

## ACID ROCK DRAINAGE

Anca Ionce<sup>1</sup>

**Key words:** Acid Rock drainage, exfiltration, tailings dams.

**Abstract.** Acid rock drainage (ARD) is an particularly important aspect for the evaluation of the decantation ponds' safety, and which has been only once taken into consideration at the Tarnicioara decantation pond, year 2002, as a consequence of the apparition of a strong seepage on the deposit's dump, that has chemically de-purified the water from the river Brateasa. We have observed ARD, which implies the release of acid solutions from the mining sterile deposits, from the underground mining works and from the quarries, in the following tailings dams: Tarnicioara, Valea Strajii, Poarta Veche- which served Tarnița Preparation Enterprise and in the Dealu Negru and Paraul Cailor ponds- which, at their time served Fundu Moldovei Preparation Enterprise, both during the period of their functioning and the period after their closure. For the decantation pond Dumitreleu which served the Calimani preparation enterprise, acid seepages from the deposit were mentioned in a study made by SC ICPM SA Baia Mare in 1993. Subsequently to the closure of the objective such seepage did not take place anymore. Instead, by raining, there is a frequent plant sterile dragging from the contour retaining wall down to the trouble pond, situated upstream.

The exfiltration from decantation ponds, especially those from “the valley” and from “the coast”, are very important for water elimination from the deposits, where a practically artificial hydrostatic level is being formed: this exfiltration is clear during a normal functioning of the pond. During the functioning periods of the decantation ponds the mentioned level is being monitored through piezometers, by comparing the water level with the appointed warning values, established by specialized institutes. The exceeding of the warning values points out the existence of an abnormal accumulation of water in the deposit bodies, which could be the cause for producing downfalls of sterile.

After stopping the sterile deposition, before overtaking the stabilization and ecologization measures for the ponds, due to financial issues, these will no longer

---

<sup>1</sup> Agency for the Environmental Protection, Suceava, ionceanca@yahoo.com

benefit of an accurate observation. As a result of the warping of the piezometers, <sup>2</sup> the observation of the behavior of the decantation ponds' "humid core" is no longer being made and, as a result, phenomena similar to those from 2005 in the Poarta Veche decantation pond, when the apparition of a suffusion in the batter, are being produced. The pond was conserved since 1975.

The physical and chemical analysis of the exfiltration quantity, both for the activity period and for the conservation period of the Tarnicioara, Valea Strajii and Poarta Veche tailings dams, which served PU Tarnita, Dealu Negru and Paraul Cailor, which at their turn served PU Fundu Moldovei, have been conducted in the APM Suceava laboratory. The contribution of pollutants from the receiving water courses- Brateasa river for the PU Tarnita and Moldova river for the PU Fundu Moldovei is felt over a relatively short distance, due to dilution. Starting with the widely sustained and approved idea by many researchers that water has memory and due to the fact that an aggression on a medium level but at the same time permanent may have a much bigger impact in the future than the pollution on higher level but on a short term, I consider as necessary to monitor these seepages.

The ARD phenomenon is associated to the sterile deposits originated from the copper ore preparation, and therefore has to be studied and understood in the perspective of finding correct solutions.

Acid rock drainage depends on the presence and reactivity of the sulfur from the drained rocks, in the presence of water and oxygen. The drainage phenomena of the acid water are accompanied, in variable proportions by the solubilization of heavy metal combinations from the tailing ponds (Fe, Mn, Cu, Zn, Pb, etc.).

The quantity and quality of the acid drained waters from the tailing ponds, in whose mass phenomena like sulfur biocatalyzed oxidations depends on the following factors:

- the volume of the exposed mining mass, the content of sulfur and their distribution in the mass of the sterile deposits;
  - the presence and quantity of alkaline minerals with neutralizing potential of acidity;
  - water and oxygen circulation influenced by the material from the tailing ponds texture;
  - quantity and quality of waters originated from precipitation, surface and subterranean waters which infiltrate in the deposits;
  - ambient temperature influenced by climate, altitude, exposition of the terrain and in some cases even by sulfur oxidation phenomenon;
  - the dimensions and form of the sterile deposit;
  - preparation technology and the period of time of the deposits preparation;
-

- oxidation degree of the sterile in the moment of its storage.

