International Conference KNOWLEDGE-BASED ORGANIZATION
Vol. XXV No 3 2019

ANTHROPIC RADIOACTIVE POLLUTION IN ROMANIA

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Abstract: *The paper presents some conclusions regarding the identification, processing and monitoring of sites contaminated with heavy and radioactive metals. The following categories of sites have been researched: abandoned mining areas, industrial perimeters for the processing of alloys containing radioactive metals, chemical wastes from the chemical fertilizer industry, railways and run- ways that serve to locate radioactive ores, military sites with forgotten radioactive waste, abandoned mines in which chemical and radioactive materials have been deposited, civil and industrial buildings where radioactive materials were used, tourist resorts affected by anthropic and entropic pollution, cases of radioactive floods and heavy metals from food, contamination of external geographic causes. The research includes the results related to the identification, processing and monitoring of the data of more than 350 contaminated sites.*

Keywords: electromagnetic spectrum, nuclear radiation, waste, population health

1. Introduction

The physical systems, in the natural tendency (General Principle of Thermo-dynamics), interact to reach steady state. In doing so they make exchange mass and energy. Mass exchange is made by exchanging the constituent particles (quantum particles – atoms, alpha particles, proton, neutron, electron, positron), and the energy exchange is made in the form of heat through several mechanisms. One way of exchanging energy is the exchange through the mechanism of electromagnetic radiation (any quantum particle with electric charge, accelerated, emit the radiation/energy in the field: radiofrequency, infrared, visible light, ultraviolet, X rays, gamma rays).

Depending on the particle energy involved in the mass exchange, the resulting systems may be in an excited or ionized state. The radiation is a natural phenomenon, on the one hand, and on the other hand is an artificial phenomenon, produced by man in various activities. Depending on the energy of different radiations we distinguish:

-ionizing radiation - causes the transformation of the atom into positive or negative ion

-non-ionizing radiation - only causes the excitation of the atoms.

The ionizing radiations has more energy than the non-ionizing radiations. They can cause chemical changes by interacting with an atom which becomes ionized.

In Figure 1 (http:// www.rfthatcher. com/ RF-Terms.html)we present the spectrum of electromagnetic radiation together with the activities/systems that produce them and in Figure 2 we present the same spectrum together with the interactions between the spectrum radiations that compose it and the systems with which they can interact.

DOI: 10.2478/kbo-2019-0136

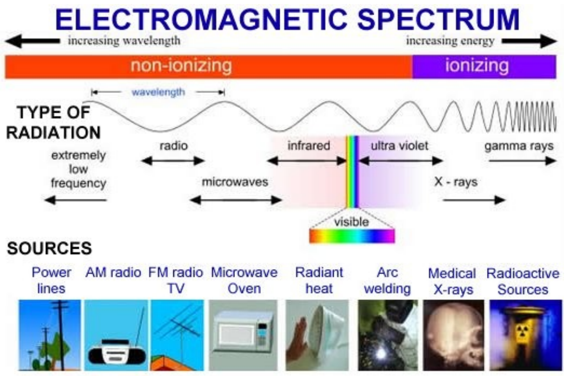

Figure 1: Electromagnetic spectrum(the activities/systems that produce)

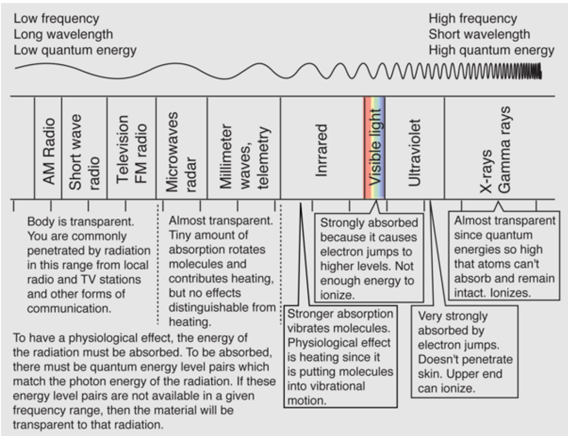

Figure 2: Electromagnetic spectrum (the interactions between the spectrum radiations that compose it and the systems with which they can interact)

The activities involving the exploitation and use of installations using the above-described radiation are well legifered [1], but the implementation of the activities according to these regulations leaves place for interpretation. In this paper we present the results of our activity starting with the year 1990, which consists mainly in identifying abandoned mining works in order to assess the environmental pollution of the population.

2. The radioactivity of some environmental factors in Romania

For measurements we used the mobile laboratory presented in the paper [2]. The mobile laboratory consists of a land vehicle equipped with: a MIP 21 radiometer with NaI detector, an AD111 radiometer with Geiger counter, a dosimeter AD23–thermo-luminescent, radio stations, system GPS Garmin, kit of tests for various chemical substances, portable chemical sets for decontamination, meteo station (Figure 3).

Figure 3: The mobile laboratory

To identify the potential polluters, it is recommended that we do not evaluate anthropogenic and entropy sources on small areas, because their influence is spread to uncontrollable surfaces.

Sources of pollution can be identified in:

- Underground – where mining works and waste stored, often illegally, are traversed by groundwater and transported to large distances;

-Overground – in which the meteoric waters wash pits and mining decanters that carry downstream, but also underground, significant amounts of radio nuclides and heavy metals;

-The atmosphere – are worn by the wind, numerous particles in different shapes, at large distances and in uncontrolled directions.

These are the ways in which large amounts of the chemical elements are transported.

