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Combining an integrated geophysical survey into a landfill model: A case study from Emersons Green, UK

Cornelia M. Inauen[1], Abigail Brooks[2], David Caterina[3], Jonathan E. Chambers[1], Ben Dashwood[1], Adrien Dimech[4], Dave A. Gunn[1], Itzel Isunza Manrique[3], Oliver Neal[2], Xavier Piquet[5], Duncan Scott[2], Arnaud Watlet[1], James S. Whiteley[1], and Paul B. Wilkinson[1]
[1]British Geological Survey
[2]VertaseFLI Ltd
[3]University of Liege
[4]Polytechnique Montreal
[5]University of Grenoble

For a large number of landfills, basic knowledge about extent, waste composition or environmental impact is incomplete. Considering the large number of non-sanitary landfills located in semi-urban areas subject to increased land use pressure plus the high cost for remediation, it is crucial to develop efficient characterization tools suitable in landfill contexts. Such tools are required on a broader level to enable the identification of landfills with high priority for remediation or high potential in terms of waste valorisation (landfill mining) and, on a more detailed level, to enable planning of remediation or landfill mining projects.

Due to the high heterogeneity and complexity of landfills, the application of different geophysical methods in combination with targeted sampling has proven to be a highly favourable approach. In contrast to conventional ground truth methods, geophysical techniques provide the possibility to characterize large portions of the landfill volume in a non-invasive and relatively efficient way. Furthermore, the application of complementary geophysical techniques reduces the risk of misinterpretation, and by verifying/calibrating the results with targeted sampling a relatively detailed landfill model can be built. However, building a landfill model from data measured at different resolution, coverage and with different uncertainties is a challenge.

We present a case study from Emersons Green (UK) where we completed multiple geophysical surveys on a former landfill site prior to its full excavation. The excavation works provided nearly continuous information on the waste and cover layer thickness as well as information on material composition from several locations. This enabled us to validate the geophysical measurements and to test different approaches for model building, as well as testing virtual sampling strategies in order to assess how the number and location of ground truth samples affects the model quality.

The case study has highlighted the advantage of a multi-geophysical approach where Electromagnetics (EM) and Magnetics (Mag) were able to provide a rapid overview of the landfill structure and its lateral extent. In contrast, Induced Polarization Tomography (IPT) and

Multichannel Analysis of Surface Waves (MASW) were most suitable to delineate the bottom interface of the waste layer. IPT was in addition able to delineate the cover layer thickness and Electrical Resistivity Tomography (ERT) seemed more sensitive to changes in moisture content. For the model building, a probabilistic approach has proven to be efficient. In terms of sampling strategy a minimum number of samples are required co-located with the geophysical measurements to train the probability model. Furthermore, additional sampling points at locations where geophysical methods are only sparsely available increase the model certainty.