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IMPACT OF METALS ON THE ENVIRONMENT DUE TO TECHNICAL ACCIDENT AT AURUL BAIA MARE, ROMANIA

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Abstract. The S.C. Aurul S.A. is a joint venture company owned by the Esmeralda from Australia and the "Remin" National Company of Precious and Non-ferrous Metals in Romania, established in 1992. The design concept was to transport the mining waste away from the city, while the gold and silver in the tailings could be recovered, using efficient and modern technology that was not available at the time the dam was established.
On 30 January, 2000, at 22.00, the dam burst and released 100,000 cubic meters of tailing pulp, heavily contaminated with cyanide and cyanide complexes, especially with copper, into the Lapus and Somes tributaries of the river Tisa.
The paper deals with the impact of metals on the environment associated with their presence in surface waters, river sediments and soils.

Key words:
Mining waste, Tailing pulp, Cyanide and cyanide complexes, Heavy metals, Safety improvement

INTRODUCTION

The S.C. Aurul S.A. is a joint venture company owned by the Esmeralda from Australia and the "Remin" National Company of Precious and Non-ferrous Metals in Romania, established in 1992. The design concept was to transport the mining waste away from the city, while the gold and silver in the tailings could be recovered, using an efficient and modern technology that was not available at the time the dam was established.

In 1993, the plant was granted an environmental agreement by the Ministry of Waters, Forests and Environmental Protection. In 1997, after receiving the Site Construction permit from the Maramures County Council, the construction of the plant commenced. The plant started its operation in April 1999 by processing a 30-year-old dam located in the neighbourhood, in the west side of the city, close to the residential area. Over 7 years, further permits were received before the final Environmental Operating Permit. These covered Water Management System Permit, Public Health Permit, Consent of the Local Council where the new dam is located, Safety in Construction Permit, in all, more than 200 permits. Granting the Environmental Operating Permit (December 1999), was preceded by a public discussion.

The S.C. Aurul S.A. Baia Mare obtains gold and silver from old mine tailings, using the carbon in pulp (CIP) process, a modern technology applied for the first time in Romania. The tailings from the old Meda pond are pumped with water to the Aurul plant, where the extraction of precious metals with cyanide solutions takes place

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[1]. After removal of precious metals, the tailings are pumped through a pipeline into a 93 ha plastic lined dam, located near Bozanta village, 6.5 km away from the plant. The Aurul dam is located in the neighbourhood of other two dams, owned by the Remin Company. The decant water from the pond is reused in the extraction process, after bringing the cyanide concentration to the required level, providing a totally closed water circuit with "zero discharge". For the wall of the dam, the concept of the "construction by operation" was chosen.

On 30 January, 2000, at 22.00, the dam burst and released 100,000 cubic meters of tailing pulp, heavily contaminated with cyanide and cyanide complexes, mostly with copper, into the Lapus and Somes tributaries of the river Tisa. The dam overflowed and washed away a stretch around 25 meters long and 2.5 meters deep. The Aurul plant stopped operations and the central and local authorities were notified. Sediments from a nearby tailing dam were used to seal the breach. A controlled discharge of 40–50 l/s continued to leak from the dam. This discharge was neutralised with sodium hypochlorite until the breach could be completely sealed. The "Remin" National Mining Company started the intake of the remaining water into its active dam located close to the Aurul dam.

The EPA Baia Mare established the County Commission for the Defence against Disasters under the coordination

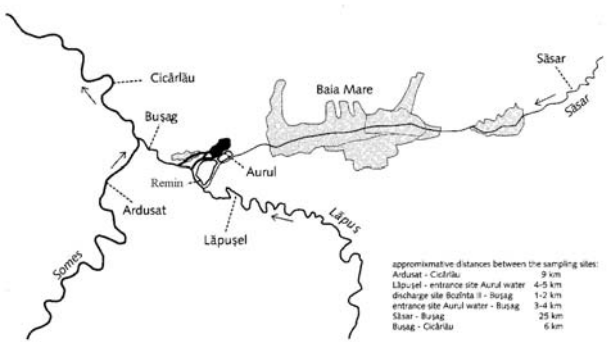

Fig. 1. Sampling map (the Sasar, Lapus and Somes rivers).

of the Prefect of the Maramures County. The water authorities started to monitor the water in the Lapus and Somes rivers. The authorities in Hungary and other downstream countries were notified, according to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

The preliminary conclusions drawn after the visits of the Task Force and other international missions in Baia Mare emphasized two major causes of the accident. First, the sudden temperature rise, which caused the snow melting, and second, the rain falls at the end of January, resulting in a dramatic raise of the water level in the pond. In addition, the recommendation of the project designer concerning the ratio between the fine and the coarse solid particles in the material used for the construction of the starting embankments was not precisely followed.

