Surface water pollution with heavy metals in Baia Mare mining basin

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1. Abstract

The Baia Mare mining basin is situated in the North West of Romania and encloses a large number of mining activities in all stages, from prospecting to mine closing and ecological reconstruction, with significant influence on the environment quality from the area. The mining activities generated huge amounts of wastes rich in heavy metals and cyanides that determined a chronic pollution of the area. The assessment of surface water pollution with heavy metals showed high heavy metal concentrations in the waters from the majority of the Somes river tributaries that along with the low pH of the waters indicate that some of the mining facilities from the area represent a pollution source for the surface waters.

2. Introduction

Mining and the related operations are the most important anthropogenic sources of heavy metals that negatively influence the nearby environment (Conesa et al., 2007; Vanderlinden et al., 2006; Vanek et al., 2005).

In Baia Mare area there was an intense nonferrous mining activity since ancient times, with mining operations such as ore processing, smelting and tailings disposal carried out near the exploitation area (Macklin et al., 2003; Bird et al., 2003).

Major non-ferrous metal deposits in the area contain copper, lead and zinc ores in the form of sulphides, pyrite and marcasite. Under aerobic conditions, the oxidation of sulphides generate acid mine drainage, which is a major source of chronic environmental pollution from tailings and mine wastes. Due to the low pH of these waters, heavy metals such as copper, zinc, cadmium, arsenic and lead, can be leached from the rock and mobilized, causing severe, long term contamination of surface and ground water, soil and vegetation. Aside from the problem of acid mine drainage, typical at old mine sites and tailings deposits, waste water discharges from current mining and ore processing activities are also of concern due to the facts that huge volumes of waste water containing heavy metals are continuously discharged into the local water system without adequate treatment, and thus with severe consequences to the local and downstream ecosystems (Burnod-Requia, 2004; Kraft et al., 2006)

The objective of this study was to evaluate the surface water pollution with Cu, Pb, Zn and Cd in the Somes direct and indirect tributaries from Baia Mare mining basin: Lapus, Cavnic, and Sasar.

3. Methods

In November 2006, 23 surface water samples were collected along Lapus river and their main tributaries affected by mining activities: Cavnic and Sasar. The map of the area and the position of the sampling points are presented in figure 1. On site, the water samples were filtered through 0.45 µm pore-diameter cellulose nitrate membrane filter, acidulated with 2 ml ultrapure grade 65 % nitric acid (Merck, Germany) and stored at 4 C^{o} until analysis. Copper, Pb, Zn and Cd concentrations were measured using inductively coupled plasma optical emission spectrometry (ICP-OES) by the scanning spectrometer SPECTROFLAME (Spectro Analytical Instruments, Kleve, Germany). Samples with concentrations below detection limits of ICP-OES were analyzed by inductively coupled plasma mass spectrometry, with ELAN DRC II (Perkin Elmer, SUA) instrument. The pH value was measured with a portable WTW MultiLine P4 Universal Pocket Meter (WTW Germany) at the sampling site.

4. Results and Discussions

The pH values along the 3 studied watercourses are presented in figure 2, the confluence of the Cavnic and Sasar rivers are marked). In the Lapus river the pH values ranged between 3.23 and 7.65 and were acidic in the first part of the river, especially in sampling point 1 and 3 from Lapus River due to the proximity with the Varatec and Brainer mines and the flotation station. The two most acid waters from the river had also the highest metal

concentrations. The higher pH values in sample 2 can be explained by the fact that the sample was taken upstream of Brainer mine. The pH of water samples collected in Cavnic and Sasar rivers ranged between 6.85 - 7.45 and 6.93 – 7.85 respectively and have no significant influence on the pH value of the Lapus river downstream of their confluence.

