

MINE-WATER POLLUTION OF AN HYDROLOGICAL SYSTEM DOWNWARD A FORMER METALLIC MINE

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Mine-water pollution is a wide problem, very often studied because it is generally associated with acid sulfate waters (ASW), contamination due to dissolved pollutants (As, S, Zn, Pb...) in surface and groundwaters, to the precipitation of these potentially toxic elements in stream sediments... (Schwertmann et al., 1995; Bigham et al., 1996).

In an abandoned mine of tungsten in the French Massif Central, an As-Fe bearing ore was extracted and the resulting tailings were spread out on a steep slope. These mine wastes are weathered by different runoff drainage waters issued from the former galleries and others natural streams. The leaching of the sulfides contained in the tailings released elements such as As, S and Fe. The only remediation of this site was realized in 1997 and has consisted in collected all the waters in one dewatering point, downward the tailings.

The hydrological system is 2 km long and can be simplified as follows: a rill issued from the drainage of the mine's tailings flows into the gallery outlet runoff (mine water discharge). The rill and gallery waters form a small stream which flows into an unpolluted local stream (Crozafon stream). Finally, these mixed waters flow into the main local river, the Lot. Currently, waters from the gallery outlet to the River Lot are characterized by low pH (from 2.7 to 3.7) and oxydant Eh (Eh ~ 500 mV). The water discharges range from 2.5 m³ s⁻¹ for the waters issued from gallery outlet to 33 m³ s⁻¹ for waters after the confluence with the Crozafon stream, whereas the Lot River annual discharge is around 96.3 m³ s⁻¹. These waters are charged in dissolved species, especially in Fe and As for which concentrations vary from upstream to downstream (e.g Fe ~ 219 to 5 mg.L⁻¹ and e.g. As ~ 0.2 to values less than 0.007 mg.L⁻¹) and precipitated as oxides when the Eh-pH conditions change. Furthermore, due to high SO₄ concentrations, these waters can be consider as classical acid sulfate waters and generate an ochre deposit in the stream-bed mainly composed of iron oxyhydroxides precipitates (goethite, amorphous ferric hydroxide) and schwertmannite. This ochreous precipitate was observed all along the hydrological system until its confluence with River Lot. It contains As (As ~ 2200 mg.kg⁻¹ after the confluence of the mine waters dewatering point and runoff waters from the tailings; As ~ 1250 mg.kg⁻¹ elsewhere) which is mainly trapped in goethite and hydrous ferric oxide. In this way, dissolved Fe and As concentrations change with time and finally the impact on the main stream is relatively low due to successive dilutions and/or precipitations. However, there is a real acid As-pollution by this mine-water. A precise knowledge of the mineralogy of the ochreous precipitate is essential regarding solid-solution equilibria.

This first study needs further collaborations to undertake a hydrological geochemical steady in order to understand the processes that control the concentrations of arsenic both in the stream and bottom-sediments. This imply a fine determination of the physicochemical parameters of the different waters, a precise speciation of arsenic and iron in order to better constrain their affinity and a complement according to the mineralogical characterisation. Finally, a biological study will allow us to estimate the impact on the biosphere by low pH.

References :

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