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4D investigation of water infiltration in waste dumps using electrical resistivity

Изследване на инфилтрация на води в руднични отвали чрез използване на 4D електросъпротивителни методи

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Abstract. Цел на изследването е да се установи по какъв начин се осъществява проникването на вода в руднични отвали. Използвани са 4D геофизични изследвания по метода на електрическото съпротивление, които позволяват да се установи разсейването на водата във времето. Получените резултати могат да се използват за прогнозиране процесите на взаимодействие на водата с насипните материали.

Keywords: electrical resistivity tomography, infiltration, mining waste dumps, unsaturated zone.

Introduction

Geophysical methods are often applied in hydrogeological investigations (Kirsch, 2006). Electrical resistivity is one of the most widely-used methods. Some applications allow to investigate groundwater flow, usually related to contaminated groundwater (e.g. Ustra et al., 2012), but also related to sea water intrusions or mine water. In Bulgaria, such investigations have been carried out as well (Gyurov, Stoyanov, 2004; Dimovski et al., 2017; Stoyanov et al., 2017). The purpose of the present study is, by applying electrical resistivity methods, to understand how water infiltrating from the surface advances in the mine waste dumps. The investigated site is in the eastern waste dumps at Elatsite open-cast mine. The dumps contain various rock types: granodiorite, hornfels, phyllite, porphyrites.

Methods

The method consisted of electrical resistivity imaging in three dimensions as the main technique with the time of process advancement representing the fourth dimension. The experimental setup included one 2x2x1 m trial pit in the center of an electrode grid over an area of 70x30 m and 10x5 m spacing between the electrodes. The setup allowed for complete coverage of the subsurface volume in which the water solution infiltrated from the trial pit. The resistivity measurements were carried out in pole-pole, pole-dipole and dipole-dipole arrays (Loke, 2002). The data were processed using RES3DINV software, which is capable of evaluating the spatial distribution of electrical resistivity (Li, Oldenburg, 1992; White et al., 2001). The water solution was prepared by dissolving 40kg NaCl in 4 m^3 of water and released in the trial pit. Preliminary calculations indicated that the electrical resistivity in the water solution would drop almost three times, which would cause significant decrease in the electrical resistivity of the saturated volumes in depth. The results were produced by calculating anomalous values in space and time after comparing electrical resistivity measurements to baseline conditions, which were recorded before the release of the water solution. The first measurement was undertaken 20 min after the release of water solution and it was followed by further 6 measurements with reducing frequency over 40 hrs.

