

TBL # 5: Resistivity-IP mapping for landfill applications at Waterval, South Africa

DUE: November 8th, 2017

Overview

Direct current resistivity (DCR) surveys work by injecting current into the ground via a set of transmitter electrodes and measuring differences in electric potential across a set of receiver electrodes. Induced polarization (IP) data can be collected in addition to resistivity data by measuring the electric potential as it discharges during the off-time.

Recent studies have shown that DCR and IP surveys are collectively sensitive to a large variety of landfill materials, including: organic waste, construction waste, metallic debris, leachate and wood clippings. In this case history, DCR and IP data are acquired across an abandoned landfill near Waterval, South Africa. As part of this assignment, you will answer a set of questions which follow the 7 step framework. In doing so, you will learn what makes resistivity-IP surveying viable for landfill applications.

Instructions

Read the article [Dahlin, Rosqvist and Leroux \(2010\)](#) and answer all multiple choice questions in the assignment. As this assignment focusses on the Waterval waste deposit in South Africa, you will not be required to read the section on the Ekeboda waste deposit, Sweden; although you are encouraged. The assignment should be completed before class on the specified due date.

Resources

- [Dahlin, Rosqvist and Leroux \(2010\)](#)
- [GPG:DC Resistivity](#)
- [GPG:Induced Polarization](#)

Setup

1. What were the geotechnical goals of the study?
 - (a) To measure the rate of waste decomposition within landfills
 - (b) To delineate leachate migration and delineate the horizontal and vertical extents of the landfill
 - (c) To map conduits for escaping methane gas
 - (d) To find high concentration of scrap metal for recycling

Physical Properties

2. Which physical properties are used as diagnostic physical properties in this study?
 - (a) Electrical resistivity and chargeability
 - (b) Electrical resistivity and magnetic permeability
 - (c) Dielectric permittivity and chargeability
 - (d) Electrical resistivity and dielectric permittivity
3. Why are these physical properties considered diagnostic?
 - (a) Leachate fluids contain salts and minerals which make them conductive
 - (b) Waste dumps with metals and organic materials have been shown to exhibit induced polarization (IP) signatures
 - (c) Metallic debris is very conductive
 - (d) All of the above.
4. Which of the following statements is **correct**?
 - (a) The leachate is characterized by low resistivity and high chargeability
 - (b) The leachate is characterized by low resistivity and high chargeability
 - (c) The leachate is characterized by low resistivity and high chargeability
 - (d) The leachate is characterized by low resistivity and high chargeability

Geophysical Survey

5. What type of electrode configuration was used in the survey?
 - (a) Pole-pole
 - (b) Pole-dipole
 - (c) Dipole-dipole

6. Consider the survey for the Waterval waste deposit. Along what orientation were the survey lines?
 - (a) Parallel to the strike of the valley
 - (b) Perpendicular to the strike of the valley
 - (c) North-South
 - (d) East-West

Data and Processing

7. In [Dahlin, Rosqvist and Leroux \(2010\)](#) , what information is being shown in Figures 1a and 1b?
 - (a) Resistivity and chargeability profiles from 2D inverted data
 - (b) Resistivity and chargeability profiles from 3D inverted data
 - (c) Interpolated resistivity and chargeability pseudosections
 - (d) True resistivity and chargeability along a 2D profile

Interpretation

8. Examine Figure 1a in [Dahlin, Rosqvist and Leroux \(2010\)](#) . There are two regions of high resistivity. One is along the surface and the other is at the bottom left. To what do these likely correspond geologically?
 - (a) Along the surface corresponds to landfill coverings. On the bottom left corresponds a thick clay unit on top of the basement..
 - (b) Along the surface corresponds to landfill coverings. On the bottom left corresponds to the basement rock.
 - (c) Along the surface corresponds to well-drained sands and gravels. On the bottom left corresponds to the basement rock.
 - (d) Along the surface corresponds to well-drained sands and gravels. On the bottom left corresponds a thick clay unit on top of the basement.

9. Examine Figure 1b in [Dahlin, Rosqvist and Leroux \(2010\)](#) . What does the large highly chargeable region on the right side of this figure most likely correspond to?
 - (a) A large clay-rich sedimentary unit
 - (b) A region with large concentrations of methane gas
 - (c) It delineates the organic and metallic waste which comprises most of the landfill
 - (d) It delineates a region entirely saturated by ionic fluids

10. Examine Figures 1a and 1b in [Dahlin, Rosqvist and Leroux \(2010\)](#) . At the surface near $x = -60m$, there is a region of low resistivity and high chargeability. What is a likely explanation for this?
 - (a) The feature corresponds to a pocket of leachate
 - (b) The feature corresponds to a culvert
 - (c) The feature corresponds to a small clay bed
 - (d) The feature corresponds to a pile of metallic clutter

11. According to the article, the leachate has migrated roughly 40 m from the toe of the landfill. What signature in the inverted data is a result of this?
 - (a) A region of low resistivity at $x = -40m$ along profile line K (Figure 2b in [Dahlin, Rosqvust and Leroux \(2010\)](#))
 - (b) A region of high resistivity on the surface of profile line K at $x = -40m$ (Figure 2b in [Dahlin, Rosqvust and Leroux \(2010\)](#))
 - (c) A region of low resistivity and high chargeability near the surface of profile line A at $x = -60m$ (Figures 1a and 1b in [Dahlin, Rosqvust and Leroux \(2010\)](#))
 - (d) None of the above

Synthesis

12. What information was used to confirm that leachate had migrated beyond the toe of the landfill?
 - (a) A second, higher resolution resistivity-IP survey over regions of interest
 - (b) Physical property measurements on soil samples from boreholes
 - (c) Density and health of plant life along the stream bed
 - (d) Confirmation that the landfill lining had been perforated