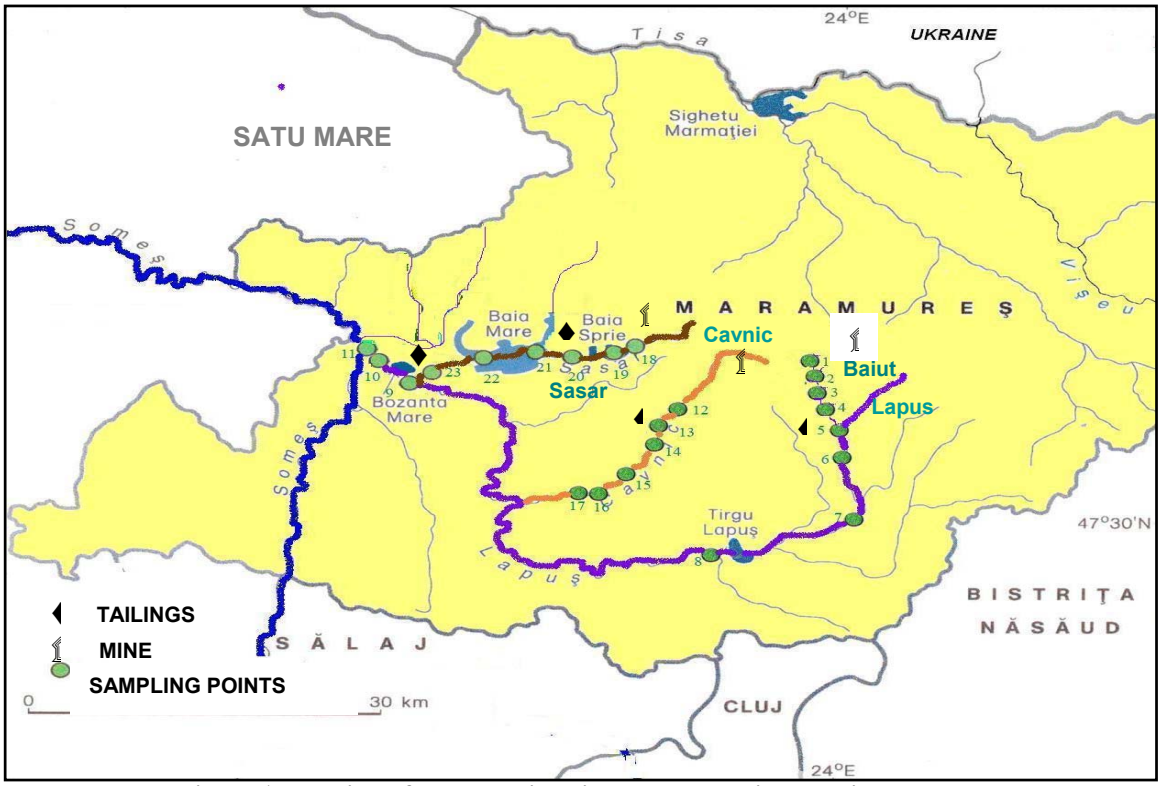

Figure 1 Location of the sampling sites and the main pollution sources.

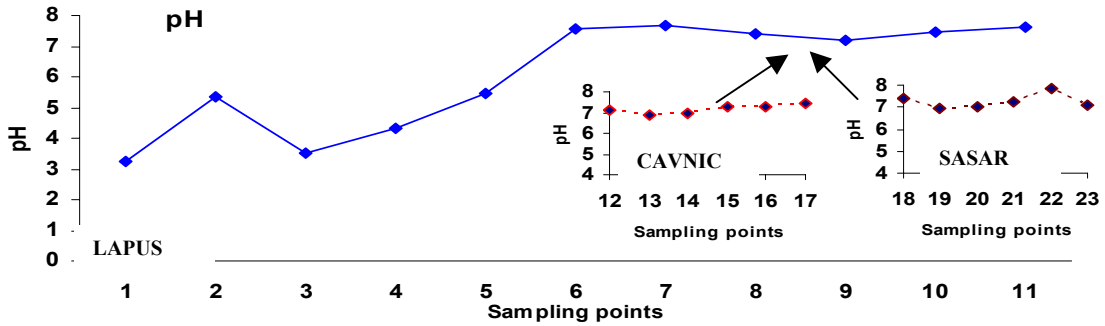

Figure 2 The variation of the pH value along the studied watercourses.

The Cu, Pb, Zn and Cd concentrations along the studied watercourses are presented in figure 3, 4, 5 and 6. In the first part of the Lapus river (sampling points 1-3) all analyzed metals were found in high concentrations due to mining and ore processing activities from the area: sample 1 was sampled downstream of Varatec mine, sample 2 upstream of Brainer mine, sample 3 downstream of Brainer mine and the flotation station. In both Cavnic and Sasar river metals concentrations generally decreased from upstream to downstream.