The projection of some control solutions of acid water drainage, with long term efficiency, must take into account the specific conditions of each deposit, due to the myriad of factors that influence the biocatalyzed sulfur oxidation.

The test results of samples taken from seepage (the annual weighted average) are shown in the figures 1-5:

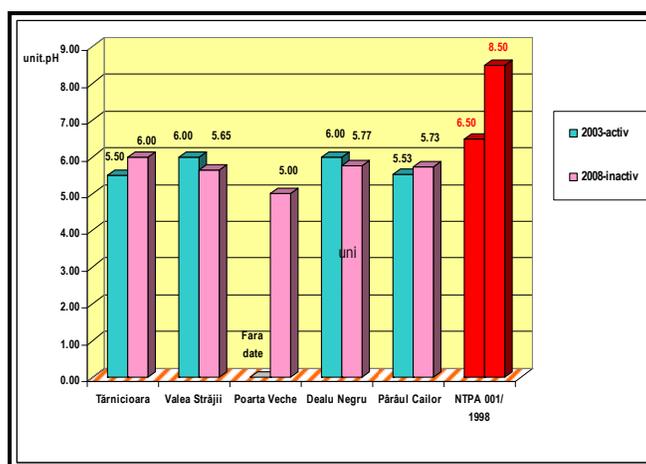


Fig.1 - PH Values – ADR of Tailing dams

Analyzing the data obtained from the tests, as those obtained from the direct observation during the 17 years of behavior tracking of the tailing ponds, the followings can be concluded:

-the seepage from the ponds generally contains an amount of heavy metal which overcomes the limits imposed through the norms NTPA- 001/2002 and are the result of mining acid drainage phenomena and of the biosolubilization of the sulfur from the sterile,

-the amount of heavy metals in the seepage is smaller compared to the one from the summer period, especially because of the dilution of seepage, as a result of greater rainwater debits;

-the amount of heavy metals in the seepage from the base of the ponds is generally smaller than in the seepage from the superior area of the slope, due to the presence of sterile in the carbonatic minerals with neutralizing potential of the acidity, minerals which contribute to the partial neutralization of the subterranean waters. In the ponds' superior level (with the exception of the tailing pond Poarta

