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Induced Polarization methodology: application to a hydrocarbon contaminated site

Amelie Blondel (1,2), Myriam Schmutz (1), Frederic Tichane (3), Michel Franceschi (1), and Margaux Carles (1)
(1) EA 4592, ENSEGID, Bordeaux, France (ablondel@ipb.fr), (2) Geoscope, Cenon, FRANCE, (3) Tereo, Cenon, France

Induced Polarization (IP) is a promising method for environmental studies (Vaudelet et al., 2011; Abdel Aal et al., 2006). This method has already been successful for the study of contaminations in the laboratory scale (Vanhala, 1997; Revil et al., 2011; Schmutz et al., 2012) but is still not trivial on the field.
Temporal IP seems relatively common for field studies. When contamination implies a significative change of the polarization parameters, successful studies have been lead (Fiandaca et al. 2012; Dahlin et al., 2002 on landfills). Otherwise hydrocarbon contamination may induce small changes on IP parameters (Vaudelet et al., 2011). Spectral induced polarization has not been widely used for field application yet: this method is sensitive to coupling effects and time consuming. Moreover, all the phenomenon responsible of the signal is not completely understood yet (Kemna et al., 2012).

The main aim of our presentation is about IP methodology, applied on site affected by a hydrocarbon contamination. In this case, precautions have to be taken to get explicit answers from the contamination. Field investigations have been made: chargeability measurements in order to delineate the free phase contamination extension and spectral induced polarization soundings in order to characterize more precisely the contamination. We would like to provide recommendations to improve induced polarization measurements especially on three aspects, (i) propose a different measurement sequence to make chargeability measurements and (ii) evaluate the influence of the current injection time on chargeability measurements (iii) give general precautions to achieve SIP measurements.

A different new chargeability sequence is proposed integrating the use of separated injection and measure cables to avoid coupling phenomena in multicore cables. Indeed, this kind of coupling can significantly decrease the signal / noise ratio (Dahlin et al., 2012). Direct and reverse measurements have been made in order to evaluate if the data and data quality are comparable. Different times of injection have also been tested to evaluate their influence on chargeability measurements: long injection times (4 and 8 seconds) indicate the same high chargeability trend, to the contrary to small injection time (2 seconds). Long injection time generate (i) the polarization of more elements (ii) a stronger polarization of polarizable elements. For environmental purposes, long injection times are recommended.
Spectral induced polarization soundings have been made using the SIP Fuchs device, with an amplifier in order to stabilize the injected current (Radic 2004). Unpolarizable measurement electrodes have been connected to the apparatus with optic fiber and metallic injection electrodes have been link with a specific cable arrangement, both to reduce coupling effect with the ground (Vaudelet et al., 2011; Ghorbani et al., 2007). These precautions give good quality result and allow the inversion of the data to obtain Cole Cole parameters (Ghorbani et al., 2007), useful for hydrogeological interpretations.