Kinetics and mechanisms of metal release from wastes of a historic copper mine – Kuvarshan, Northeastern Turkey

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The study area located in the Eastern Pontide Metallogenic Belt hosts many active and abondoned Volcanogenic Massive Sulfide (VMS) deposits. Mine wastes and acidic drainages from these abondoned mines put serious threat on the environmental health. This study focuses on determining the kinetics and mechanisms of metal release from wastes of an abondoned mine (Kuvarshan, Artvin), which was not in operation since 1945. Chemical and mineralogical characterization of the mine wastes were performed through XRF, XRD analyses and examination of polished sections, respectively. The rates of metal release were determined from humidity cell tests which lasted for a year. Leachates sampled weekly from the humidity cells were monitored for pH, electrical conductivity, ORP, alkalinity/acidity, sulfate, and metal contents.

Sulfide minerals (1-2 μm to 2 mm) in the wastes is composed of mainly disseminated pyrite and minor amounts of chalcosite and sphalerite. Other minerals include quartz, jarosite, gypsum, kaolinite, hematite, and goethite. Leachates obtained from the wastes showed strongly acidic character with a pH value ranging from 1.4 to 3 throughout the tests. Sulphate concentrations in the leachates was significant and mostly around 2-3 g/L. Rate of sulphate release was initally fast (10-15 g/kg/week), then slowed down to a rate of around 1 g/kg/week and later showed a increase trend. The amount of metal release in the leachate was also significant with decreasing order of Fe, Al, As, Cu, Zn, and Mn. Furthermore, metal releases from the mine wastes exhibited similar behavior. Initally fast rate of metal release indicated the adsorption of metals to the easily exchangable sites. Later decrease in the rate of metal release was controlled by the rate-limited desorption process. During the humidity cell tests, drop in the rate of metal release was followed by an increase trend at the later times. The increase in rate of sulphate and iron release along with a decrease in leachate pH indicated the initiation of pyrite oxidation in the mine wastes during the test.