Chemosphere

Aluminium (Al) fractionation and speciation; getting closer to describing the factors influencing Al^{3+} in water impacted by acid mine drainage

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Abstract

Acid mine drainage (AMD) severely impacts the water chemistry of a receiving resource, changing the occurrence, speciation and toxicity of metals such as Aluminium (Al). The toxicity of Al is determined by its speciation represented by the labile monomer Al fraction or Al3+. The purpose of the study was to combine fractionation and Visual MINTEQ speciation to calculate the effect of AMD altered water chemistry on Al speciation and Al3+ concentration. Water in rivers impacted by AMD presented with monomeric Al (Almon) concentrations between 0.35 and 15.37 mg L□1 which existed almost exclusively in the toxic labile form (98%). For the reference site, Almon was less than 2% (10 lg L□1), suggesting significantly lower Al toxicity. Principal component analysis plots illustrated that labile Al was directly related to the total Al and iron concentrations and strongly influenced by parameters such as pH, electrical conductivity, sulphate and dissolved organic carbon. Visual MINTEQ modelling was used to determine the primary Al species distribution. The dominant form of Al in AMD impacted water was AlSO4 + , which increased proportionally with the sulphate and Al3+ concentration. Heavily impacted areas, presented with an average of 1 mg mL□1 Al3+, which poses a potential human health risk. A novel centrifugal ultrafiltration method was investigated as an alternative to determining Almon to simplify the speciation of Al. Monomeric and centrifugal ultrafiltrated (<10 kD) Al fractions were significantly similar (p = 0.74), suggesting that ultrafiltration may present a time, energy and cost saving alternative to organic extraction of Almon.