ΕΓΕ 2019
15th International Congress of the Geological Society of Greece
Athens, 22-24 May, 2019 | Harokopio University of Athens, Greece
Bulletin of the Geological Society of Greece, Sp. Pub. **7** Ext. Abs. GSG2019-227

Evaluation of the impact of a landfill on the soil physicochemical parameters

E. Koutsopoulou[1], D. Papoulis[1], P. Tsolis-Katagas[1]
(1) University of Patras, 26504 Rion, Greece, ekoutsop@upatras.gr

Introduction

Although proper waste management nowadays includes collection, transport, treatment and finally disposal of waste together with monitoring and regulation, landfilling is still widely used as a waste management method for municipal solid waste. However, landfills if not properly managed, give rise to air and water pollution and may severely affect the environment due to leachate leakage and contaminant transport in the surrounding environment which can cause numerous contamination problems long after disposal has ceased. Landfill leachate may contaminate the natural soil and groundwater if allowed to migrate without appropriate engineered facilities to mitigate its effect on the natural environment.

The aim of the study was to evaluate the environmental risks associated with the waste disposal facility in the municipality of Zakythos and the extent of the leachate adverse impacts on the natural soil environment.

Materials and Methods

Samples were collected around the landfill and from sediments from a stream system, in the vicinity of the waste disposal site. The mineralogical composition of all samples was determined by XRD and bulk sample chemical analyses for major and trace elements were performed with INAA and ICP-MS. Surface soil samples were also collected down gradient of the landfill and analysed to determine some physicochemical parameters which are usually considered indicators of pollution from solid waste disposal. Determination of the physicochemical parameters was performed in soil extracted solutions according to Handbook of Soil Analysis (Pansu and Gautheyrou, 2006). Chloride (Cl^-) was measured using the $AgNO_3$ method by Hach® titration kits while sulphate (SO_4^{2-}), nitrate (NO_3^-), nitrite (NO_2^-) and ammonium (NH_4^+) were determined using a spectrophotometer (Hach® DR/4000). pH and Electrical Conductivity (EC) were measured according to 9045D EPA (Environmental Protection Agency) and USDA, National Soil Survey Handbook (2011) methods respectively.

Results and Discussion

Clays and clay minerals are widely used in environmental applications due to their ability for adsorption and removal of heavy metal contaminants, organic and biological cations and non-ionic organic compounds (Koutsopoulou et al., 2010, Schoonheydt et al., 2018). The determination of the clay mineralogy of the clayey material used in a waste disposal site is a key factor in controlling the contaminant transport in the surrounding environment which can cause numerous problems long after disposal has ceased. X-ray diffraction patterns of random powder mounts revealed the presence of quartz, calcite, plagioclase, traces of gypsum and clay minerals in all samples. The clay fraction (<2μm) of the samples is dominated by smectite, chlorite, illite, serpentine and mixed-layer chlorite-smectite. X-Ray Diffraction patterns of the <2 μm fraction of samples collected around the landfill are shown in Figure 1. Chemical analyses showed that the highest values of heavy metals such as As, Cu, Zn and Pb are evident in the stream sediments (Koutsopoulou et al., 2013). The pH values calculated range between 7.7 and 8.8 for all samples which do not exceed the permissible WHO limits and EC values range between 120μS/cm and 2750μS/cm with the highest values found in the stream sediments. Chloride values ranged between 20 and 400 mg/L and sulphates between 19 and 2000 mg/L. Chloride is usually considered as a tracer around landfill sites; the presence of sulphates, however could also be attributed to the dissolution of gypsum present in most of the samples. The mean values of some of the physicochemical parameters determined are given in Figure 2. The comparison of mean soil extraction values with surface runoff water and rainwater shows that stream sediments are becoming enriched in most of the analyzed physicochemical parameters. The ammonium concentration of the soil extractions and the surface runoff water display elevated values that exceed the EE drinking water guidelines (0.2 mg/L). Ammonium in soils and surface water is usually a marker of bacterial, sewage or animal waste pollution and could be attributed to contamination from the landfill site (Koutsopoulou et al., 2013). The mean nitrite concentration (0.7 mg/L) of the soil extractions and the surface water is also an indicator of contamination from the landfill.

