UNIVERSITY OF PETROȘANI
DOCTORAL SCHOOL

SUMMARY
DOCTORAL THESIS

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BUD ADINA

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THE IMPACT OF UNCONTROLLED SPILLS OF HEAVY METALS FROM THE MINING ACTIVITY – BAIA MARE REGION ON THE ENVIRONMENT AND THE HEALTH OF THE POPULATION

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The mining activity was closed at a final stage in 2006 in a faulty way with the disregard of many rules of good engineering practice, in effect an abandonment of all mining perimeters. The consequence of these improperly performed works has recently led to discharges of mine water into the environment. These mine waters are loaded with heavy metal and transported over very long distances. Heavy metals (lead, copper, zinc, cadmium, arsenic, iron, manganese, etc.) discharged into the aquatic environment and sediments, reach the food chain with bioaccumulation effects. The final consumer will be man, who will accumulate these metals in the body, producing numerous imbalances affecting health.

In the last period of time, numerous studies have confirmed the relationship between the accumulation of heavy metals in the body and various diseases, including cancer.

The rivers in Maramureș county (Lăpuș, Cavnic, Săsar, Someș, Cisla, Vaser, Tisa – the Someș - Tisa hydrographic basin) are already contaminated with these mine waters which will affect the entire ecosystem in the long term. There is a tradition of fishing and hunting as well as animal husbandry in the area, all of which consume contaminated water. Also, the development of agriculture around these waters determined the accumulation of heavy metals in vegetables and vegetation.

The aim of the thesis is to identify the sources of natural release of mine water, to quantify this phenomenon, to signal the authorities and public opinion on these consequences, and to propose technical solutions that will allow the reduction of the environmental impact.

The Baia Mare mining region has a long tradition in the exploitation of metal deposits, which has extended over very large areas throughout the northern part of the country. Due to the fact that closure or conservation works were not carried out correctly, difficult-to-control phenomena are now manifesting with expansion over large areas, including across borders.

For this purpose, monitoring and analyzes were carried out regarding the status of the main sources of discharge of contaminated mine water. The field visits were focused on two types of discharge sources: the settling ponds in the surroundings of Baia Mare (5 ponds), Cavnicului Valley (4 ponds), Baiuț (3 ponds), Borșa (6 ponds) and the mouths of the mine galleries through which significant quantities of mine waters have begun to be discharged up to now. In the case of settling ponds, waterproofing works were needed to stop the oxidation reactions of sulphides and the entrainment of toxic dust by the wind. In the case of underground mining works, technical solutions to reduce the reactivity of sulphides were not used. These shortcomings generate strong oxidation reactions that lead to the phenomenon of acid drainage. Mine water samples were taken both from sources and outfalls, contaminated sediment samples,

water samples from wells located in risk areas and food (vegetables, milk, cheeses) which were determined in accredited laboratories .

Heavy metal contamination of the area in the Baia Mare Mining Region (Maramureș County) is extremely important and current because it presents a short, medium and long-term impact on the environment and public health. The analyzed impact and risk of this phenomenon led to a worrying conclusion regarding the amplification and expansion of the contamination areas through ever-increasing discharges. During mining, acid drainage was partially controlled by using lime in the processing plants before the tailings were dumped into tailings ponds, and underground water was pumped and partially precipitated in tailings ponds. underground water collection. After the closure of the mines, the phenomenon of acid drainage is triggered. In the underground, after a certain period of time, the waters accumulate in the excavated spaces below the base horizon, after which their discharge begins (from some areas, these discharges have begun, followed by others). In settling ponds, the acid drainage phenomenon is accentuated by the lack of waterproofing. In this way, the problem is serious, current and will increase in the future if not addressed

One of my concerns is the way of life and the environment in which we live, especially the issue of food, the water we drink and the air we breathe. The profession of a mine engineer, the training during the school as well as from the practical activity, provided me with information how the mining perimeters should look both during the activity and after the closure, especially since there is an international experience in this field. From field visits in Maramureș county, we found a very large discrepancy between reality and a normal situation. All this worries me and leads me to study, warn and raise awareness of this phenomenon, which I also consider a civic duty.

