Resistivity-IP Characterisation and Short Term Monitoring at Filborna Waste Deposit

T. Dahlin (Lund University), S. Johansson (Tyréns AB),*
H. Rosqvist (Rosqvist Resurs) & M. Svensson (Tyréns AB)

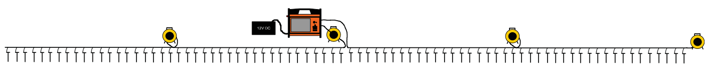
Introduction

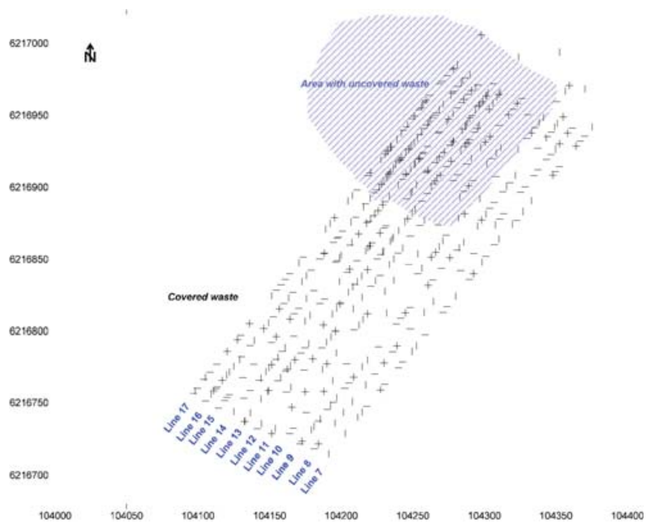
Buried waste in old landfills is an increasing problem as cities expand and grow into areas with former waste deposits. In order to be able to manage and as far as possible reclaim land in such areas, better tools are needed for mapping and characterisation of buried waste and contaminated land. Other problems associated with landfills are leachate water and methane emissions. In the results presented internal landfill structure was successfully mapped using a combination of resistivity and time-domain IP, confirming results earlier results (e.g. Dahlin et al. 2010).

A 3D resistivity and time-domain induced polarisation (IP) survey was carried out over part of a Municipal Solid Waste (MSW) landfill, the Filborna landfill site, Helsingborg, Sweden. The objective was to assess the possibilities to map variations in material distribution in the landfill. This was later followed by short-term monitoring aiming at detecting variations in fluid and gas contents. The satellite image (left) gives and overview of the landfill. The survey was carried out over the elevated parts in the background of the photo to the right.

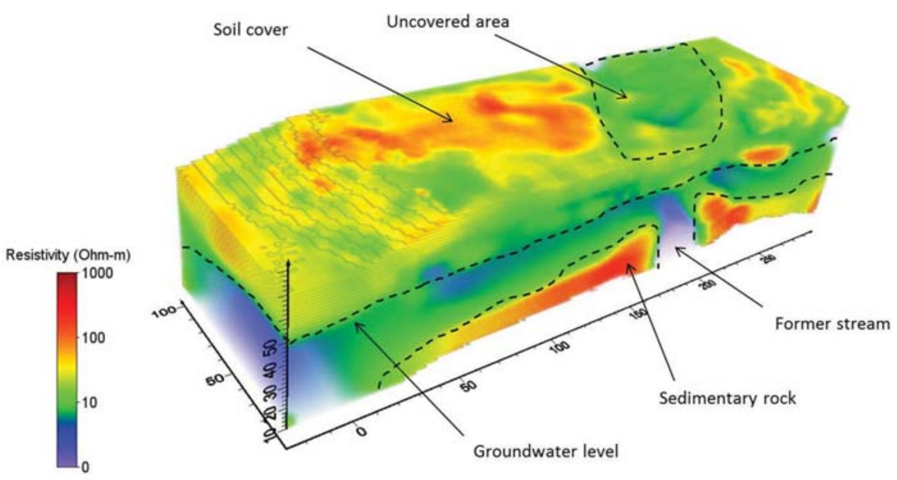
Method

Data acquisition was made with an ABEM Terrameter LS with 12 measuring channels, using 300 m long layouts with 5 m electrode take-out spacing. A total of 11 lines 300 m long and spaced 10 m were measured in one field week, resulting in 17680 resistivity-IP data points on a total of 3300 m of profile. An expanded multiple gradient array was employed. Data were inverted with Res3dinv using L1-norm (robust) inversion.