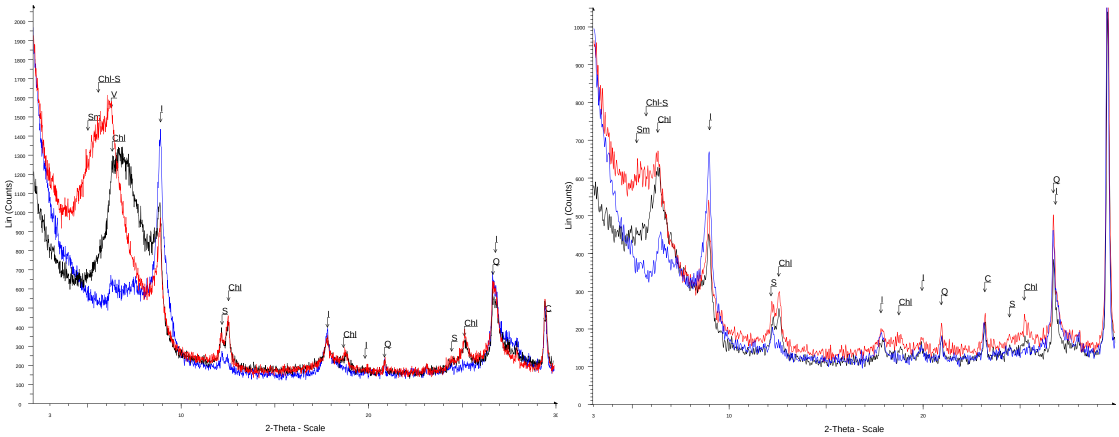

Figure 1. X-Ray diffraction patterns of the <2 μm fraction of the samples. Sm: smectite, Chl: chlorite, I: illite, S: serpentine, Chl-S: mixed layer chlorite-smectite, Q: quartz, C: calcite.

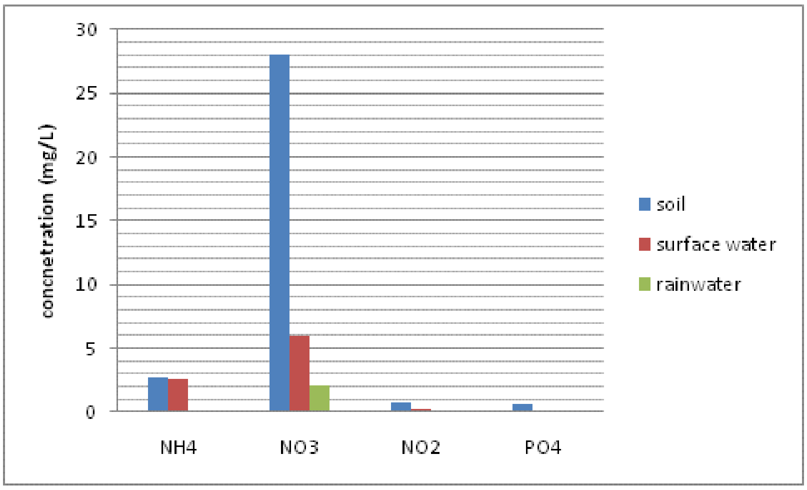

Figure 2. Mean chemical composition of soil extractions, surface runoff water and rainwater in mg/L.

Conclusions

The environmental impact of the landfill in the downstream area was evaluated. The mineralogical composition of the samples collected from the landfill site revealed the presence of abundant clay minerals (i.e. smectite) which are widely used as natural clay barriers in waste disposal sites. The mean chemical composition of the soil extractions and surface runoff waters show that stream sediments are becoming enriched in most of the analyzed physicochemical parameters. The concentrations of the aforementioned physicochemical parameters in the soil samples exceeded the average permissible concentrations and are considered as human induced contamination from the landfill.

Acknowledgements

This research was funded by the University of Patras through the 'K. Karatheodoris' basic research funding scheme.

References

Koutsopoulou, E., Papoulis, D., Tsolis-Katagas, P., and Kornaros, M., 2010. Clay minerals used in sanitary landfills for the retention of organic and inorganic pollutants. Applied Clay Science 49, 372-382.

Koutsopoulou, E., Katsanou, K., Papoulis, D., Zagana, E., Tsolis-Katagas, P., 2013. Environmental assessment of contaminants in a downstream area of a landfill, Bulletin of the Geological Society of Greece, 47, 972-980.

Lambert, J.F., 2018. Organic Pollutant adsorption on clay minerals, in: Schoonheydt, R., Johnston, C.T., Bergaya, F., (Eds.), Surface and Interface Chemistry of Clay Minerals, Developments in Clay Science, vol. 9, 195-244.

Pansu, M., Gautheyrou, J., 2006. Handbook of Soil Analysis. Mineralogical, Organic and Inorganic Methods. Springer-Verlag, Berlin, Heidelberg. 995 pp.

USDA, National Soil Survey Handbook, 2011. United States Department of Agriculture, Part 618, Soil Properties and Qualities.