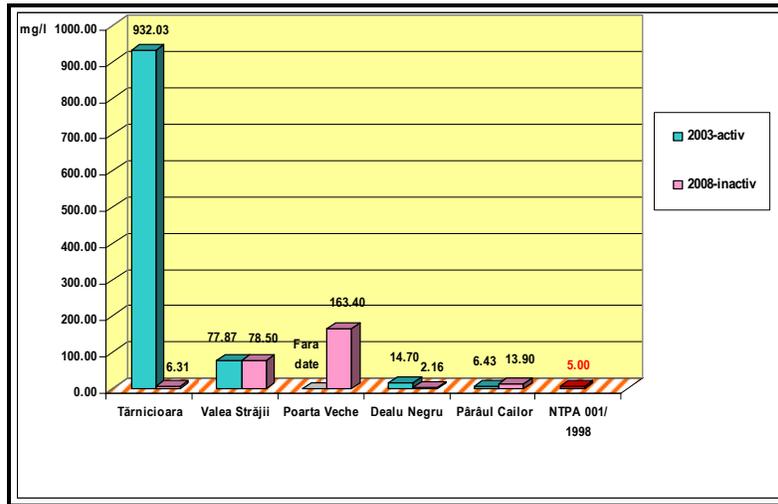


Fig.2 - Values of Iron ions- ADR of Tailing Dams

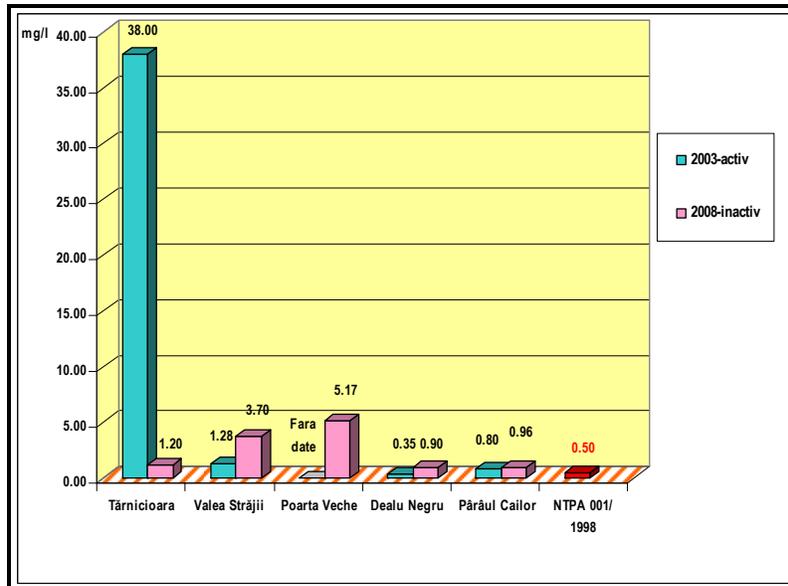


Fig.3 - Values of Zn ions- ADR Tailing Dams

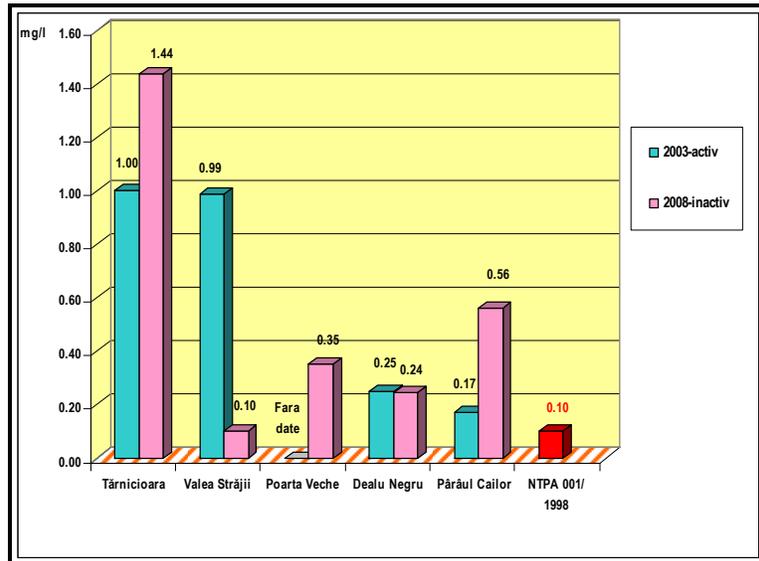


Fig.4 - Values of Cu ions- ADR Tailing Dams

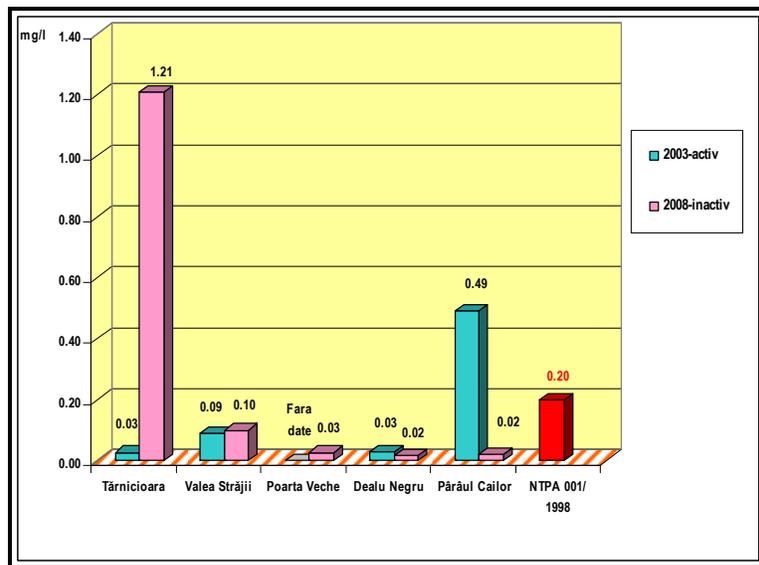


Fig.5 - Values of Pb ions-ADR Tailings Dams

Veche and from the PE Tarnita, in the sterile stored after 1996, when there was no more selling of pyrite concentrate on the market and SC MINBUCOVINA SA decided its transport on the dumps) a bigger amount of pyrite compared to the inferior zone can be found exposed (in favorable conditions for the mining acid drainage);

-the decantation pond Dealu Negru (P.U. Fundu Moldovei), being a coast pond, with smaller dimensions, shows a better subsidence and dewatering because the seepage stops during the dry season;

-the seepage on the base of the tailing pond Valea Strajii (P.U. Tarnita) has an artesian aspect, with constant debit which, together with the apparition of the lake behind the deposit, imposes the necessity of an urgent study in order to verify the stability; the lake behind the pond denotes an inefficient drainage, and the seepage on the base of the main dump signifies the accumulation of a greater water volume which can determine the sliding of the pond downstream.

As a result of the occurrence in 2002 of a seepage with sterile material drag and the formation of a big ravine on the main dump of the decantation pond Tarnicioara (P.U. Tarnita), with the penetration of the retaining wall, a study has been realized in order to identify the causes and to eliminate the polluting effects of the seepage (SC IPROMIN SA Bucuresti, 2003). Water samples from the seepage, from the water evacuated by the reverse probe into the river Tarnicioara, river Scaldatori and river Brateasa in December 2002 and June 2003, have been collected and analyzed.

