WATER QUALITY MONITORING RESULTS AT BAIA DE ARIEŞ UNDERGROUND CLOSED MINE

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As a result of reduced mining activity in Romania, it was decided Baia de Aries mine closure due to inefficient economic weight. The works involve demolition of existing buildings, decontamination of soils, the setling ponds and sterile dumps rehabilitation. This paper presents these closure workings effects on waters quality.

Introduction

The objective of the mining industry is located in Baia de Aries Baia de Aries, Alba County, 24 km from the city Câmpeni and 60 km from Turda. The objective is bordered to the north of Aries River, south of the upper basin of the Poienița Valley, Sasha Valley west and east of Ciorii Valley.

Mining exploration in Baia de Aries deposit ceased in accordance with art. 51 art. C of the Mining Law no. 85/2003 because business became unprofitable and closed completely according to art. 1d from order 116/166725/1998. The Government Decision no. 1.846/28.10.2004 conservation and closure of mines and quarries are approved permanent closure of the perimeter of Baia de Aries.

Categories of waters in the mining area Baia de Aries, whose quality will be monitored are:

Table 1. Categories of waters in the mining area Baia de Aries

1.	Mine water pumped from mining works (galleries):	Pacea Gallery (duct) (A1) Noroc Nesperat Gallery (A37) Buturoasa Gallery (A38) Binecuvantarea Domnului Gallery (A39) Mihai I Gallery (A40)
	Water from ponds and industrial premises [water from the reverse well, water seepage, water discharged from the pond into the environment (water pumped from wells inverse system, water channel guard)]	Cuții Valley setling ponds(A2, A3) Sartăș Valley setling ponds (A4, A5, A8,) Brazești Valley setling ponds (A9, A10, A11) water collection channel Pacea) (A42)
	Input water Sartas Valley sewage treatment station Discharge water Sartas Valley sewage treatment station – purified water discharged (river Aries)	Sartas Valley sewage treatment station input (A6) output (A7)
2.	Emissaries waters § emissaries that flow under ponds; § receptors emissaries of mine water § water from steril ponds	Cuții Valley river (A12, A13, A16) Sartăș Valley river (A14, A15, A46) Hărmăneasa Valley river (A17, A18) Arieș river (A19, A20, A21, A22, A43, A44). Ambrului Valley river (A23, A24)

1. Technologic waters mine

1.1. Waters discharged from the mine works

The quality of mine water discharged from the mine works before starting the closure of the mine are presented in Table 2.

Table 2. The quality of mine water discharged from the mine works before the mine closure works

Sample	Ph	Sulphates	Fe	Zn	Cu	Mn	Pb	cyanides	Cd
	pH Unit	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A01	7,38	1650	0,054	0,52	3,58	12,5	1,35	<0,005	<0,02
A38	8	239	0,015	0,62	2,37	0,2	0,19	<0,005	<0,002
A39	7,32	3,62	0,177	0,02	1,91	1,22	0,43	<0,005	<0,002

In these waters, the contamination comes from acid leaching of sulfide minerals in the rocks traversed by the existing mine workings. The water chemistry, sulphate ion because of the high and very low iron and pH neutral, it can be concluded that these waters are formed from a mixture of acidic water with high natural alkalinity waters. Because of this, iron ions precipitate, leaving only heavy metal ions in water with amphoteric character. It should be noted that Mn ion concentration shows high values reported in neutral pH water. Also, to explain the high ratio Mn / Fe, and the existence of other heavy metals, it is necessary to known and potential acid generating rock from the perimeter leakage taken into account. Also, concentrations of Cu and Pb ions have high values for the existing water chemistry

The quality of mine water discharged from the mine works after closure of the mine are presented in Table 3.

Table 3. The quality of mine water discharged from the mine works after closure works

	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd	As
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A01	7,52	1315	12,4	1,55	0,192	10,1	0,017	<0,002	0,006	0,218
A38	8,04	246	0,192	0,29	0,103	0,03	0,008	<0,002	0,001	0,005
A39	7,78	687	0,189	0,221	0,129	0,022	0,015	<0,002	<0,001	0,011

1.2. Water from the ponds and the industrial site

The quality of mine water from the ponds and the industrial site before starting the closure of the mine are presented in Table 4.