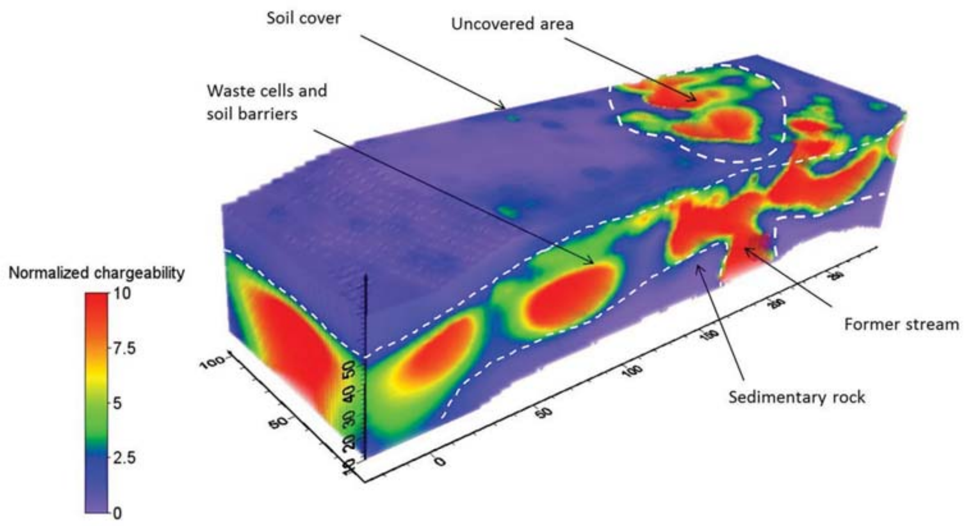


3D Survey



The figure to the left shows the inverted and interpreted resistivity model. The sedimentary rock, the expected ground water level and the soil cover is visible. A zone with low resistivity at the surface is evident in the right part of the model, where the cover layer is missing. At length coordinate 200 m a distinct low resistivity zone is visible, which corresponds to the position of a former stream below the landfill, indicating contaminant leachate migrating into the former stream.

The inverted IP model is shown as normalised chargeability in the figure to the right. The volumes with high normalised chargeability are interpreted to consist of mixed waste or leakage contamination, whereas low chargeability volumes are interpreted as soil cover on top of the waste, soil barriers between waste cells and sedimentary rock below the waste respectively. The parts of the waste that are not covered by soil are clearly visible as high chargeability at the surface. High chargeability in the bottom part of the model may possibly be caused by chemical precipitation in connection with contaminant migration along the former stream channel.



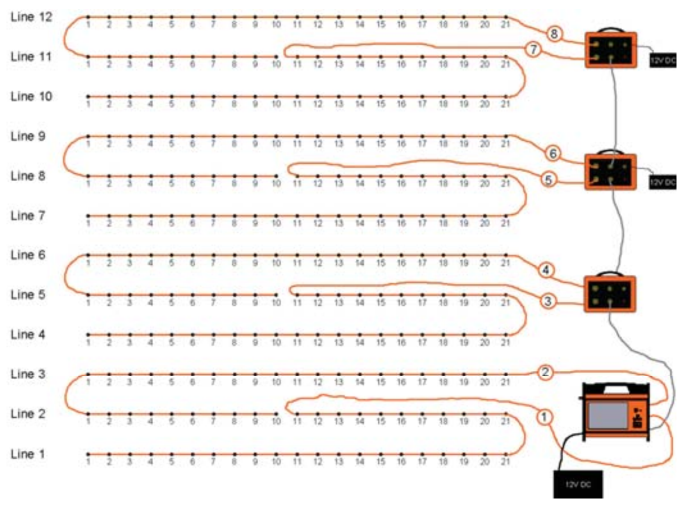
TYRÉNS ROSQVIST RESURS NSR

Resistivity-IP Characterisation and Short Term Monitoring at Filborna Waste Deposit

