PARIS 2017

Th SP2 05

Resistivity and IP monitoring near a tailings storage - A case study from Hungary

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Summary

The surveys were realized in the framework of the WELLaHEAD project in cooperation with the Department of Hydrogeology and Engineering Geology and the Department of Geophysics (University of Miskolc). The measurements were carried out on two occasions during 2013, by the Háromkő Geological and Geophysical Prospecting Company. Eighteen (18) different points were measured in May, and twenty-four (24) points in August along 6 profiles. The local map of the survey can be seen on Figure 1. After the appearance of the contamination outside the dam became obvious, the aim of the geoelectric survey was to determine the temporal and spatial spread of the contamination.

Introduction

After the toxic red sludge catastrophy (2010) of Kolontár, Hungary, the control of other tailings became more accurate. This case study – without the exact position of the area (because of industrial encryption) – proved that it was not unfounded, beacause these facilities have high environmental risk. The safe storage of the mud is a geotechnical problem basically, but geoelectric methods are able to monitor an accidental leakage.

DC resistivity and IP measurements were applied in the vicinity of a tailings. The surveys were realized in the framework of the WELLaHEAD project in cooperation with the Department of Hydrogeology and Engineering Geology and the Department of Geophysics (University of Miskolc). The measurements were carried out on two occasions during 2013, by the Háromkő Geological and Geophysical Prospecting Company. Eighteen (18) different points were measured in May, and twenty-four (24) points in August along 6 profiles. The local map of the survey can be seen on Figure 1. After the appearance of the contamination outside the dam became obvious, the aim of the geoelectric survey was to determine the temporal and spatial spread of the contamination. It was necessary to add reference points to the measurement system in order to know which values are specific inside the dam (REF1) and far from the tailings (REF2).

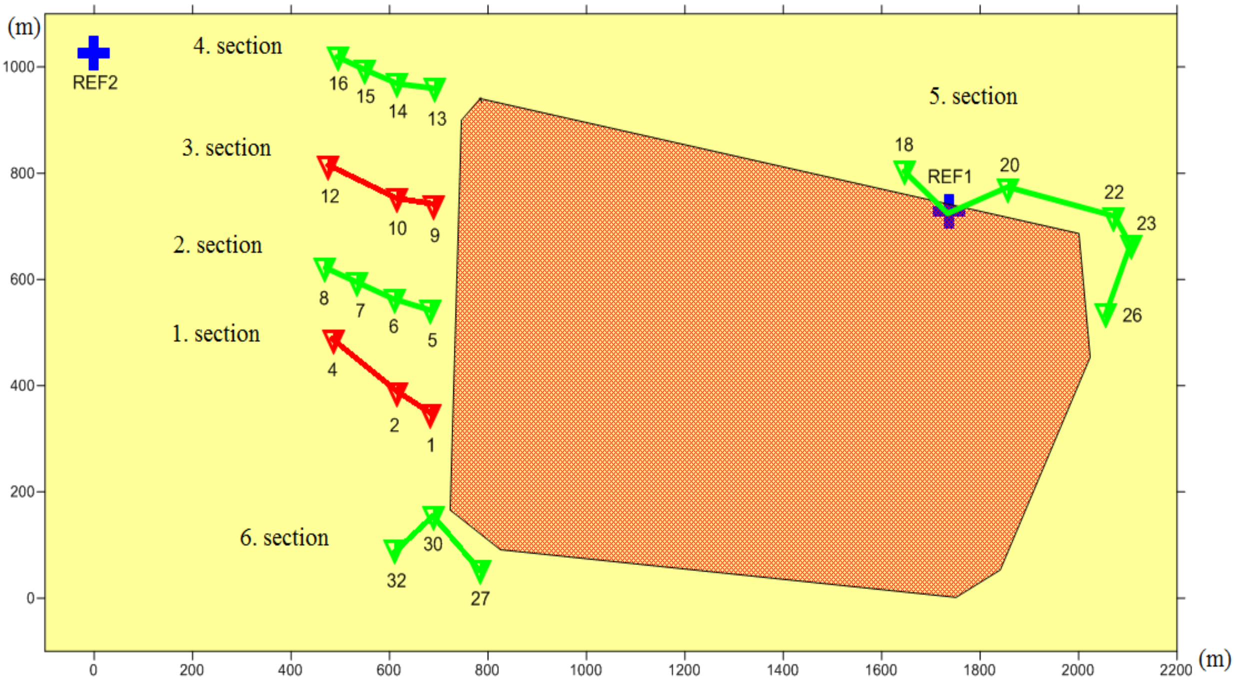

Figure 1 *The local map with the investigated area (orange color signifies the tailings)*

