Detecting fluid leakage of a reservoir dam based on streaming self-potential measurements

Seo Young Song (1), Bitnarae Kim (1), Myung Jin Nam (1), and Sung Keun Lim (2)

(1) Sejoung University, Energy and Mineral Resources Engineering, Seoul, Korea, Republic Of (nmj1203@gmail.com), (2) Technical Review & Quality Management Institute, Korea Rural Community & Corporation (KRC), Daejeon, Korea

Between many reservoir dams for agriculture in suburban area of South Korea, water leakage has been reported several times. The dam under consideration in this study, which is located in Gyeong-buk, in the south-east of the Korean Peninsula, was reported to have a large leakage at the right foot of downstream side of the reservoir dam. For the detection of the leakage, not only geological survey but also geophysical explorations have been made for precision safety diagnosis, since the leakage can lead to dam failure. Geophysical exploration includes both electrical-resistivity and self-potential surveys, while geological surveys water permeability test, standard penetration test, and sampling for undisturbed sample during the course of the drilling investigation. The geophysical explorations were made not only along the top of dam but also transverse the heel of dam. The leakage of water installations can change the known-heterogeneous structure of the dam body but also cause streaming spontaneous (self) potential (SP) anomaly, which can be detected by electrical resistivity and SP measurements, respectively. For the interpretation of streaming SP, we used trial-and-error method by comparing synthetic SP data with field SP data for model update. For the computation, we first invert the resistivity data to obtain the distorted resistivity structure of the dam levee then make three-dimensional electrical-resistivity modeling for the streaming potential distribution of the dam levee. Our simulation algorithm of streaming SP distribution based on the integrated finite difference scheme computes two-dimensional (2D) SP distribution based on the distribution of calculated flow velocities of fluid for a given permeability structure together with physical properties. This permeability is repeatedly updated based on error between synthetic and field SP data, until the synthetic data match the field data. Through this trial-and-error-based SP interpretation, we locate the leakage of reservoir-water formed locally inside the levee body of the reservoir dam within the limitation due to the 2D nature of stream SP simulation.