3D borehole DC data processing and inversion for remediation monitoring

Diego Domenzain[1], Lichao Liu[1], Iván Yélamos Vela[2], Anders V. Christiansen[1]
(1) Aarhus University, Aarhus, Denmark
(2) Ejlskov A/S, Aarhus, Denmark
Keywords: DC, contaminant remediation, instrumentation

Contaminant remediation campaigns often inject an electrically conductive agent that chemically transforms the underground pollutant into a less toxic substance. Given that the subsurface is generally unknown, the injected remediation agent can flow through unexpected, underground, three-dimensional paths. When this happens, the underground pollutant might be missed by the remediation agent. This in turn raises the cost of the remediation campaign by excessively injecting in order to cover the spatial gaps. We aim to address this issue by in-situ monitoring in feasible time the contaminated region using DCIP borehole data.

Here, we present a proof-of-concept remediation campaign by introducing three novel technologies: (1) a new DCIP instrument that is able to measure large amounts of data in relatively short periods of time (10 thousand quadrupoles in 20 minutes) and with a sample rate of 4kHz, (2) a robust and computationally light IP signal-processing routine that yields 90% of DC data under a 3% standard deviation, and (3) a 3D inversion algorithm that can handle large amounts of data (60 thousand data-points), and a very fine discretization of the domain (300 thousand model unknowns) without losing resolution between forward and inverse models.

We test our instrument, signal processing routine, and inversion algorithm in an uncontaminated site near Aarhus, DK. The site exhibits two distinct geological layers of clay (shallow 10 m) and sand (below 10 m). Our results show a distinct increase in conductivity where the remediation agent was injected.

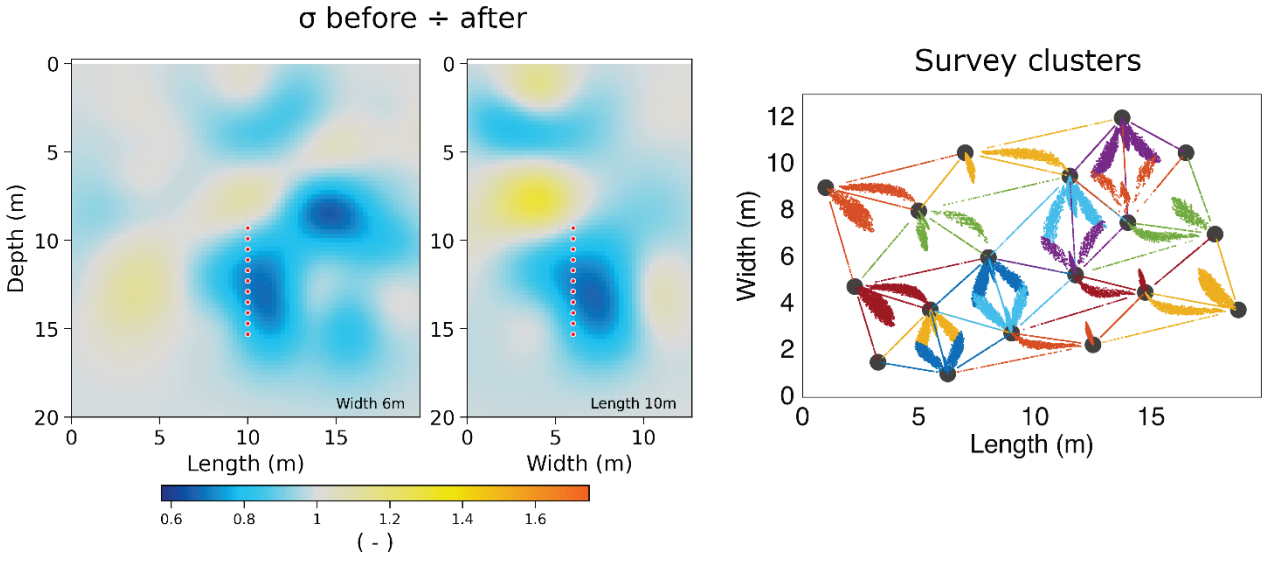

Figure: Left: slices in width and length of the 3D time-lapse quotient of recovered conductivities before and after injection of the remediation agent. Red dots denote the injection locations of the remediation agent. Each element in the domain is a cube with a side length of 0.25m. Right: top view of the pseudo-locations (colored points) of all measurements performed in our survey (60 thousand DC data-points). The gray dots denote electrode borehole locations. This survey took 7.5 hours of field acquisition.