For a better and more widespread use of geophysics in landfill applications

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Site investigations and characterization at landfills and in their surroundings benefit from non-intrusive geophysical mapping techniques. These offer rapid screening possibilities and can help to estimate volumes and to optimize collection of samples in the field, thereby potentially enabling substantial savings. Their use is since long recognized as a natural step in site characterisation (see for example the Swedish Environmental Agency, 1994, 1999).

However the range of existing geophysical methods is large and choosing the most appropriate can be difficult. Sometimes failure to relate geophysical results to other data has even led to them being hastily assessed as unreliable. As a consequence they are not so seldom omitted or come at a late stage in the field investigations.

We intend here to remind of some criteria for selecting geophysical methods, based on general considerations and illustrated with examples from our own experience. In any case it is important to have a clear idea of the desired information and its scale and to remember the capabilities and the limitations of the methods.

Since geophysical methods are indirect methods, one important criterion is the sensitivity of the measured physical property to the desired information. Others are the depth of investigation and the resolution that are desired and/or can be obtained, and these are related to both practical and economical considerations.

Hereafter is presented a short and non-exhaustive review of methods applicable at landfills, from the most large-scale to the most detailed ones.

Airborne infra red measurements

Airborne infra red measurements (thermic IR, near IR and colour IR) from four pilot sites (both rural and urbanized) in Denmark were analyzed. The idea was that municipal solid waste generates heat when decomposing and that thermal anomalies could be used to locate and delimitate old dumping sites.

Care must be taken to distinguish the response of vegetation and of surface water, but the method is promising, especially for low-urbanized areas. Large surfaces can easily be covered.

Screening with electromagnetic methods:

Electromagnetic methods in the time domain (like EM61 from the ground) and in the frequency-domain (like GEM 2 from Geophex, but other manufacturers exist) in the intermediate frequency range make it possible to rapidly screen large areas. Their use at landfills is based on the expected

higher conductivity of waste due to increased ion content and to occurrence of metal particles and objects. The depth of investigation varies, but about one to between 5 and 10 meters can usually be reached. Interpretation is often qualitative but 1D inversion can be made in some cases.

At the Roskilde-Musicon site in Denmark, these two methods were used to locate buried rifles and ammunition. They are especially effective for metal detection.

Measurements in profiles: DC resistivity and induced polarisation

When more exact and detailed depth assessment is wanted, DC-resistivity, usually measured in profiles can be used. Depending on the available information on the site, they can be used alone or perhaps better in combination, with electromagnetic mapping methods for example. Lower resistivity is expected and landfills and in areas affected by leachate water. However, due to varying water contents and to natural low-resistivity deposits, resistivity gains of being complemented by induced-polarisation measurements which have shown to respond more specifically to waste materials (see for example Leroux et al, 2007). A number of such measurements were acquired at landfills.

Borehole geophysics

When boreholes are present, geophysical measurements in boreholes are a means to directly relate properties to specific materials. They can also be used for tomography measurements.

In conclusion: comparison with other data and combination of results

For the final interpretation but also when planning a survey, study of available data (maps, chemical analysis, sampling, geological information). A few methods exist for combining different geophysical measurements and borehole information (for example Martinez et al, 2011), but the development of such methodology is a topical subject.

The examples will be presented in more detail at the workshop. [This presentation is intended as a base for discussion between professionals working in the area.]

References

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