Environmental impact evaluation of uranifer waste dumps from mining explorations – Barzava mine

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Abstract. The Barzava Uranium Mine is located in the west of Romania, in Arad District, in the south of the Zarand Mountains. The exploitation of the Uranium Ore started in 1963. This procedure was achieved by 2 shafts and 2 galleries located in the Poc Stream Valley, an affluent of the Barzava River. In 40 years, the waste rocks suffered erosion and migration activities of the Uranium. It contaminated the soil nearby. The waste rock from the Central Shaft 3 is located in the Barzava City, extremely close to the Barzava River and lengths on a 3,600 sqm surface. It has a 20,000 m^3 volume and the gamma debit values are within 0, 3 μSv/h and 4.5 μSv/h as maximum values and the Radon have a concentration of 1,250 Bq/ m^3.

Introduction

The old Barzava exploitation is located in the south of the Highis-Drocea Mountains, in the north of the Barzava Village, Arad district, in the west of Romania.

Between 1963—1964 there had been executed some exploitation in the Barzava area, that is mining and drilling exploitation. In 1966 starts the Uranium exploitation. It lasted 3 years and stopped in April 1969, as a result of the low profitableness and the decreased resources.

The utilities and the appending buildings were set out of order after the suspension of the activities, but it wasn't made any ecology of the area and there wasn't any mine closing project, because, in that time, the environmental protection was not a priority, but more, it was the last to consider.

Three shafts and two galleries were the result of the exploitation. Their location is the following: the Main Shaft and the Shaft no.1 are located near the Barzava

Brook, an affluent of the Mures River, at about 70 meters from it. Shaft no.2 and Galleries no.1 and 2 are located on the Poc Brook Valley, a temporary affluent of the Barzava Brook.

The Main Shaft Dump is located at 50 meters from the first houses of the Barzava Village and it is very important because of its impact over the environment and over the people (Fig.1).

The exploitation area is located in the Drocea Mountain, at the junction with Mures Corridor. It is characterized by simple forms: hills with an altitude of about

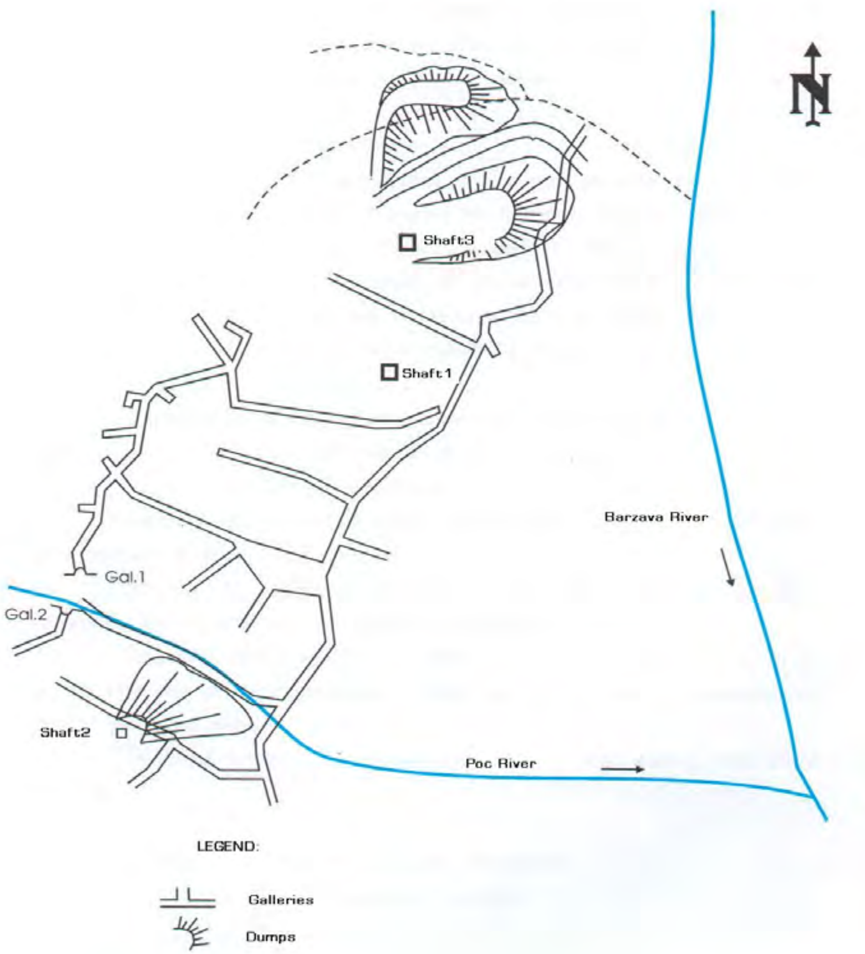

Fig. 1. The location of the old Barzava mine.