The conclusions of the study mentioned are as followed:

- The pollution of the Brateasa river's emissaries is the result of the mineral solubilization inside the tailing pond;

- Sulfur mineral solubilization is being produced as a result of the oxidizing action of the  $\text{SO}_4$  ion and of  $\text{Fe}^{2+}$ , favored by the presence of a Thiobacillus ferrooxidans type of bacteria;

- The reddish color of the water from the Brateasa river is given by the precipitation of the ferric hydroxide, especially during the functioning period of the preparation enterprise;

- The minerals' solubility speed in time in the pond differs according to the degree of congregation of the conditions to produce this phenomenon

Mineral solubilization is being continuously produced, also during colder weather, because the oxidation reactions are exothermic.

#### **Bibliography:**

Auty R., Mikesell, (1998), *Sustainable development in Mineral Economies*, Oxford: Clarendon Press

- 
- Filipek L.H., Hatton C., Gusek J., Tsikamoto T.,** (2003), *Passive treatment of acid rock drainage (ARD): stat of the practice*, Tailings and Mine Waste 2003. Proceedings of the tenth international conference on tailings and mine waste, 12-13 Oct. 2003, Colorado, USA, A.A. Balkema Publishers
- IPROMIN SA Bucuresti,** (2003), *Determinarea cauzelor si stabilirea solutiilor de eliminare a efectelor exfiltratiilor prin corpul barajului Tarnicioara si a poluarii chimice a paraului Brateasa*, (Arhiva APM Suceava)
- ICPM SA Baia Mare, Laboratorul de Acvacultura si Ecologie Acvatica Piatra Neamt,** (1993), *studiu si analiza de impact- E.M. Calimani*, (Arhiva APM Suceava)
- Marszalek A.S.,** (1996), *Preventative and Remedial Environmental Engineering Measure to Control Acid Mine Drainage in Australia*, in Preprints of Papers, Engineering Tomorrow Today. The Darwin Summit, National Engineering Conferences, Darwin, northern Territory (21-24 April, 1996)

