Monitoring of a shallow CO_2 injection using time lapse electrical resistivity and induced polarization methods

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Through a field scale experiment, we investigated the efficiency and the reliability of two electrical methods for the detection and monitoring of a CO_2 leakage. The leak was simulated by injecting gaseous CO_2 at a depth of 6 meters, while electrical resistivity tomography (ERT) and temporal induced polarization (TIP) profiles, centred on the injection well, were acquired at the surface. We monitored the temporal evolution of the electrical resistivity and TIP parameters compared to a reference acquisition performed before the gas injection. The injection lasted for approximately four hours, and the cumulative mass of CO_2 injected approached six kilograms.

Both methods started showing temporal variations thirty minutes after the beginning of the injection. ERT measurements successively showed a decrease in resistivity (Fig. 1) followed by an increase in resistivity that we interpret respectively in terms of gas dissolution and water/gas saturation evolution.

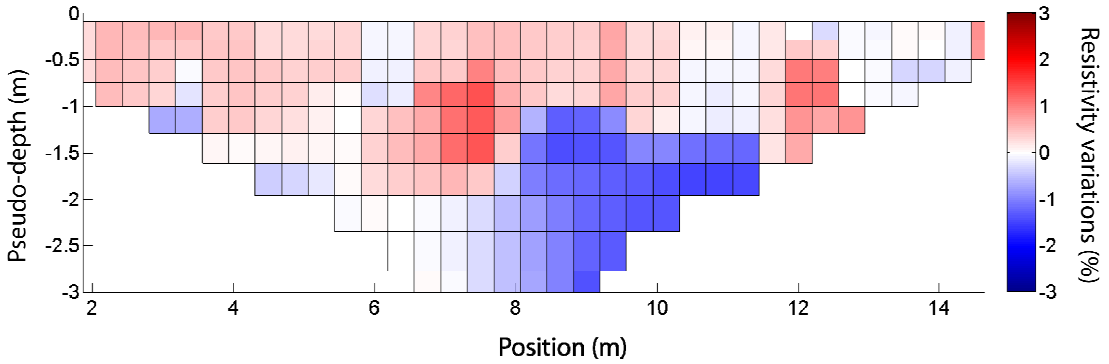

Fig. 1: Resistivity variations with respect to zero-state measurement (i.e. prior to injection), 30 minutes after CO_2 injection started. A decrease of the resistivity values in the lower part of the section can be interpreted as the arrival of a dissolution front induced by the CO_2 injection. The section is centred on the 6-m deep injection well.

Chargeability measurements proved to be much more sensitive to CO_2 injection than resistivity measurements. Measured values showed a continuous increase during the experiment (Fig. 2), suggesting that gas dissolution and saturation evolution alone cannot explain these changes, and that another process is involved.

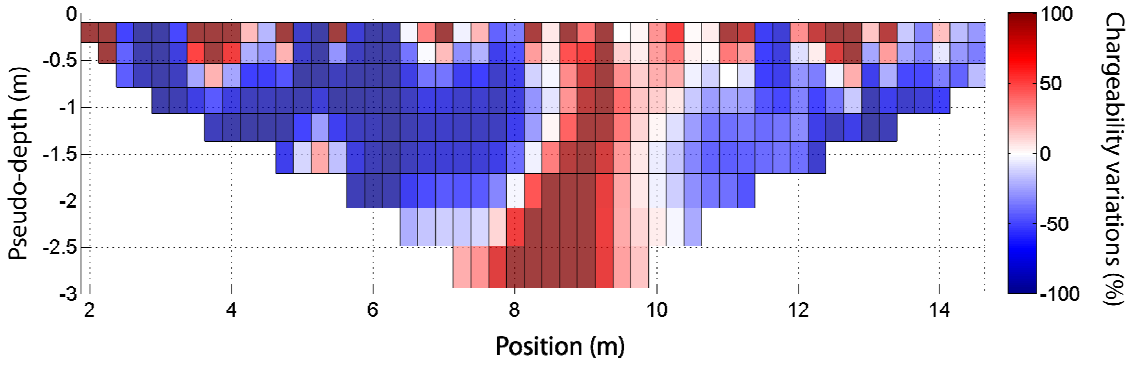

Fig. 2: Chargeability variations after 5 hours of CO_2 injection. Note the strong increase of chargeability values (> 100 %) in the lower central part of the 2D section.

These results are consistent with a previous laboratory study that underlined the larger sensitivity of IP methods to detect CO_2 transfers in the subsurface.

We gratefully acknowledge the support of the ADEME agency, Schlumberger and Total in this project and their permission to present this work. However, the views expressed here are those of the authors who are solely responsible for any errors.