500 meters, crossed by deep valleys with small water volumes, affluent of the Mures River.

The waste-dump with the low ore and sterile was drilled at the shaft entrance and has the following characteristics: it has a surface of 3,600 m^2 and has a volume of 20,000 m^3; it is located on a land with a rate of 6-12^O; the ore material is made of gray sandstone; micro-conglomerates; clay with organic substances and adulterated crystalline schistose, with a grain size between 10 – 100 mm; it is not covered with vegetation (Fig. 2)

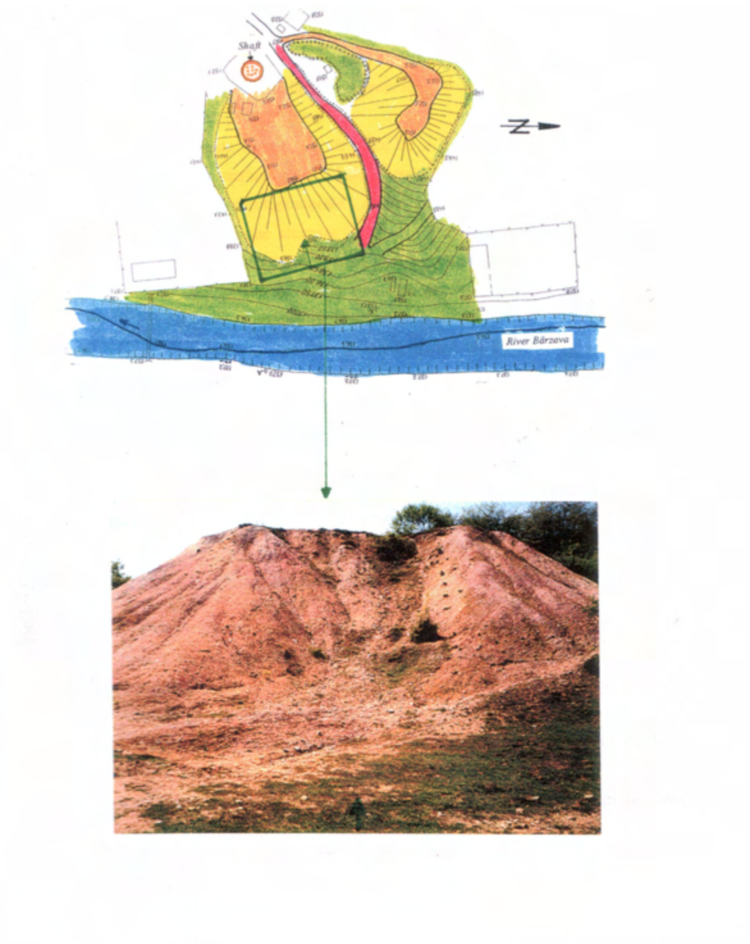

Fig. 2. Picture of Barzava dumps from shaft 3.

Table 1. Radioactives elements concentrations.

No.	Sampling place	U_{nat}(mg/Kg)	Ra226 (Bq/g)
1	Near shaft 3	53	0.15
2	4 m from the base of the dump	55	0.32
3	10 m east from the dump	85	0.50
4	On the road near the dump	175	0.90

Environmental Impact

In order to observe the impact of the sterile waste dump the environment during the 40 years of exploitation, there were gathered samples from all directions, especially from the flowing direction of the spouting waters towards the Barzava Brook.

The laboratory analyses proved that there are outruns of the Legal Standard only for radioactive elements U_{nat} (up to 25 times bigger) and Ra^{226} .

There is a concentration process of the radioactive elements in the soils nearby the Main Shaft Dump. The argillaceous materials in the soil acted like an absorption barrier, especially for Uranium.

The vegetation samples

The radioactive elements analyzed for these samples are saturated Uranium and Radium. The Romanian Legislation does not provide references values for chemical and radioactive elements in vegetation. The interpretation of the concentrations will be done comparing the background values from the mineralized area: U = 4 ppm/mg/kg of ash; Ra = 0, 03 Bq/g of ash.