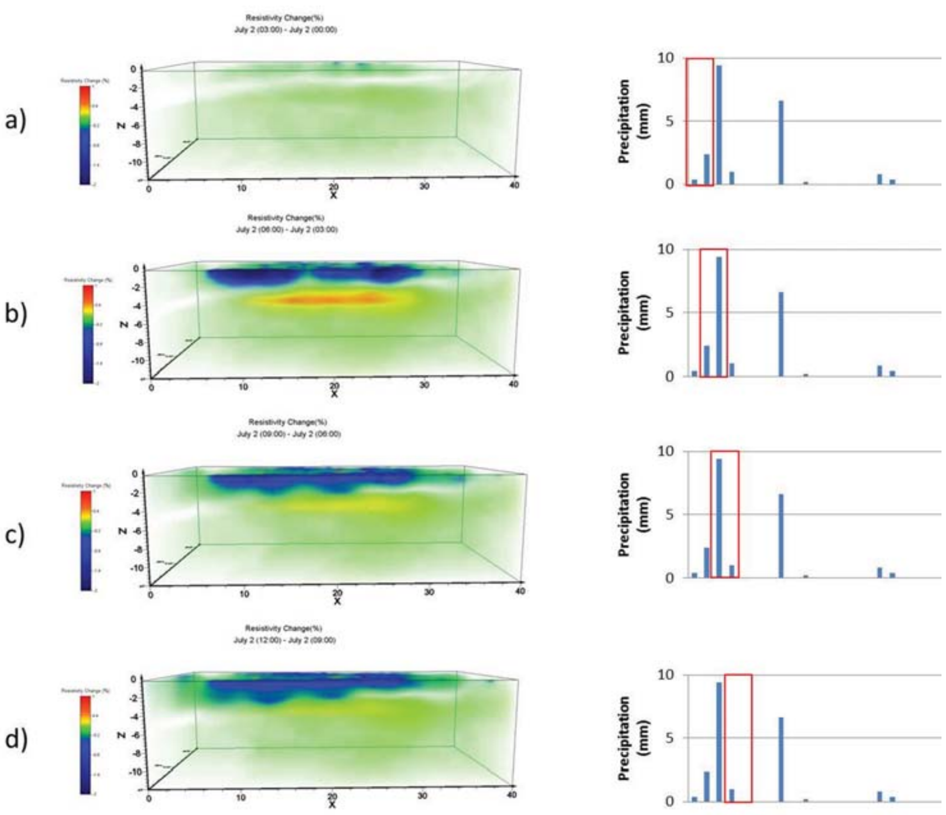
T. Dahlin (Lund University), S. Johansson (Tyréns AB),*
H. Rosqvist (Rosqvist Resurs) & M. Svensson (Tyréns AB)

Short term 3D monitoring

An area measuring 40 by 22 meter within the previously investigated field site was later (June-July 2011) monitored during a couple of weeks. A grid with 21 x 12 electrodes was monitored, with an electrode spacing of 2 m in both directions. Stainless steel electrodes were used, where buried plates were found to be the best solution (see photo to the right). A remote controlled data acquisition system based on the ABEM Terrameter LS complemented by 3 external relay switches, lightning protection, internet modem etc was employed. In addition to the resistivity-IP monitoring the weather was recorded locally. Res3dinv was used for time-lapse inversion of the resistivity data.



A few examples of 3D difference images based on the short term monitoring are presented in the figure below. The images show the relative change in resistivity compared to the previous model, being in the range -2% - +1%, following varying amounts of precipitation. If they are plotted as change relative to start of experiment it is not possible to catch as subtle changes. The varying amount of accumulated precipitation during the monitoring period is reflected by varying extent of the zones of decreasing and increasing resistivity respectively. The decrease in resistivity is without doubt caused by infiltrating precipitation water. The increase in resistivity, although subtle, might be explained by increasing gas pressure beneath the infiltrated water that is expected to act as a lid preventing gas to escape to the atmosphere (Rosqvist et al. 2011).



Conclusions

Internal landfill structure was successfully mapped using a combination of resistivity and time-domain IP. Variations in resistivity and chargeability can be related to different types of materials. Furthermore the results indicate that leachate water migrates into a former stream under the landfill. The results have major practical applications since undocumented buried waste and contaminated land in many cases form severe threats to the environment and are obstacles for infrastructure and building development.

Variations in resistivity linked to variation in fluid and gas content were captured by short term monitoring. Rainfall events that occurred during the monitoring period acts as infiltration tests and the changes in resistivity outlines the water migration pattern. Patterns that may be due to increasing gas contents, in line with previous results, are also seen.

References

Dahlin, T., Rosqvist, H., Leroux, V. (2010) Resistivity-IP for landfill applications, First Break, 28(8) 101-105.

Rosqvist, H., Leroux, V., Dahlin, T., Svensson, M., Lindsjö, M., Månsson, C-H. and Johansson, S. (2011) Mapping landfill gas migration using resistivity monitoring, Waste and Resource Management, 164(1), 3-15.

Acknowledgements

The work at at Filborna was carried out within the MaLaGa project (Mapping of Landfill structures and Gas migration based on geophysical measurements) in co-operation between Lund University, NSR AB and Tyréns AB, with funding from Swedish Waste Management (Avfall Sverige), Swedish Gas Centre (Svenskt Gastekniskt Center AB), Sven Tyréns Stiftelse and NSR AB.