Distance impacts toxic metals pollution in mining affected river sediments

ABSTRACT

The study of metals mobility derived from mining activities in an ultramafic lithology is limited. This study investigates the effects of distance on potentially toxic metals such as Co, Cu, Fe, Mn, Ni, Pb, and Zn pollution, and the geochemical processes of fluvial system downstream of an ex-copper mine (Mamut River). The toxicity level of the river was evaluated using various sediment quality guidelines, ecotoxicological risks (ecological risk and risk index) and pollution indices. The geochemical behavior and stability of these toxic metals in the solid-phase samples were also examined. The results show that elevated concentrations of Ni, Cu, and Fe in the sediments can be linked to the adsorption and precipitation of metals from the aqueous-phase samples. We found that the metal scavenging rate as a function of distance is more evident in tropical environments than it was previously thought (10 km downstream). Such an inference could be explained by the greater amount of rainfall (pH 5.5–6.5) received in the tropics and higher weathering products that could react and form stable complexes. Geochemical analysis of the river sediment indicates that Ni, Cu, and Fe in the river sediment have increased 44-, 81-, and 90-fold compared to the background values, respectively. A significant decrease in the concentration of the potentially toxic metals was found at 5.5 km downstream. The scavenging rate of Fe is the highest (1485.82 $\mu g\ g^{-1}\ km^{-1}$) followed by Cu (141.48 $\mu g\ g^{-1}\ km^{-1}$), Ni (10.23 $\mu g\ g^{-1}\ km^{-1}$), Pb (8.12 $\mu g\ g^{-1}\ km^{-1}$) and Zn (5.01 $\mu g\ g^{-1}\ km^{-1}$) in the tropical river system. In contrast, the concentration of Co and Mn in the river sediments doubled as the river flows approximately 5 km downstream due to the higher mineral solubility and weaker metal partition coefficient. This study also discusses the possibility of asbestos (mainly as chrysotile in the X-ray diffraction) as a potential hidden risk present within the ultramafic setting. This case study can be extrapolated to explain the dispersion of inorganic pollutants in an ultramafic environment in a global context.