Kossge International Symposium on Soil & Groundwater Environment
October 27-28, 2005 Mayfield Hotel, Seoul, Korea

Application of Isotope Techniques for the Analysis of Leakage Pathway in Small Earth Dams, Chungnam Province, Korea

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ABSTRACT

The irrigation dams are more than 700 in number which are about 90% of the total dams in Korea. A majority of dams have been constructed since 1960's. Nowadays, the environmental impacts and some geological instability around the reservoirs are important aspects in water management in Korea. For the dam safety, the leakage from dams is a major problem and the identification of the locations where the leakage occurs is the most important and immediate task. In addition, the ascertainment of the rate of leakage and its preferential paths is an important thing, also. The problems related to leakages from irrigation dams can be grouped into dam foundation leakage (grouting area), dam seepage (dam core) and abutment seepage. For this study, two reservoirs (Songseok and Kangcheong dams) which had been identified some problems related to leakages/seepage, in the Chungnam province were selected and the investigation of leakage paths has been carried out using the isotope techniques. The application of environmental isotope techniques in leakage study comprises the use of the stable and radioactive isotopes of the water molecule. Among the stable isotopes, O-18 and Deutrium are valuable tools in studying the hydraulic connections of water in groundwater system if waters are of different isotopic contents resulting from either orographic origin, seasonal variations, or isotopic enrichment of lake water. These isotope techniques in combination with other hydrogeological, geophysical and geochemical data can provide key hydrological information including the characteristics of flow path.

The Kangcheong and Songseok reservoirs are small earth-fill type dams with core and spillway. The Kangcheong reservoir has the dimension of 165m in length, 16m height and 323,000m^3 of reservoir volume. Jurassic granodiorite and Precambrian metamorphic rocks are distributed around the reservoir area. The Songseok reservoir has the dimension of 220m in length, 20m height and 1,449,000m^3 of reservoir volume.

Precambrian banded gneiss is distributed around the reservoir area. Several over-saturated zones were identified in the dam itself from geophysical investigation. In the hydrogeochemical properties, distinctive difference in chemical composition was not observed among the surface water, reservoir water and groundwater samples. The chemical compositions in the reservoir water were somewhat diluted in some elements compared with other waters in the vicinity area, however, these chemical differences are difficult to access the leakage paths and related problems. In the isotopic composition, the Kangcheong reservoir water is somewhat isotopically enriched with reference to the surface water and groundwaters, showing the possibility of the isotope application to the leakage study. The isotopic compositions between the distal and proximal areas of the reservoir can be delineated, but there is no significant difference among isotopic values. The Kangcheong area is more typical than the Songseok reservoir. These patterns of isotopic composition are likely to indicate that the reservoir water is clearly contributed to the groundwater in the downstream area of dam. Consequently, isotope techniques in combination with other hydrogeological, geophysical and geochemical methods could provide decisive hydrological information including flow path and travel time. Although the geological settings and dam designs are unique in each problematic reservoir, the isotope techniques and interpretation methodologies established through this study can be applied to solve the similar problems in Korea.

Key words : environmental isotope, dam leakage, reservoir, groundwater