yellow River Basin. Water samples from Qinghai showed unusual results. Normally the Qinghai samples should show low delta values on both oxygen and hydrogen by the altitude effect, and some samples in fact show low delta values. However, many other samples from Qinghai Lake show high delta values in turn. It is supposed a special condition such as the low precipitation rate and high evaporation rate, where the evaporated low delta values vapor is quickly removed by the prevailing westerlies (west winds), resulting that the high delta values water exclusively remains in the lake environment.