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Hydrogeochemical Study of an Arsenic-Bearing Gold-Mine Site

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The results presented, which are a direct continuation of the work carried out by Roussel et al. (1997) and Roussel (1998), were obtained during 1998 and 1999 as part of the hydrogeochemical monitoring carried out at an ancient gold-mine dump at the Chéni site in the Massif Central.

During the 20th Century, the main Au production in this gold-bearing area generated 660,000 tons of ore-processing waste rich in arsenic and sulphide. The waste covers some 7.5 ha along the Isle River, including a 30-m-high heap and three settling basins separated by dams.

The waste consists mainly of quartz-mica silt (60 µm particle size) with traces of sulphides (pyrite, arsenopyrite). Arsenic is generated during arsenopyrite oxidation and released in acidic aqueous discharge that is rich in calcium and sulphate.

Water samples were collected in wells, lysimeters and piezometers throughout the site. Field measurements of pH, T C, Eh, conductivity and alkalinity (Gran method titration) were made before any sampling. The water samples for chemical analysis included filtered (0.1 µm) unacidified samples for anion analysis and filtered (0.1 µ) HNO3-acidifed samples for cation and trace element analysis. AsIII and AsV were separated in the field using an ion exchange method. In situ measurements of FeI) and sulphite were carried out by colorimetric spectroscopy using phenantroline and iodine reagents respectively.

The analytical results reveal contrasting waters with a large variation of pH, Eh and major elements. These results are in good agreement with the previous work of Roussel et al. (1997) and Roussel (1998). In addition, our data allow the values of the redox couple ratios (AsIII/AsV, FeII/FeIII, SIV/SVI) to be correlated with the observed pH and Eh variations. The pH and Eh values fall in the range of 3.2-7.6 and 0-800mV respectively, and the AsIII/AsV, FeII/FeIII and SO_3/SO_4 w/w ratios in the range of 0-12, 0-0.8, 0-1.2 respectively. These redox data, in the same volume, are discussed in Lassin and Azaroual (2000).

Reduced and highly mineralised waters, observed at the lower part of the heap, present the highest As contents (up to 120mg/l), corresponding to arsenite species. Water chemical compositions are time-stable during all the monitoring period. Multivariate analysis of chemical elements shows a good As-Fe correlation that reflects the As complexation within secondary iron-rich precipitates, by adsorption and co-precipitation processes.

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