Measurement of Possible Ground-Water Flow Using Surface Resistivity in TCDP Site

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Abstract

Surface electrical resistivity measurements can be used to estimate the horizontal flow direction and velocity of ground water in aquifers. Water injected into ground water through a well can be traced with resistivity measurements on the ground surface in the vicinity of the injection point. The direction of greatest resistivity decrease, subsequent to injection, identifies the direction of ground-water flow. Ground-water velocity is estimated by measuring the time taken, after injection, for the resistivity to decrease to a minimum at those resistivity arrays in the direction of flow.

With the valuable advantages of the Controlled Source Audiofrequency Magneotelluric method (CSAMT) sounding, such as: great depth of detection, excellent lateral resolution, flexible survey design, and little topographic effect, CSAMT was applied in TCDP area for understanding ground-water flow. Theoretically, the CSAMT method is used to receive the E-field and the orthogonally H-field which is produced by the magnetic field induced by transmitting the step current source into the subsurface by grounded bipole. We use the well casing as the transmitting bipole to insure deep penetration of the current source. For calculating the apparent resistivity, the Cagniard resistivity formula together with the near field correction was employed. Finally the resistivity layers of each station will be obtained by means of matching the field apparent resistivity curve with the model one.

Preliminary results from TCDP test site (Fig.1) before injecting a water slug into an aquifer shows that the background low resistivity anomaly, possible indication of water, migrate to the SW at shallow depth ~500 m, while still concentrate in between well A and B at depth ~1000 m. The repeat CSAMT survey will start after the on going water injection finished; measurement of ground-water velocity in conditions of changing ground resistivity requires the monitoring of apparent resistivity changes at sites. The preliminary results show that it is applicable to investigating water aquifers as deep as 1 km of the ground surface and when highly conductive materials (metal casings) do occur on site.

This proposed method of measuring ground-water velocities has several advantages over conventional well-to-well tracer experiments. Only a single access to the aquifer is required. Velocity estimates are more representative of true ground-water velocities. The method is inexpensive and straight-forward to perform. Moreover, the possible aquifer hydraulic conductivity can be derived from the measured velocity, the hydraulic gradient, and the aquifer porosity.

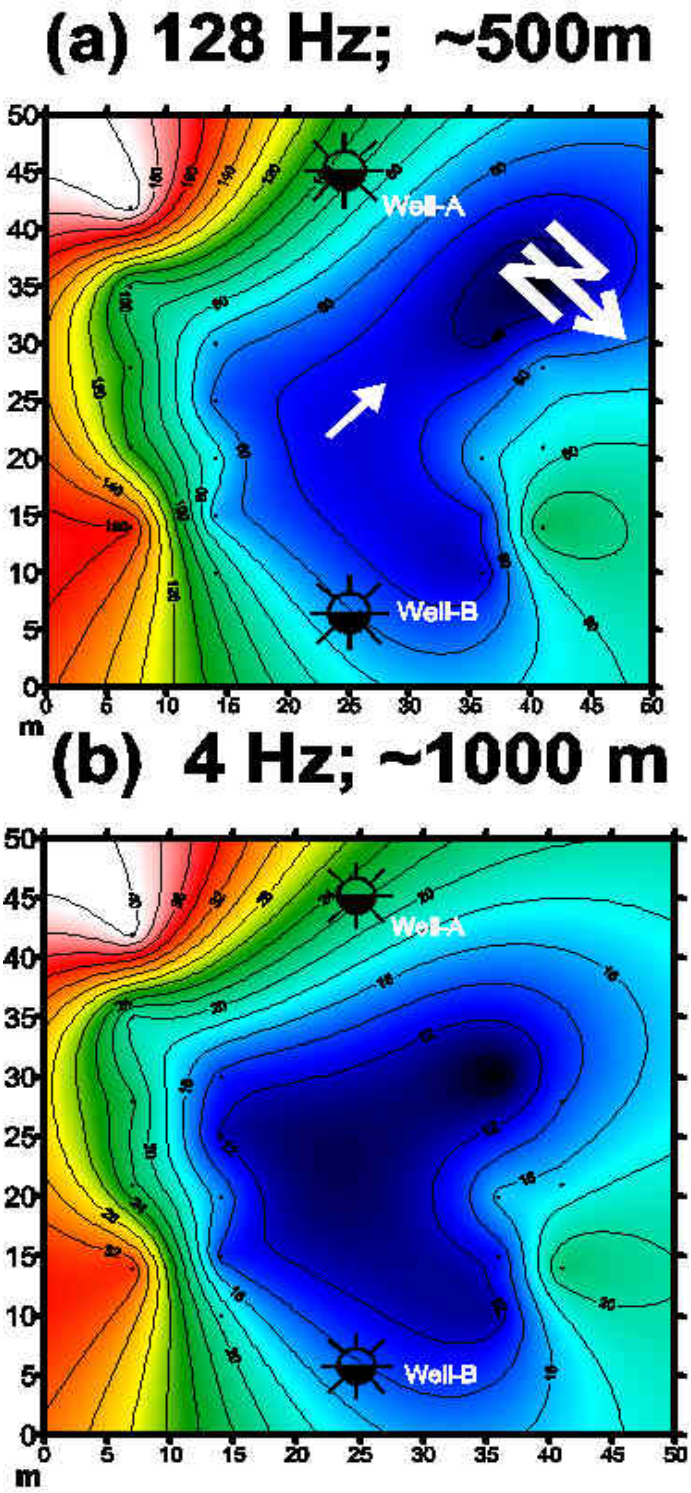

Fig. 1 The background apparent resistivity (in ohm-m) contour maps of frequencies (a) 128Hz (skin depth ~500 m) and (b) 4 Hz (skin depth ~1000 m), respectively, in TCDP area before water injection. Dots in each map indicate the sounding points. Note that low resistivity anomaly, indication of water, migrate to the SW at shallow depth ~500 m, while concentrate in between well A and B at depth ~1000 m. The repeat CSAMT survey

will start after water injection finished; measurement of ground-water velocity in conditions of changing ground resistivity requires the monitoring of apparent resistivity changes at sites.