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## **A multi-faceted approach to mine water source determination in South Africa. A review**

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Local and international publications dealing with mine water source apportionment were reviewed in the present work, with a focus on methods and results [1, 2, 3]. The main goal of this analysis is to provide an overview of the most commonly used source apportionment methods, their comparability and results, and to evaluate current trends and identify possible gaps of the methods and future research directions. The approach outlined for the study involved an integrated methodology that can be tested through case studies. Traditionally, an end of pipe (i.e. at the mine discharge point) treatment strategy has been employed to treat acid mine drainage (AMD) prior to mixing with local surface waters. A more recent approach to controlling AMD involves developing targeted remediation strategies that address the feasibility of actually reducing or shutting off the AMD at its source. Thus, there is an additional need to define hydrologic connectivity between surface water, groundwater and mine workings in a particular area, to understand the source of both water and contaminants in the drainage tunnel discharge. This review describes the use and application of stable isotope analysis of O<sub>18</sub> and H<sub>2</sub>, geochemical modelling, multivariate statistics and natural and applied tracers to guide targeted remediation efforts in AMD systems. In addition, a case study is presented that shows how these techniques can scientifically quantify environmental risks associated with existing and historical mining activities, identify the parties whose activities are responsible for impairment of water resources, and to translate these in terms of responsible parties' respective contributions according to the "polluter pays" principle.

### *References:*

- [1] Nijenhuis I et al. (2013) A stable isotope approach for source apportionment of chlorinated ethane plumes at a complex multi-contamination events urban site. *Journal of Contaminant Hydrology* 153 92-105
- [2] Cowie R et al. (2014) Use of Natural and Applied Tracers to Guide Targeted Remediation Efforts in an Acid Mine Drainage System, Colorado Rockies, USA. *Water* 6 745-777
- [3] Haiyang C et al. (2016) Source apportionment of trace metals in river sediments: A comparison of three methods. *Environmental Pollution* 211 28-37