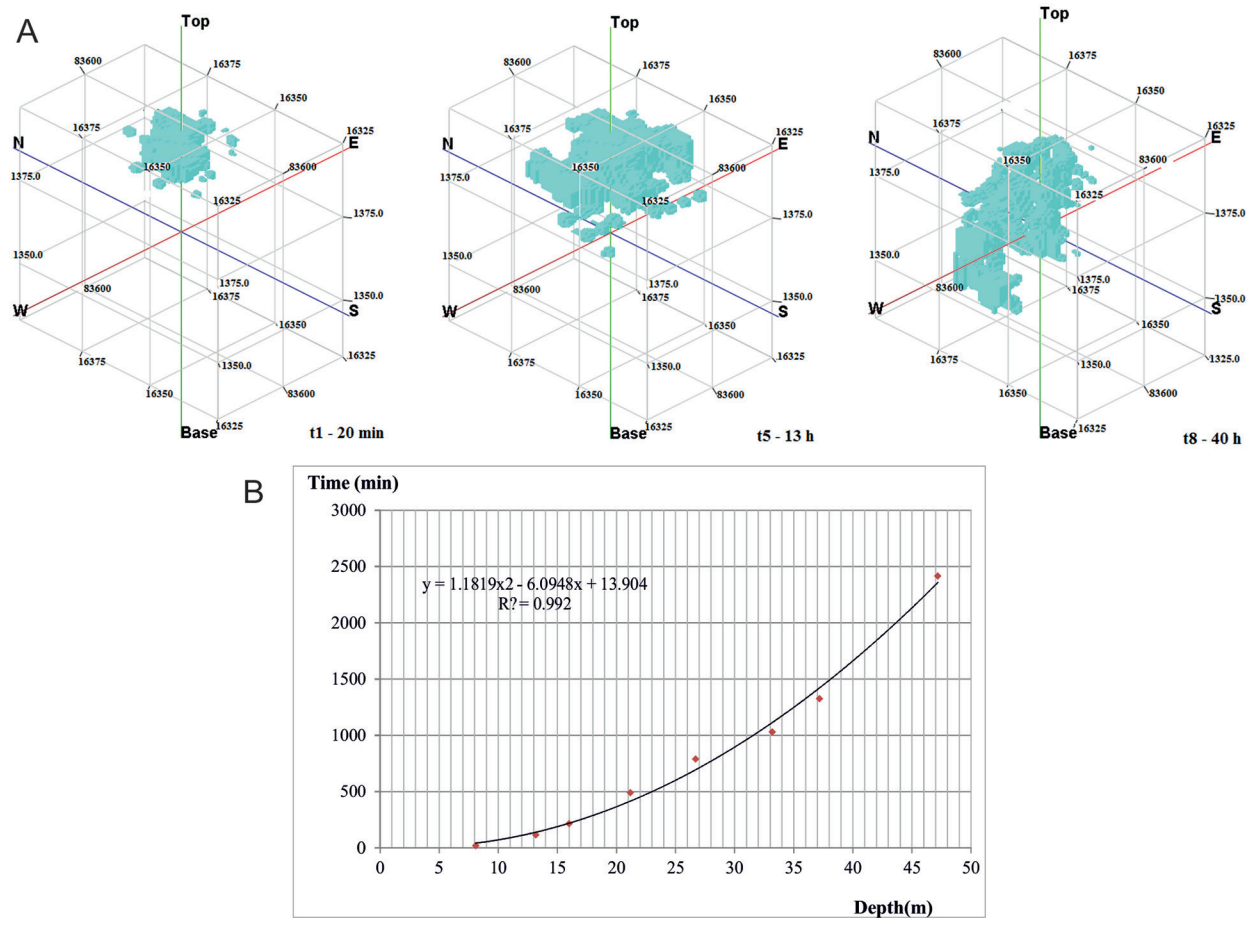

Fig. 1. Spatial dispersal of the infiltrating saline solution at different times (A) and advancement in depth of the infiltrating saline solution below the trial pit (B)

Results

The data from the electrical resistivity measurements were processed to obtain 3D results for different times of the infiltrating saline solution (Fig. 1). It was established that after infiltrating from the surface, the water dispersed and was retained within the dump materials. Maximum velocity of infiltration was also estimated.

Conclusions

The results indicate that the applied method provides very clear understanding of how water infiltrates unsaturated material in waste dumps. It makes it possible to obtain quantitative parameters for predicting the interaction between water and porous medium.

References

Dimovski, S., N. Stoyanov, C. Tzankov, A. Kisyov. 2017. A geophysics approach for mapping of abandoned mining workings and unconsolidated zones in coal mining areas. – *J. Mining and Geol. Sci.*, *60*, 99–103.

Gyurov, C., N. Stoyanov. 2004. Possibilities of 2D resistivity method for locating the extension of old landfills. – In: *Proceedings of the 4th National Geophysical Conference with International Participation "Geophysics in Economic Activity, Environment and Cultural Heritage Investigations"*. Sofia, 28–131.

Kirsch, R. 2006. *Groundwater Geophysics. A Tool for Hydrogeology*. Berlin-Heidelberg-New York, Springer Verlag, 493 p.

Li, Y., D. W. Oldenburg. 1992. Approximate inverse mappings in DC resistivity problems. – *Geophys. J. Intern.*, *109*, 343–362.

Loke, M. H. 2001. *A Practical Guide to RES2DINV ver. Rapid 2-D Resistivity & IP Inversion Using the Leastsquares Method*. Geoelectrical Imaging 2-D & Geotomo Software. Penang, Malaysia, 96 p.

Stoyanov, N., P. Gerginov, E. Tarabees, A. Benderev, S. Dimovski. 2017. State of the art and the problems of interaction between groundwater and marine waters in the Nile delta. District Rashid, Egypt. – In: *Proceedings of the 17th International Multidisciplinary Scientific Geoconference SGEM*, *17*, 12, 793–800.

Ustra, A., V. Elis, G. Mondelli, L. Zuquette, H. Giacheti. 2012. Case study: a 3D resistivity and induced polarization imaging from downstream a waste disposal site in Brazil. – *Environmental Earth Sci.*, *66*, 3, 763–772.

White, R. M. S., S. Collins, R. Denne, R. Hee, P. Brown. 2001. A new survey design for 3D IP modelling at Copper hill. – *Exploration Geophys.*, *32*, 152–155.