

PREVIEW

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## IP signature of metallic particles: lessons learnt from field and laboratory experiments

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Past metallurgical sites and deposits account for a significant proportion of potentially contaminated sites in the European Union (EU): about 100,000 have been identified only in the North West regions of the EU. While recent wastes from sites still in operation are commonly recovered, this is not the case for old aggregated materials with a high content of ferrous (and other) metals, white and black slag, etc., which are considered to be sources of pollution and are costly to manage or dispose of. These sites could be considered as opportunities to recover large volumes of resources (metals, materials and land) using urban mining techniques if they were better characterized.

The induced polarization (IP) method is a geophysical method known to be sensitive to the presence of various metallic particles disseminated in the soil layers. If qualitative interpretation of the measured IP parameters in the field (i.e. resistivity and chargeability) are widespread, quantitative interpretation in terms of concentrations of different metallic particles is yet to be developed.

The example of the Pompey field site (FR), investigated as part of the NWE-REGENERATIS project (<https://www.nweurope.eu/projects/project-search/nwe-regeneratis-regeneration-of-past-metallurgical-sites-and-deposits-through-innovative-circularity-for-raw-materials/>), is used in this study to present the interest in using time domain IP (TDIP) field measurements to characterize metallurgical past deposits. Several paths are explored to convert resistivity and chargeability TDIP tomographies into quantitative interpretation of metallic element concentrations: (1) extraction of frequency data from TDIP field measurements; and (2) upscaling of lab results through numerical simulations.

Regarding (1), TDIP measurement were made with different time windows (different frequencies), giving us access to spectral IP (SIP) processing and interpretation at 5 frequencies. These new frequency interpretations of the TDIP can be compared to lab measurements and facilitate the upscaling of the found petrophysical relationships.

Regarding (2), in order to interpret the TDIP results in terms of concentration of metallic particles, known petrophysical relationships and geochemical measurements obtained at the lab scale need to be interpreted at the field scale. We propose to use a Bayesian framework for inferring field-

scale metallic particles concentrations, taking into account heterogeneity and anisotropy within the inversion schemes. This work is ongoing.

For both (1) and (2), it is crucial to find the best petrophysical relationships linking the IP parameters to concentration and size of metallic particles. Wong (1979) developed a physics-based electrochemical model that is still used today. We further investigate the Wong model to explore the role of the background porous medium itself in determining the IP signature of disseminated metallic particles and discuss the sensitivity of the model to estimate metallic grains concentration.

All these different research paths lead to a better understanding of metallic particles IP signature at a small scale, as well as discussions on how to use these findings to better characterize and reevaluate past metallurgical sites and deposits.

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