The vein deposits that were the object of the mining operations in Maramureș County contain polymetallic sulfides with significant amounts of pyrite, marcasite, chalcopyrite, which represent the minerals with a large weight and triggers of acid drainage. For the most part, the deposits were extended to the surface with outcrops and some of them were in the oxidation zone. For the most part, the exploitations were carried out underground in the zone of sulphide stability. These exploitations allowed the reactivation of sulphides, a fact that has led to a strong environmental impact. Exploitation without complying with some rules by which acid drainage should have been lessened led to this state of affairs to which the closure method was added. The presence of polymetallic sulphides both in the exploited perimeters and in the tailings ponds, tailings dumps and flotation perimeters exposed to environmental factors (water and

oxygen) triggers oxidation reactions that are manifested by the pollution of the mine waters that led to the infestation of the main rivers in the county , of the soils and the water table.

Currently, Maramureș County is in a critical situation regarding heavy metal pollution due to the way in which polymetallic sulphide deposits were exploited, through which the opportunities of these resources were transformed into dangers.

The exemplification of open, prepared and exploited mining perimeters shows the extent of the works carried out over time, the geomining conditions, the quantities of polymetallic sulphides remaining in the excavated space, the lack of backfilling with buffering material, the recovery of open and prepared or abandoned reserves, etc. The deposit opening was divided into two zones: above a base level through which rainwater will percolate and drain to its base without accumulating in underground excavations, and below a base horizon where mine waters accumulate. The projects and works executed to close these perimeters ignored the rules and the possibilities to reduce the environmental impact of the mine waters.

Another deficiency in the design and execution of the closing works of the coastal galleries on the portion from the slope (the entrance to the mine) is the creation of plugs consisting of a dike located at a certain distance from the entrance (depending on the topography of the land - up to the point in which the height of the covering formations is 50 m) and a pier at the mouth of the gallery. Between the two dikes, the gallery was filled in, leaving a water drainage channel (work carried out with numerous deficiencies). This construction created all the conditions for the clogging of the drainage channel by the deposition of precipitation and the accumulation behind the dike of a large amount of water. When a critical pressure is reached, the accumulated water and precipitate are released, called untimely vents.

The closure projects were carried out in a short period of time, without analyzing the possibilities of using the underground spaces for different purposes: tourism, scientific research, recovery of mine flowers, recovery of metals from mine waters or abandoned reserves, spaces of storage, refuges in extreme cases, the exploitation of thermal energy identified especially at Cavnic and Baia Sprie, where the temperature of the rock in depth was high.

The monitoring carried out in recent years (both before the start of the doctoral activity and during it) on the mining perimeters in Maramureș county revealed that the sources of pollution are becoming more and more reactive, proving the amplification effect of acid drainage. Also, new sources of pollutant release into the environment were identified, either through the destruction of dams or diversions from underground or through the untimely release of the precipitate accumulated on the mine water evacuation routes. The amount of toxic material released into rivers is constantly increasing, leading to the contamination of ever-

expanding areas. The determinations carried out in the laboratory on samples taken from the Cavnic and Lăpuș rivers revealed extremely high values that can hardly be quantified to express the level of toxicity. Including visually, from the respective points that are in the area of the towns (the water representing a source for animals and irrigation) we did not find any form of life in the water. The contamination of the two rivers is very advanced.

The impact of heavy metals on the environment and public health has been studied in detail and published in numerous specialist articles. For the Baia Mare area, many studies, projects, grants have been carried out, being financed by both national and international authorities. Baia Mare has a long history of pollution with heavy metals, sclerosing dust and toxic gases, constituting an object of study and interest for the mass media, NGOs, various organizations, etc. All these publications referred to the mining activity, but with a preponderance to the metallurgical activity, being considered the main source of pollution. In the framework of the thesis, I want to highlight the new context of pollution in Maramureș county generated by an irresponsible action regarding the way to close the mining perimeters. These closing activities were described and detailed during the course of the thesis, through which I signaled the new problem given by the extent of the phenomenon of the release of constantly increasing quantities into nature through another transport vector, namely mine waters through the phenomenon of acid drainage .