Table 1. Heavy metals in the Sasar, Lapus and Somes rivers

River	Sampling site	Period	As	Zn	Cu	Pb	Cd	Fe	Mn
			mg/l						
The Sasar	Baia Mare	1992	0.40	2.8	1.7	0.92	0.02	14.8	3.7
The Lapus	Busag	1992	0.42	3.4	2.2	0.38	0.02	14.0	2.1
		1998	-	0.42	0.05	-	-	-	-
		1999	-	0.56	0.06	-	-	-	-
The Somes	Ulmeni	1992	0.00	0.04	0.02	0.02	0.00	1.10	0.27
	Cicarlau	1992	0.36	1.5	1.6	0.32	0.01	7.30	1.2
		1998	-	0.15	0.05	-	-	-	-
		1999	-	0.42	0.03	-	-	-	-
		20.01.2000	-	0.20	0.20	0.00	-	0.33	0.44
	Satu Mare	1992	0.13	1.0	0.56	0.12	0.00	6.03	2.0
Romanian regulations			0.01	0.03	0.05	0.05	0.003	1.00	0.80
EU Standards			0.01	-	2.00	0.01	0.005	-	0.05

This study deals with the impact of metals on the environment associated with their presence in surface waters, river sediments and soils.

MONITORING DATA AND OBSERVATIONS

The "Apele Romane" Company routine monitoring supplied data used for this study. The data generated by the teams of international experts who carried out scientific observations on the site after the accident were also used. The sampling points are shown in Fig. 1.

Surface water

Background conditions. The background data for heavy metals in the Sasar, Lapus and Somes rivers are summarized in Table 1 [2].

As one can see, there is a chronic pollution, inputs include mainly industrial effluents. The metal content shows a downward trend probably due to the decreasing industrial activity over the recent years.

At the time of the accident. The heavy metals contents in the Somes river at Cicarlau are plotted in Fig. 2, and compared to the Romanian regulations and the European Union (EU) standards [2].

Figure 2 shows that at Cicarlau the peak concentrations of Cu, Zn, Pb and Mn were 10.5 mg/l, 0.419 mg/l, 0.16 mg/l and 0.437 mg/l, respectively. It should be noted that the peak concentrations of the various heavy metals were recorded at different dates. According to the 1998 EU standards, the content of Zn, Pb and Mn exceeded the limits, while the concentration of Cu, mostly related with the Aurul accident, met the standard value, two days after the accident.

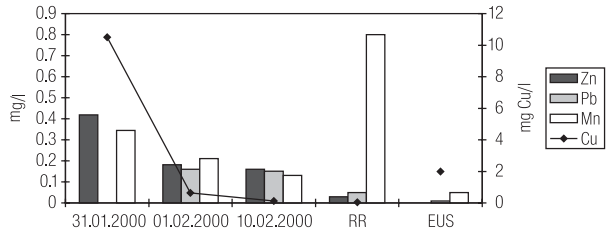

Fig. 2. Concentrations of heavy metals in the Somes river at Cicarlau.

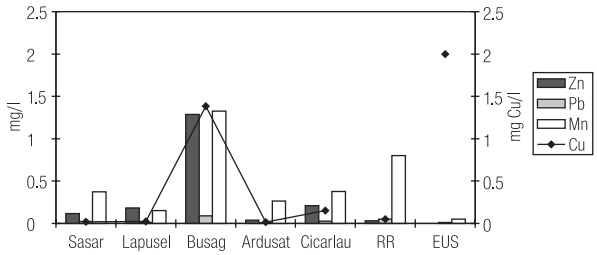

Fig. 3. Concentrations of heavy metals in the Sasar, Lapus and Somes rivers.

One month after the accident. Figure 3 shows the concentrations of heavy metals in the Sasar, Lapus and Somes rivers (sampling points are given in Fig. 1), compared to the Romanian regulations and the EU standards [3].

Figure 3 demonstrates that the water quality of the Somes is strongly influenced by the influx from the Lapus. With regard to iron (Fe), its concentrations at Cicarlau are slightly below those at Ardusat. Concentrations of other metals at Cicarlau are much higher than those at Ardusat. This increase can be fully explained by the inlux from the Lapus that is crossing the mining dams area, including the Aurul pond. In order to better understand the effect on the Lapus river quality, wastewater samples from the Bozanta Remin and Aurul ponds were also analyzed. The results are shown in Table 2 [3].