Methods, results

Based on the geoelectric measurements, two methods were applied for the estimation of the type and the amount of soil contamination. The first one, when the type of the contamination can be concluded from the time constant value of the time constant spectra ($\omega(\tau)$), and the estimated level of contamination comes from the Weighted Amplitude Value (WAV) of the time constant spectra (Turai, 1985). The second one, when the corrected apparent conductivity (σ_{corr}) of the contaminated material is calculated as a product of WAV parameter and measured apparent conductivity (Turai and Dobróka, 2001; 2011). The measurable apparent polarizability curve in time domain $\eta_a(t)$ can be determined by the following integral transform:

$$\eta_a(t) = \int_0^{\infty} \omega(\tau) e^{-\frac{t}{\tau}} d\tau$$

It can be seen at Figure 2, how the corrected apparent conductivity, and the polarization contamination scale changed by the time at the number 30 measured point. This type of charts has been produced from all the 18 different measured points data.

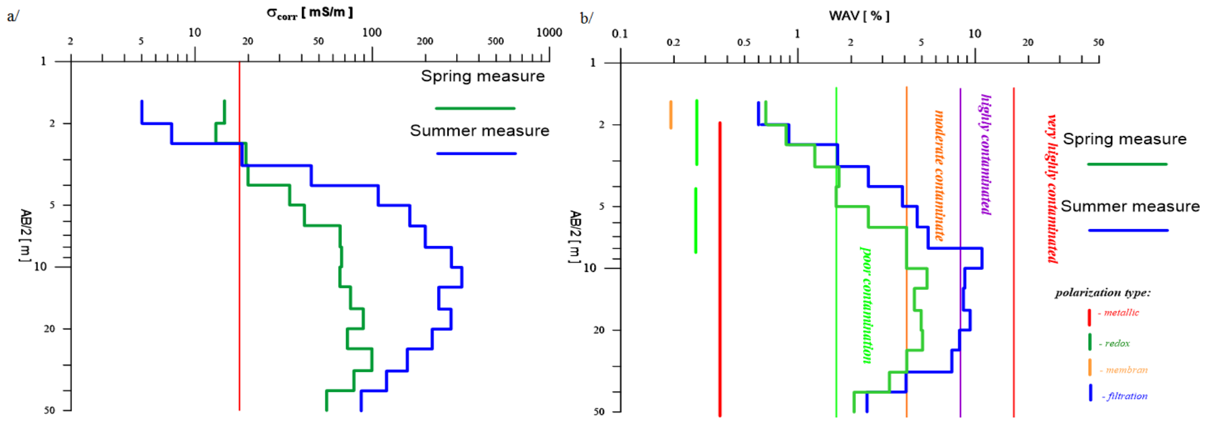

Figure 2 *Corrected apparent conductivity (a), and the polarization contamination scale and type (b) under the number 30 point.*

Along the indicated profiles (Figure 1), sections were edited from the above-mentioned parameters, which showed significant differences between the spring and the summer period measurements. The contamination spreading is very spectacular, starting from the tailings. With the passing of time (a => b) the degree of the contamination increases over the whole area. Especially at the depths of H~4 m and H~12 m, where the dam possibly leaks.

Conclusions

From this case study, it was revealed that this method is working well with high metal content and can be detect where the contamination spread out. It is useful for prospecting shallow objects. The results of the measurements and processing shows, that the pollutants leak from the reservoir at a depth of about 4-8 meters. For the further research would be necessary – especially close to the tailings – to measure more parallel sections along the dam of the storage, with smaller point distance. In order to validate the geophysical measurements and for the precise indication of the extent of the contamination, it would be essential to drill some geotechnical hole with core samples. In situ and laboratory geochemistry tests are also needed. Transportation modelling of this area is also recommended, which needs petrophysical parameters such as porosity, saturation, hydraulic conductivity, and storage coefficient.

Acknowledgements

“The research was carried out in the framework of the Sustainable Resource Management Center of Excellence at the University of Miskolc, as part of the TÁMOP-4.2.2/A-11/1-KONV-2012-0049 „WELL aHEAD” project in the framework of the New Széchenyi Plan, funded by the European Union, co-financed by the European Social Fund.”

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