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3D Time-lapse monitoring of water infiltration in the vadose zone by means of a high-speed resistivity measurement tool

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Infiltration process of water into the surficial vadose zone of an embankment was monitored at short intervals by means of a newly developed high-speed resistivity measurement tool. The tool can transmit 24 individual current signals and measure 24 potential responses simultaneously. A code division multiple transmission technique was adopted for the current signal transmission. It took only 30 seconds to obtain and store a dataset composed of a total of 576 (24 by 24) potential data along with time series waveforms. The tool enabled us to conduct high-speed time-lapse or dense 3D resistivity measurements in the field. We monitored infiltration process of surface water into the vadose zone of an actual embankment. A total of 4 current lines and 4 potential lines were set parallel on a flank of the embankment, and infused water into the vadose zone through a narrow and shallow trench dug on the crest. Electrode stakes were placed at 25 cm spacing along each line, and spacing between the lines was set to 50 cm. A total of 6,912 (12 pairs x 576) data were acquired at 5 min intervals in the beginning and at 30 min later. 3D electrical resistivity tomography (ERT) analysis, applied to the dataset composed of a total of 40 stages during the infiltration across two days, successfully imaged the extent of infiltrated water in the vadose zone. Consequently, our field measurements demonstrated the usefulness of dense time-lapse 3D ERT monitoring for the characterization of dynamic unsaturated permeability of the vadose zone of embankments in the field.

Keywords: resistivity, vadose zone, infiltration, time-lapse monitoring, 3D