Table 4. The quality of water from the ponds and the industrial site before the mine closure works

	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A02	6,85	59,1	0,1481	< 0,2	3,33	1,1	0,47	<0,005	<0,025
A03	7,51	360	0,015	0,27	3,65	< 0,2	0,27	<0,054	<0,025
A09	7,19	130	2,0968	0,026	3,77	2,98	0,98	<0,005	<0,025
A10	7,05	310	0,0274	0,62	1,21	8,57	1,11	0,131	<0,025
A11	6,75	162	0,6534	0,68	1,69	9,64	1,82	0,072	<0,025
A42	7,41	1594	0,0261	0,62	2,24	11,53	1,22	<0,005	<0,025

In these waters, the contamination comes from acid leaching of sulfide minerals existing in sterile material. From water chemistry, because of the high contents of sulphate ion and very low contents of iron and pH neutral, it can be concluded that these waters are formed from a mixture of acidic water with high natural alkalinity waters. Because of this, iron ions precipitate, leaving only heavy metal ions with amphoteric

character in water. It should be noted that Mn ion concentration shows high values reported in neutral pH water. Also, to explain the high ratio Mn / Fe, and the existence of other heavy metals, it is necessary to known and potential acid generating rock from the perimeter leakage taken into account. Also, concentrations of Cu and Pb ions have high values for the chemistry of these waters. For sample A42 heavy metals occur as a result of sulfide minerals in acidic leşierii concentrates were stored on site.

The quality of mine water from the ponds and the industrial site after the closure of the mine are presented in Table 5.

Table 5. The quality of from the ponds and the industrial site after the mine closure works

	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd	As
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A02	7,98	159	0,84	0,24	0,11	2,10	0,013	<0,002	0,001	0,014
A03	7,74	1190	0,19	0,23	0,13	0,03	0,016	<0,002	<0,001	0,332
A09	8,22	72	0,17	0,20	0,15	0,02	0,015	<0,002	0,001	0,006
A10	7,97	78	0,18	0,22	0,17	0,02	0,015	<0,002	0,001	0,006
A11	7,45	385	0,88	0,22	0,16	5,62	0,014	<0,002	0,001	0,165
A 42	7,08	1216	10,3	1,48	0,14	3,2	0,012	<0,002	0,005	0,182

1.3. Water from wastewater treatment plants

The quality of water from wastewater treatment plants before starting the closure of the mine are presented in Table 6.

Table 6. The quality of water from wastewater treatment plants before the mine closure works

	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A06	11,5	365	0,0048	0,48	0,67	< 0,2	0,25	0,175	<0,025
A07	8,46	383	0,0466	0,026	1,5	2	0,41	<0,005	<0,025

Although differences should occur, these waters are found to have a chemistry similar to that of water above. The explanation lies in the fact that the acidic water treatment applies the same treatment that occurs naturally and by mixing it with alkaline water.The quality of water from wastewater treatment plants after closure of the mine are presented in Table 7.

Table 7. The quality of water from wastewater treatment plants after the mine closure works

	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd	As
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A06	12,12	391	2,99	0,417	0,123	2,397	0,026	<0,002	0,002	0,074
A07	7,97	475	0,354	0,312	0,124	0,085	0,012	<0,002	0,001	0,015

2. Waters of the emissaries

2.1. Emissaries that flows under ponds

The quality of water that flows under ponds before starting the closure of the mine are presented in Table 8.

Table 8. The quality of water that flows under ponds before the mine closure works

Pro-ba	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd	As
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A12	7,6	36,5	0,0171	0,039	1,49	< 0,2	0,26	<0,005	<0,025	
A13	7,47	98,2	0,7611	0,66	3,6	2,28	0,78	0,164	<0,025	
A14	7,61	85,3	0,0597	0,68	4,22	< 0,2	0,14	< 0,005	< 0,025	
A15	7,85	46,8	0,7575	0,039	4,19	1,37	0,84	< 0,005	< 0,025	
A16	7,63	447	0,1872	0,08	2,91	1,75	0,65	0,122	<0,025	

Given the contents of exfiltrations, reverse well and undercrossing pipe explained concentrations Citii Valley to the flowing in the Hărmănesei Valley. These waters should have characteristics similar to those of undercrossing pipe water. The dilution from downstream runoff may explain concerted decrease in the concentration of most pollutants. The quality of water that flows under ponds afterclosure of the mine are presented in Table 9.