In Lapus river a decreasing of Cu and Pb concentrations was observed from upstream to downstream. In the Cavnic river high concentrations of Cu were observed in sampling point 13, situated downstream of a pyrite deposit and point 14 situated near Piatra Soimului tailing pond were high concentrations of Pb were also determined. In the Sasar river both the Cu and Pb concentrations were low, ranging between 5-21 and 3-25 µg/l, respectively. The

concentrations of these metals from Cavic and Sasar rivers have no significant influence on the Cu and Pb concentration downstream of the confluence with the Lapus river.

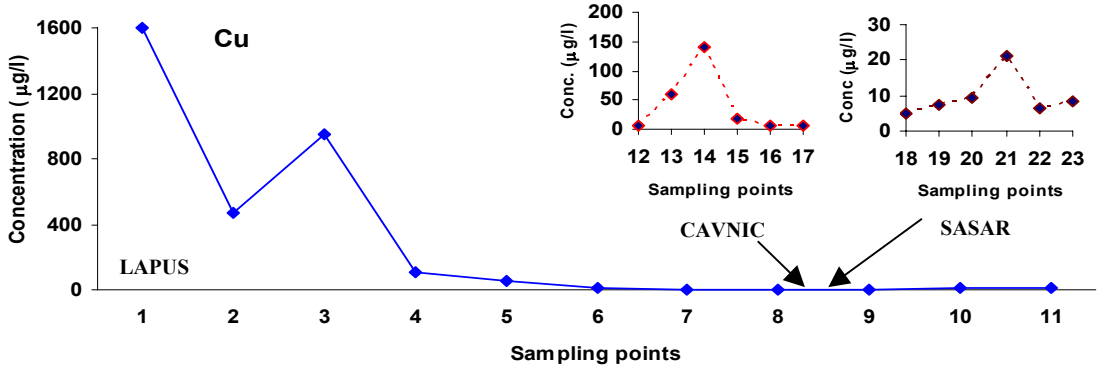

Figure 3 The variation of the Cu concentration along the studied watercourses.

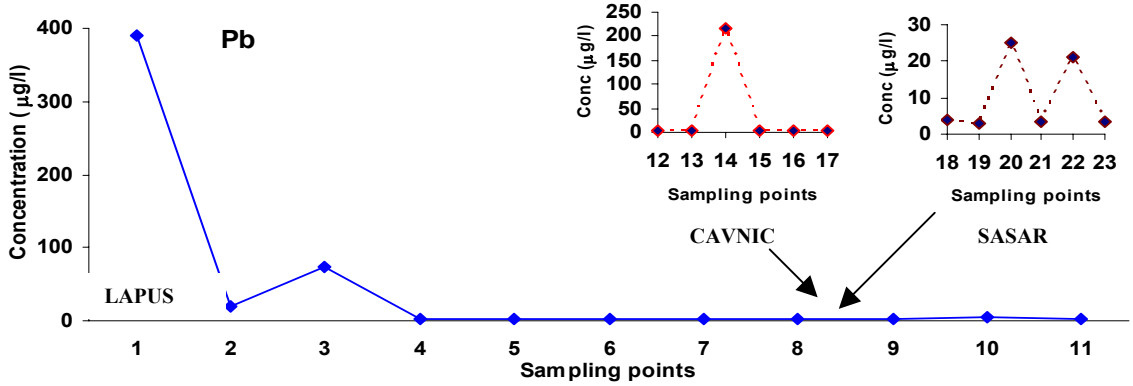

Figure 4 The variation of the Pb concentration along the studied watercourses.

Very high concentrations of Zn were found in the majority of the samples. In case of Lapus River the Zn concentrations ranged between 49000-750 µg/l, with very high concentrations in the first four sampling points situated in the vicinity of the mines. After sampling point 4 a decrease of Zn concentration was observed until sampling point 8 situated before the confluence with Cavnic and Sasar rivers, followed by an increase in point 9 and then by a decrease, due to the dilution effects. High concentrations of Zn (10200-33900 µg/l) were found also along Cavnic river, except for sample 12 were 360 µg/l was found. In Sasar river Zn was in the range of 850-19200 µg/l. Both in Cavnic and Sasar rivers a decreasing trend upstream of the pollution sources was observed.

