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Application of a Mise-à-la-Masse approach to detect the leak of water reservoirs

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Water reservoirs with synthetic geomembranes are widely used for storing water resources and chemical solutions in the agricultures and industries, respectively. Leakages of water reservoirs are respondible for the loss of water resources and the spread of contaminants. It is usually difficult to perceive and localize the leakage of water reseroirs. As a cheap, non-invasive, and non-destructive geophysical technique, the mise-à-la-masse method is used to detect leaks of water reservoirs. In principle, the positive (A) and negative (B) current electrodes are placed inside and outside the reservroir, respectively. A number of voltage electrodes are located around the reservoir and potentials relative to a remote reference potential electrode are measured. In the data processing, a method silimar to the self-potential inversion method is proposed to inverse the voltages recorded around the reservoir. Forward modeling was first carried out to simulate the mise-à-la-masse measurement. A kernel matrix (i.e., the collection of Green's funstions) from forward modelings was imported to the inverse modeling. In inverse modeling, a global objective function with a data misfit term and regularization term is minimized to invert the measured voltages. An initial model based on the distribution of root mean square values between the observation and the simulation data is first given to the inversion algorithm. A weighting matrix and a minimum support function is used to strengthen the detection resolution of the leak of reservoirs. The distributions of source current density from the inverse modeling are used to provide the best estimated of the positions of leaks. Two laboratory and one field experiments are used to verify the effectiveness and reliability of the mise-à-la-masse method. The results show that the proposed method and inversion algorithm can localize a single leak. For a leak with a crack shape, the inversion algorithm detects the location of the leak with a small bias. Effects of the leak size and an undetected condutive zone on the inversion results are further analyzed. For the side leakage, the inverse algorithm overestimated the depth for a small-size leak, while is slightly underestimated the depth of big leaks. For the bottom leakage, effects of the leak size on inversion results are negligable. An undetected conductive zone could significantly distort the inversion results. This study provides an efficient approach to detect the leakage of reservoirs. In addtion, for the leakage of leachate in landfills or mine tailings, the mise-à-la-masse method is also a promising method.