Forensic investigation of contaminated groundwater combining multivariate statistical techniques and screening analyses

SUTLIFF-JOHANSSON, S*., PONTÉR, S., WIDERLUND, A., MÄKI, A., ENGSTRÖM, E., PELTOLA, P.

Division of Geosciences and Environmental Engineering Luleå University of Technology SE-971 87 Luleå, Sweden [*Stacy.Sutliff-Johansson@LTU.se]

Heavy metal contamination was identified in groundwater monitoring wells surrounding a waste deposit facility at the Rönnskär sulfide ore smelter in northern Sweden. Locating sources of contamination in the environment is often difficult when groundwater quality is controlled by both natural and anthropogenic factors, which may not be easily distinguished from one another. This study explores the use of environmental forensics as a tool to identify sources of contamination, utilizing element screening analyses and multivariate statistical techniques such as principal component analyses.

Water samples were taken from four groundwater monitoring wells and six waste deposit cells surrounding the contaminated area. Seventy-two elements were statistically examined, and the dataset was reduced to the variables representative of the leaking contaminant. A three-component model is identified and explains 87.7% of the total variation in the dataset. The concluded results indicate a correlation between Cd, Co, Ni, Rb, Re, and Zn. These elements displayed a high association with two of the deposit cells and their subsequent groundwater monitoring wells. These results were supported by Zn isotope data. However, the principal component analyses performed as well as the Zn isotopes were unable to distinguish a difference between the two cells and further investigation is suggested. A similarity in variability was also found between Sb, Mo, and Cu. These elements showed a correlation between all monitoring wells and deposit cells, likely due to their high mobility as oxyanions (Sb, Mo) or organic complexes (Cu) in a high pH environment. Arsenic displayed correlation to the three oldest deposit cells in the investigated area as well as the nearby groundwater monitoring well. The application of screening analyses and multivariate statistics in this study provided a better overview of the investigated area and has achieved a meaningful identification of sources of contamination.