Table 9. The quality of water that flows under ponds after mine closure works

Proba	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd	As
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A12	8,04	18,5	0,206	0,307	0,132	0,076	0,008	<0,002	<0,001	0,007
A13	7,81	80	0,72	0,25	0,091	1,49	0,006	0,009	<0,001	0,017
A14	8,02	12	0,171	0,26	0,09	0,015	0,007	<0,002	<0,001	0,003
A15	7,92	13,6	0,249	0,256	0,12	0,023	0,014	<0,002	<0,001	0,005
A16	7,85	265	0,459	0,301	0,115	1,22	0,016	0,005	<0,001	0,038

The quality of these waters improved significantly during mine closure working.

2.2. Receptors emissaries

The quality of receptors emissaries before starting the closure of the mine are presented in Table 10.

Table 10. The quality of receptors emissaries before the mine closure works

Proba	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd	As
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A17	7,93	27,7	0,0302	0,4	3,36	< 0,2	0,16	<0,005	<0,025	
A18	7,91	68,7	0,2781	< 0,02	3,73	1,02	0,69	0,031	<0,028	
A43	7,38	86,4	0,3092	0,82	2,9	1,03	0,74	< 0,005	< 0,025	
A44	7,36	84	0	0,82	3,64	0,46	0,32	< 0,005	< 0,025	

Their chemistry can not be correlated with the situation at Baia de Aries, because the input data is a net discharging acid.There is an increase in the concentration of several pollutants in the Valley Hărmănesei after the junction of Cutii Valley in the Aries water after the junction with Valley Hărmănesei, Aries after the discharge of water from the platform (with the exception of zinc, copper and lead) and preserving the quality or mild decreases the concentration of pollutants after junction with Sarteş Valley.

The quality of receptors emissaries after the closure of the mine are presented in Table 11.

Table 11. The quality of receptors emissaries after the mine closure works

Proba	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd	As
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A17	8,15	18,1	0,162	0,306	0,126	0,011	0,008	<0,002	<0,001	0,002
A18	7,76	40	0,171	0,393	0,078	0,056	0,004	<0,002	<0,001	0,006
A22	5,9	130	3,105	0,518	0,829	0,595	0,012	<0,002	0,003	0,002
A43	5,86	123	3,225	0,679	0,838	0,603	0,013	<0,002	0,004	0,005
A44	5,87	123	3,001	0,619	0,831	0,567	0,018	<0,002	0,003	0,003

The quality of these waters did not change during mine closure working.

2.3. Emissaries from the dumps

The quality of emissaries from the dumps before starting the closure of the mine are presented in Table 12.

Table 12. The quality of Emissaries from the dumps before the mine closure works

Proba	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd	As
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A23	8	42	0,0206	0,62	7,26	< 0,2	0,29	< 0,005	< 0,025	
A24	8,18	3,9	0,1419	<0,02	1,22	0,2	0,24	< 0,005	< 0,025	

In these waters, the chemistry is simpler than the previous case, acidic water being diluted and taken temporary alkalinity neutralized because they have. Amase the large values obtained for lead and copper ion. Also correlation of water quality parameters with weather data is essential to determine the exact origin of heavy metal ions. If maintain high values previously determined for heavy metal ions, these waters will be treated. Following tests for determining the potential formation of acidic water from the rock dumps will be established if necessary to collect these waters or to their treatment is possible in situ.

The quality of emissaries from the dumps after the closure of the mine are presented in Table 13.

Table 13. The quality of Emissaries from the dumps after the mine closure works (Traistă E., 2010)

Proba	Ph	Sulfati	Fe total	Zn	Cu total	Mn	Pb	cianuri	Cd	As
	Unitati pH	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
A23	7,93	38,6	0,188	0,34	0,078	0,018	0,012	<0,002	<0,001	0,002
A24	8,16	31	0,169	0,347	0,115	0,016	0,021	<0,002	0,001	0,002

The quality of these waters improuved during mine closure working.

Conclusion

Mining activity took place in Baia de Aries had a significant impact on the environment. Following the execution of mine closure workings it was found that the surface and underground water heavily contaminated with heavy metals improuved after this works.

References

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