It has been noticed that the vegetation that grew on the contaminated soil from the bottom of the waste dump concentrated values of Uranium up to 20 ppm and Ra up to 0, 4 Bq/g.

Through assimilation processes the vegetation can lead to the limitation of the migration of the elements and, this way, reduces the pollution of the hydrographic network nearby.

The analysis of the water samples and sediments from the Barzava Brook and the fountains nearby does not revealed pollution with radioactive elements or hard metals.

The external Gamma irradiation level

In order to distinguish the areas found over the influence of the sterile waste dump and the irradiation potential of the persons who stay or travel around the dumps, there had been made measurements of the Gamma rate dose in the following ways: on all the waste-sump surface, both horizontal and inclined surfaces; around the waste dump – on the access road, the farming lands; in the inhabited area (the nearest to the waste dump); in the middle of the Barzava Village.

The external gamma irradiation measurements had been done in a grind (Fig.3) that covers both the dump and the land between the waste-dump and the Barzava Brook.

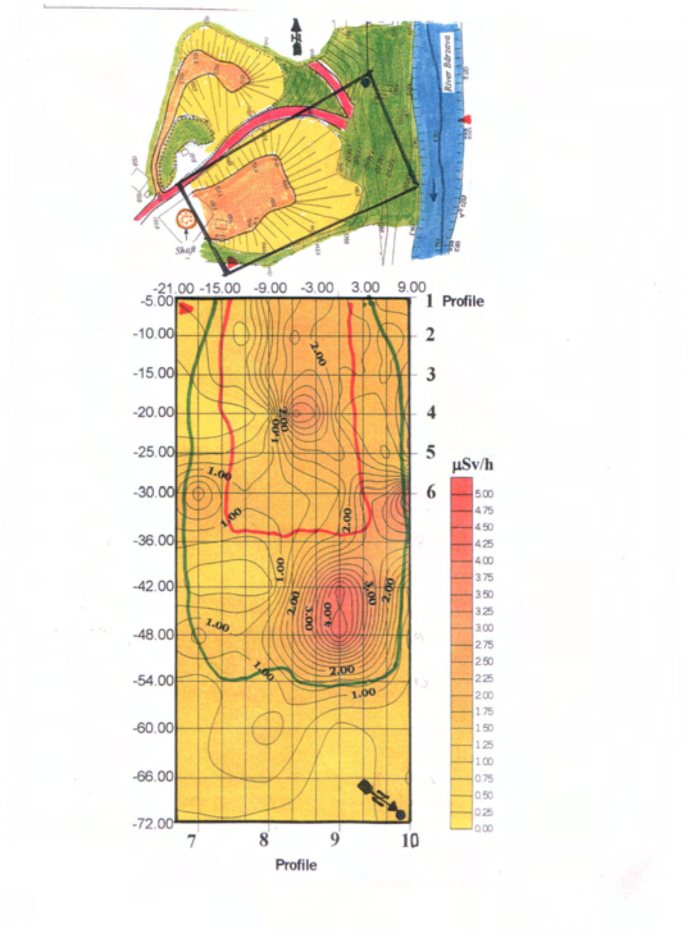

Fig. 3. The external gamma irradiation measurements

The Radon Measurements

Outruns of the Radon concentration for the population had been observed on the dump, especially on the horizontal area and on in eastern side of the inclined surface. This can signify a danger for the people who travel through the waste dump, mostly for children who can choose the dump as a playground as a result of its location near the houses and because the wastes dump is not surrounded by a fence or guarded.

Scenario

The source is the surface of the 3rd shaft and the Barzava Brook.
Location: on the right side of the Barzava Brook. The nearest houses are located at 50m from the waste-dump.
Contaminants: U, Ra, Rn; gamma radiation
Exposure ways to gamma radiation: water and food ingestion, Rn and its short-life descendants, long-life radionuclid dust ingestion.
Receivers: people who lives near the dump, animals that eats near the dump, vegetation.
Altitude – 300 meters, wind direction – S and SV, annual rainfalls media - 623mm.

The calculation for a dose received by a person through ingestion (internal irradiation)

Aquatic way

We suppose that an adult person, from the critical group, uses for drinking and irrigation of the crops, in a period of one year, the water from the Barzava brook from the waste dump area.