Besides these there are also terrestrial and naval transport (sometimes air) but here the amount of radioactive ores is small and controllable. In Figure 4 we present the map of radioactive mineral resources in Romania. From the study of this map, we found a significant wealth of these resources. On the map there are marked not only the holdings of uranium ore known, but also explorations and areas with ores considered neuranium, but containing these ores.
Each place marked on the map from Figure4 covers a vast geographic area where there may be dozens of mines and tens of kilometers of galleries.

Figure 4: The map of radioactive resources in Romania

Among the mining holdings investigated by us we mention: the Cross – Botusana; Ciudanovita – Natra – Lisava – Rapsag; and Stei – Avram Iancu. But on the map there are other areas where there are no mining holdings:- the Beba Veche area is contaminated due to hydrocarbon drilling;
- the Bucharest-Brănești area is a warehouse for monazite, right in the UM0182 yard; it is a government repository for thorium ore, which was to be processed;
-Brașov –Feldioara area where the radioactive ore preparation plant is located;
-Deva – Mintia area where the contamination is due to combustion of coal.
- Pitești-Colibasi where there is the uranium preparation plant or Nuclear power plant in Cernavodă where uranium is used.
The areas with problems of the kind listed above are the order of hundreds.
In Figure 5 we present the map of the Poiana Ruscă mountains where we performed measurements in the mining areas containing radioactive ores. On this map we marked only the troubled areas, but if the valleys are visited, it is found that on each valley there are dozens of mines, hundreds of kilometers of galleries and hundreds of hectares that are occupied with the perimeter of the factories of prepare-flotation, decanters, ponds of decantation and mines with useful or sterile ore.

Figure 5: The map of Poiana Ruscă mountain

From this area we present the results of the measurements in the Rusca Montană-Rushchița Valley, valley in which there are coal deposits (natural cocs), gold, complexes (silver, zinc, lead), iron (magnetite, pyrite, siderite), marble and uranium – brannerite. It's a very beautiful area, very rich, but partly, very polluted.
Details in the South of this valley are shown in Figure 6 (black-Coal, yellow-Gold) where the recorded activity was under 250 Cps.

Details in the northern part of this valley are shown in Figure 7 (red – Fe, red + Radioactive marking – radioactive Fe, silver – complex ores, radioactive marking – mining decanters).

In this area we have not found any radioactive signs of marking. We also found that the planted forest grew uncontrolled, chaotic (we put this development on a tree cancer) due to the radioactive ore in the area. All heavy and radioactive metals through migration, reach the most unexpected areas, where they can go further or remain temporarily, in the form of sediment. To explain this we are addressing the problem of mining drainage and we will not only limit ourselves to the perimeter of the Poiana Rusca mountains, but we will also highlight several adjacent mountainous areas, where radionuclides arrive and can finally reach in the Banat plain.

Figure 6: The southern part of the valley of Rusca Montană-Rușchița

Figure 7: The northern part of the valley of Rusca Montană-Rușchița

The drainage of groundwater or surface waters are complex phenomena, with major implications for ecosystems and land stability [3-5]. In general, these drainages are acidic due to simple chemical reactions and depend on the complexity of ores found in the extraction galleries, in sterile dumps, in useful ore or in decanters. For the study of the various types of mining drainage, we approach the way of existence of water in the studied geological mass. Water can be found as water that is attracted around the particles, depending on the electric field. This is known as "tied" water and there are various types of it:

• Tightly connected water, with a thickness of 3 – 4 water molecules, retained by higher pressures near the particles, has a higher density and freezes harder;

- Poorly connected water is located at the limit of the attraction of the particle;
- Free or gravitational water.

The moisture in the mining materials is due to the water tightly connected, and free water flows due to the existence of piezometric head or hydraulic potential. If the water flows between two points we have a hydrodynamic regime. The piezometric head directly influences the speed of water circulation in accordance with the law of Darcy:

$$Q = KJ$$

where: Q - hydraulic flow, K = permeability coefficient, J = hydraulic gradient proportional to piezometric head.
The theoretical studies are useful when the characteristics of mining works are known (types of ore, gallery geometry, the materials from which the retention dams of the decanters are constructed). The hydrodynamic spectrum of infiltrations is an important element when calculating the stability of mining works, the influence of drained water on groundwater, the way of controlled drainage of drains to the treatment stations or the calculation of infiltrations before and after exploitation. The way to achieve the foundations (waterproof, permeable and semi-permeable) helps a lot in mathematical modeling as well as in finding optimal solutions to achieve drainage studies. The drainage is even more effective as the free surface of the infiltration is larger and the equipotential lines are closer. In principle, drains for decanters, which are not arranged in the mountain valleys (where the slopes of the mountains and the downstream dam dictate the drainage mode), can be classified in:

• Drainage prisms, with the realization of upstream or downstream deposits. They're not very effective.
• Filter strips (mattresses) with upstream development and drainage systems located at the base are very stable and efficient.

Any solution adopted must take into account the degrees of non-determination (changes) that may occur during exploitation or after, until stabilization operations (cementation, coagulations, physical-chemical reactions), because they all lead to a degree of instability that grows continuously. In the case of mining dumps and decanters the purpose of drainage can be:

• to ensure stability foundation,
• to ensure the stability of the slopes,
• to reduce pressure from pores (which would lead to liquefaction phenomena).

3. Conclusions and perspectives

The ideas mentioned above lead to some conclusions that are very useful for starting interdisciplinary studies on:

• Population health,
• Stabilization of the mining works,
• Sustainable development of the areas,
• Establishing safe routes of evacuation of the population in case of disasters.
• Initiation of interdisciplinary studies

Our team started a project consisting in the realization of an interactive map of Romania, which provides data on the level of irradiation in the locations where we performed measurements or for which we have official data (CNCAN-The National Commission for the Control of the Nuclear Activities).

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