Mine water discharges are limited and variable (depending on the level of precipitation with relatively constant flows), to which are added discharges with uncontrollable and very high flows, called untimely vents.

If the studies carried out so far have shown high levels of heavy metals, especially in soils and in restricted areas, in the future, the risks regarding the environmental impact of heavy metals will be given by the expansion of these areas through the transport of pollutants by contaminated rivers.

Most of the studies were carried out for Baia Mare and the localities belonging to them, which showed the levels of contamination, but the new studies must be directed to the most extensive areas and in close relation with the contaminated rivers. For example, the discharges from the Băiuț – Cavnic area have contaminated the Cavnic and Lăpuș rivers on important portions, turning them into dead rivers, expanding. The two rivers intersect, causing contamination of the Someș River. In addition to the two rivers, the Săsar river and numerous other streams that drain the eastern part of the Maramureș mining basin (the perimeter of the Săsar, Nistru, Băița, Ilba) contribute to the contamination of the Someș. Another area with the same environmental impact is in the north of the county in the Borșa mining perimeter, from

which two important rivers are contaminated: Cisla and Vaser which reach the Vișeu river and later the Tisa.

The intake of heavy metals in water and soil contributes to their bioaccumulation in the food chain. On the Lăpuș and Someș alignment, the main activity of the population is agriculture and fishing, a fact that endangers their health, including that of the people who buy their products. In this context, time will not lead to a decrease in pollution despite the closure of the mining activity, on the contrary, it will lead to an amplification. Due to the complexity of the mineralization in the vein area (complex ores – for example the Baia Sprie vein with 70 polymetallic minerals), the multitude of heavy metals leads to a synergistic effect, amplifying the impact all the more.

In the doctoral thesis, the effects of the bioaccumulation of heavy metals in the food chain in mountain areas (far from Baia Mare) were highlighted. In this sense, food samples (vegetables, water and milk) were taken from the vicinity of Baia Mare and Poiana Botizei (mountainous area). If the contamination levels were predictable for the Baia Mare area, the contamination dose of the milk from Poiana Botizei remains surprising. Goat, sheep and cow milk was taken from this area. The animals graze in an isolated, mountainous area, they are watered with water from springs and streams (clean water), but during the summer they are also watered with water from the Poieni and Cizma streams, which cross the town. This stream is highly contaminated, an aspect demonstrated by the analyzes carried out from the water and sediments. Milk samples showed alarming concentrations of heavy metals, especially lead, with tens of times exceeded. These analyzes demonstrate the impact of the irresponsible closure of the Băiuț mining perimeter (respectively Cizma) with the destruction of the aquatic environment, the contamination of food products and finally the contamination of the uninformed population about the risks to which they are exposed. All this demonstrates the need for more extensive studies, including information, but the most important thing is the urgent finding of technical solutions to stop pollution.

During the preparation of the doctoral thesis I had the following contributions:

1. Identification of the main sources of pollution by studying the technical documentation of the mining perimeters within REMIN S.A. on the area of Maramureș county, called Baia Mare mining region.

2. Monitoring the main sources of mine water pollution through successive visits for each perimeter. This monitoring was carried out before being officially enrolled as a doctoral student, which motivated me to deepen this subject, and during the doctoral training, the monitoring continued in a rigorous way, based on a plan that allowed estimating the way to

evolution of these sources, namely the anticipation of certain events, especially untimely vents or new sources of mine water discharge.