We also assume that the same water is used for watering the cattle and the food of the cattle is the grass contaminated by the same water, which has the following concentrations: U = 0,014mg/l; Ra = 0,043Bq/l.

The calculation for the dose received by a person in the previous conditions through water ingestion, vegetal, meat, milk, fish is 0,051mSv/year, from which the additional dose obtained through ingestion is :

$E^{a}_{additional\ i}$ = 0,033mSv/year

Terestrial way

We suppose that a person who stays near the dump ingests daily, as a result of unpredicted causes, a certain quantity of radioactive material. This quantity is presumed to be 0,1g/day for an adult person and 0,5g/day for children.

In this case:
$E^{t}_{additional\ i}$ = 0,023mSv/year (for adults)
$E^{t}_{additional\ i}$ = 0,450mSv/year (for children)

The total additional dose obtained through ingestion for a period of one year is:
$E^{t}_{total\ i}$ = 0,033 + 0,023 = 0,056mSv/year (for adults)
$E^{t}_{total\ i}$ = 0,033 + 0,450 = 0,483mSv/year (for children)

The calculation for a dose received by a person through external irradiation

The data used for the calculation is:
- the gamma dose rate is 4,5 µSv/hour
- the maximum Uranium concentration is U = 0,0175%
- the stationing time – 5 months x 180hours/month = 900hours

In the previous conditions, the total dose caused by gamma irradiation is:

E_{γ} = 4,050mSv/year

To this value we should add 0,943mSv/year for the rest of 7860 hours spent in the normal conditions, with the background value of 0, 15µSv/year.

So, the total annual gamma irradiation dose is:

$E_{\gamma T}$ = 4,993mSv/year

from which the additional dose received by a person is:

$E_{\gamma\ supl}$ = 3,942mSv/year

The calculation for a dose received by a person through Rn and short life descendants ingestion (internal irradiation) – air way

The data used for the calculation is:
- CRn = 1250 Bq/m3
- the stationing time – 5 months x 180hours/month = 900hours

In case of staying/passing near the high Rn concentration area, the total dose is:

$E_{h\ Rn\ l}$ = 2,835mSv/year

to which should be added $E_{h\ Rn\ 2}$ = 0,185mSv/year for the rest of the time spent in the background conditions C_{Rn} = 12 Bq/m^3

The total annual dose received through ingestion is:

$$E_{h\ Rn\ T} = 3{,}020\text{mSv/year}$$

from which the annual additional dose is

$$E_{h\ Rn\ additional} = 2{,}808\text{mSv/year}$$

The calculation for a dose received by a person through long-life radionuclids dust ingestion (internal irradiation) – air way

The data used for the calculation is:

- the dust quantity in air = 0,01g/m^3
- the Uranium quantity in the waste-dump U = 0,0175%
- the Uranium quantity in the air U = 0,00175 µg/ m^3
- A = 0,444 Bq/ m^3
- period of exposure – 900 hours
- respiratory volume - 1 m^3/hour

  $E_{h\ i\ additional}$ = 0,0008mSv/year

The total dose obtained from all the doses obtained by all the ways by a person, in all the scenario conditions is:

E_T = 8,086mSv/year (adults)
E_T = 8,512mSv/year (children)

The total additional dose for a year is:

$E_{T\ additional}$ = 6,807mSv/year (adults)
$E_{T\ additional}$ = 7,234mSv/year (children)

Attention: The total additional dose for a period of a year outruns 7 times the admitted value for the population, in accordance to the Romanian Legislation.

Conclusions

The sterile and low Uranium ore dumps from Barzava Valley are the sources and pollution potential of the soil and vegetation from the Barzava Brook area. During the 40 years since the exploitation had been stopped, there had been a migration of the Uranium and Radium radioactive elements and they concentrated in the soil area from the bottom of the dump. The samples showed values of Unat – 175mg/kg; Ra^{226} – 0,9Bq/g. It can be said that the argillaceous soil from the bottom of the waste dump worked as a frontier that stopped the pollution with radioactive elements of the Barzava Brook.

In case of some pouring summer rains the flowing waters from the dump will surely discharge in the Barzava Brook, along with the easily elutriating Uranium element.

I hope that in a nearby future the Barzava waste-dump will be encapsulated and integrated in the natural landscape of the surrounding area.

References

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