Sediments

At the same river sites where water was sampled, sediment samples were taken from spots providing fine sediments, one month after the accident at Aurul Company [3]. The background data for sediment composition were not available, so analyses for heavy metal contents in sediment were not performed.

Figure 4. shows the contents of heavy metals in the sediments from the Lapus and Somes rivers, expressed at 4% Fe content. The values are compared with the natural

Table 2. Heavy metal contents in wastewater from the Bozanta Remin and Aurul ponds

	Zn	Pb	Fe	Mn	Cu
	mg/l				
Bozanta Remin pond wastewater	0.406	0.008	0	2.07	17.51
Aurul pond wastewater	0.991	0.005	0.01	1.142	31.7

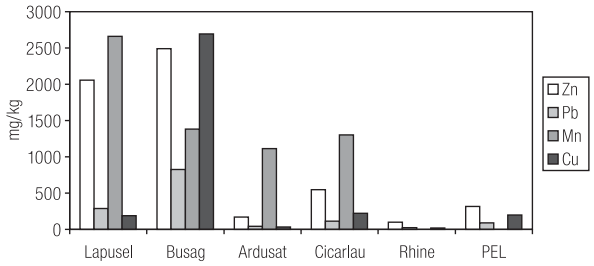

Fig. 4. Heavy metal contents of the sediments from the Lapus and Somes rivers.

background for suspended matter of the Rhine [3] and the limit values for heavy metals laid down in the Canadian sediment quality guidelines. The Canadian guidelines define so called probable effect levels (PELs) for some heavy metals [2].

According to the values of Zn, Pb and Cu concentrations it may be concluded that the Somes river is not seriously contaminated at Ardusat. The sediment at Cicarlau is obviously contaminated to a higher extent with these metals. This indicates that there is a serious source of heavy metal contamination of the Somes river between Ardusat and Cicarlau. This source is undoubtedly the Lapus river that is crossing the mining dams area and whose sediment at Busag is also highly contaminated. The pollution was increased by the movement and settling of the solid particles from the tailings as a consequence of the accident. The analysis of the water samples confirmed the contamination of the Lapus river (Fig. 3).

Soil

The heavy metal analyses of the soil samples taken from the flooded area between the Aurul dam and the Lapus river (8 samples) are summarized in Fig. 5, and compared

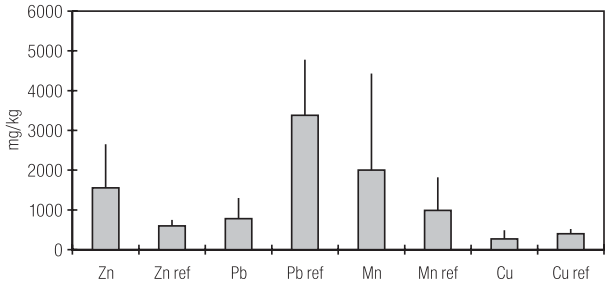

Fig. 5. Concentrations of heavy metals in soil samples from flooded area (maximum and average values).

with the samples taken from the field not affected by the spill (4 samples) [3]. The data confirm a high background contamination in the Baia Mare area and in the neighbourhood of the Aurul dam, however the accident cannot be found responsible for this contamination.

CONCLUSIONS

1. The Lapus river at Busag is highly contaminated with heavy metals as appears from the water and sediment analyses. According to the analyses performed before and after the accident the origin of the high heavy metal concentrations in the Lapus at Busag and consequently, to some extent in the Somes at Cicarlau, cannot be related to the accident. Possible sources are the regular disposal by the mining industry, the influx from the Sasar and other industrial wastewater discharges. The presence of heavy metals in the water and soil samples may also be attributed to the occurrence of sulphide ores in the land. The basin that the Sasar is crossing contains substantial amounts of Cu, Zn, and Pb-bearing ores. Natural oxidation of sulphides results in high metal concentrations in surface waters and soils [4]. This process is intensified by the mining industry, especially by the bioleaching of tailing heaps.

2. The heavy metal contents in the soil samples were high in both the area affected by the accident and in the reference samples, confirming the presence of high background contamination in the Baia Mare area and in the neighbourhood of the Aurul dam.

3. In July 2000, the Aurul Company restarted operations at low capacity in order to improve the safety of the dam. The relevant authorities required some other works for the protection of the environment (emergency pond and the construction of cleaning station). New environmental impact assessment and risk assessment studies will be submitted and a public discussion will be held. As a result of these measures, the EPA Baia Mare will decide to grant or not the Aurul Company the Environmental Operating Permit.

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