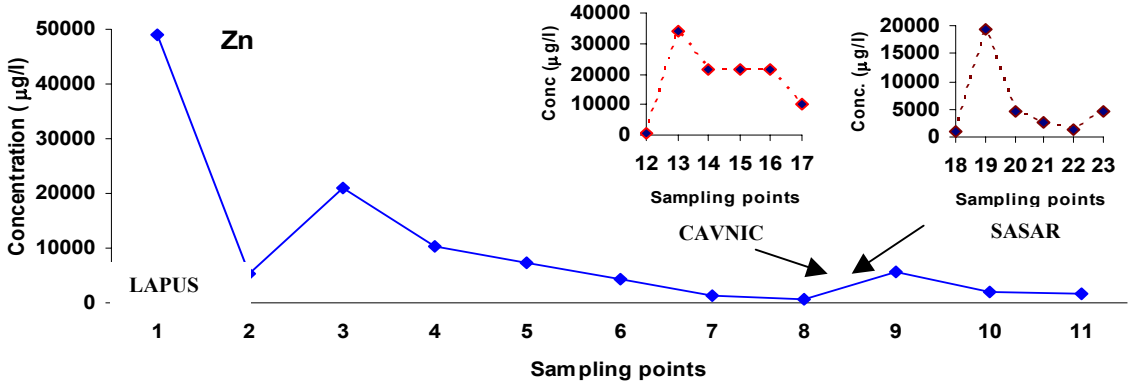

Figure 5 The variation of the Zn concentration along the studied watercourses.

In case of Cd a decreasing trend from upstream to downstream was observed in Lapus river with concentrations ranging between 1.8-149 µg/l. After the confluence of Cavnic and Sasar with Lapus river (sampling point 8) an increase of the Cd concentration was observed. In Cavnic and Sasar rivers the Cd concentrations ranged between 2.2-83 µg/l and 1.6-18 µg/l, respectively. In both rivers the concentration decrease from the upstream to downstream except from point 12 respectively point 18 situated upstream of pollution sources.

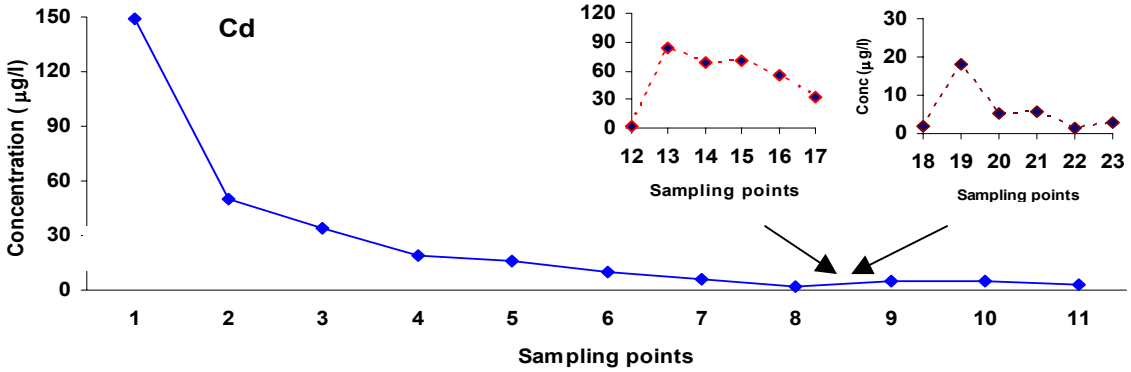

Figure 6 The variation of the Cd concentration along the studied watercourses.

The tributaries of Somes from Baia Mare mining basin are polluted with Zn and Cd from upstream to downstream and with Cu and Pb in some segments, situated under the influence of active or closed mine, tailing deposits or ore processing facilities. The upper part of Lapus was found to be the most polluted watercourse, followed by Cavnic and Sasar. In case of these metals the contribution of polluted waters from Cavnic and Sasar rivers on the concentration of these metals in Lapus river is significantly reduced due to the fact that Lapus river has a higher flow rate than Cavnic and Sasar.

The obtained results shoved that despite the facts that the mining activities were reduced in the area, the improperly closed mines and poorly managed tailing deposits still generate a significant heavy metal pollution of surface waters in the area.

6. References

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