3. Carrying out a sociological analysis on the population that we considered exposed to the risk of heavy metal contamination. This analysis allowed the identification of several people with poor health and without an explanation related to lifestyle or genetic factors. For example, the case of an active person who follows a healthy lifestyle, but his health has suddenly deteriorated. The correlations made by the type of food consumed and their proximity to a settling pond led to the conclusion of the contamination of the food, respectively the person's body.

4. Studying specialized literature in the field of acid drainage and in particular the relationship between the level of contamination of an organism with heavy metals and their effect on the organism.

5. Studying the public information that should have been made available to the population regarding the risks they are exposed to in case of heavy metal contamination. This analysis led to the conclusion of the lack of information of the population, including the educated population is not aware of the risks to which they are exposed.

6. Risk assessment regarding the physical and chemical stability of tailings ponds, especially those located upstream of residential areas. The case study was carried out on the Colbu pond, which presents numerous non-conformities with a maximum risk of breaking the dike and entrainment of the material from this pond, which in turn risks entrainment of 3 other ponds downstream from it. The community at risk is that of Baia Borșa and part of the residents of Borșa. The physical stability generates serious dust entrainment problems from the Bozânta pond and the Central pond, located in the middle of the most crowded area in the county – the Baia Mare metropolitan area.

7. Sampling of water and sediments from the main contaminated rivers in the county with a worrying evolution regarding the expansion of this contamination – the Cavnic river and the Lăpuș river.

8. Sampling and analysis of contaminated waters from a mining perimeter located in the middle of some communities - upstream of the city of Baia Mare and flanked by the towns of Tăuții de Sus and Satu Nou de Sus.

9. Taking water samples from wells located outside the mining perimeters, but in connection with them.

10. Food sampling and analysis: lettuce, onion, garlic, cow's milk, sheep's milk, goat's milk, goat's cheese from contaminated areas and their proximity. The milk samples from Poiana

Botizei were analyzed under the hypothesis of the use in certain periods of the year of watering the animals from the main streams (Poieni and Cizma) contaminated with mine waters, a hypothesis confirmed by the metal contents in the milk, even if the animals live in a mountain area and water sporadically in streams only in summer. The metal contents were present in the milk about 5 months after stopping their watering in the contaminated streams (during the winter they are watered from an uncontaminated pool with mine waters).

11. Comparison of the results of the determinations made in the laboratory with national, European and international norms, regulations.

12. Analysis of technical solutions to remedy the problems generated by acid drainage, non-compliant closure of mining works

13. Critical analysis of solutions for the construction and installation of treatment plants in the vicinity of the main mine water outlets. The conclusion of the analysis is the following: the violation of the principle of sustainable development by the fact that it will create a problem for future generations, including the present one, because the acid drainage will not decrease for a very long period of time, and the second conclusion is the inability present to manage the enormous amount of sludge resulting from the treatment of mine waters by the proposed methods. Analysis of data from the sewage treatment plant of the company Romaltyn Mining S.R.L. which treats the water from the Aurul pond shows large volumes of sludge. By extrapolating these data to the stations that should treat the mine waters in the entire county, the conclusion is reached that it is impossible to manage the resulting sludge. Until now, it has not been possible to build a compliant warehouse for storing the resulting sludge at the existing stations.

14. Analysis of management plans for protected areas that involve major impediments in the development of exploitation or rehabilitation projects in mining perimeters. These plans or regulations by which the custodians are guided block the possibilities of intervention in these sites, including the recovery of resources abandoned in dumps, exploited areas or the exploitation of new perimeters. This conclusion imposes the need to reanalyze these rules in order to prioritize both the recovery of mineral resources from existing perimeters and from new perimeters. Also, a legislative approach is needed that facilitates the exploitation of mineral resources with beneficial consequences for society.

15. Analysis of the technical documentation regarding the opening, preparation and exploitation of the deposits in the Baia Mare mining region and the projects/execution of the closing works of these perimeters. The lack of correlation between the closure works and the actual status of the opening schemes has caused numerous negative effects.

16. Starting a campaign to inform public opinion regarding the risk of its exposure to contamination with heavy metals through an NGO as a founding member.