Qualitative interpretation of jet fuel contamination in soils using Induced Polarization laboratory measurements

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Hydrocarbon pollution in soils is one of the most widespread environmental problem worldwide. Among them, Light Non Aqueous Petroleum Liquid (LNAPL) is commonly found in contaminated sites. Most of them are derived from the refining of crude oil, such as lubricants, feedstock for the chemical industry, gasoline, diesel or jet fuel. Their low density and their buoyancy as well as their low solubility, force the LNAPLs to mostly "float" on top of the water table. Due to the low mobility and the low solubility of the LNAPLs compounds, the plum is very slow to degrade naturally. It is thus important to develop methods that can detect and monitor the LNAPL contamination qualitatively. We evaluated the potential of Induced Polarization (IP), an active geophysical method, to estimate the concentration and degradation process of LNAPLs.

We chose to study jet fuel contamination in soil samples as it is the main contaminant of our field site. Indeed, jet-fuel leaks have been identified at the NATO base of Decimomannu in Sardinia (Italy) since 2007. The estimated total amount of jet-fuel spilled in the ground is 50,000 L. A series of 62 wells have been drilled around the contaminated area to get hydrological and geological information on the spread and the degradation of the contamination. A preliminary field geophysial study, including EM (Electro-Magnetic), ERT (Electrical Resistivity Tomography) and TDIP (Time Domain IP) data, has also been lead to understand better the extent and the degradation state of the hydrocarbons.

In parallel, we led a laboratory study on soil samples from the Decimomannu field site. The goal is to quantify the IP signature of (i) the natural uncontaminated materials, (ii) the non-aqueous free phase of the LNAPLs, (iii) the soluble fraction of some of the contamination ingredients and (iv) the bio-degradation by-products. Regarding the soluble fraction, a particular attention has been drawn to understand the role of the micro-emulsioned contaminants, resulting from the bacterial activity, as we suspect they have a significant role in aquifer water contamination. These IP signatures are studied through a series of batch experimentations, where the amount of jet-fuel is increased by controlled steps and the degradation of the hydrocarbon over time is monitored. A column experiment is also used to study in detail the IP signature in the smear zone through oscillations of the water level and complementary measures including visual track of the LNAPLs, monitoring of the water content (TDR probes) and of the water and oil capillary pressure (tensiometers).