ABOUT THE IRRADIATION ON THE GĂINA MOUNT

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Abstract: *An activity with a spectacular development in recent times is the touristic activity. More internal and external tourist offers appear and more and more of us are involved in such activities. A complementary facet of this activity is the protection of the environment, a problem with two aspects: of the man action on the environment, respectively the action of the environment on the man. The second facet constitute the subject of this paper, in which we will present aspects of ionizing irradiation of the tourists on the Mount Găina*
Keywords: *tourism, radioactivity, electromagnetic spectrum, abandoned mines, contamination*

Introduction

A tourist attraction in Romania during July is the girls' fair on Mount Gaina, where tourists are attracted to the beauty of the places. At the same time there are a number of legends about how this fair took place during 2 days, Saturday and Sunday, closest to July 20th. Parents came to the fair to sell or buy products specific to the area and were accompanied by children, on which occasion the marriages were arranged between them. We no longer find these concerns among the participants, focusing on tourist issues.

Theory

We call irradiation the interaction between substance and field, the two facets of matter. Depending on the energy of the field irradiation may be non-ionising, when the energy of radiation less than 12.4 [eV], respectively ionizing when the energy of the radiation is greater than 12.4 [eV]. The atom, the smallest particle that enters the substance, determining its properties, after interaction with the radiation can be found in two situations:

• may lose an electron, becoming a positive ion, if the energy of radiation is sufficient

• the electron that interacts with the photon passes into an excitable state if the radiation energy is not sufficient to produce ionization. By excitation of atoms can be produced free radicals, harmful elements for the human body. The two types of irradiation can occur due to both the natural environment and human activities. In Figure 1 [electromagnetic-spectrum-chart.jpg] we present the components of the radiation field where we "swim" and the activities in which these radiation occurs. From left to right there are lower energy to higher energy waves. In this figure it is shown an application for each frequency domain. High frequency waves are capable of ionizing while low frequency waves are not. Electromagnetic waves become even more dangerous when phenomena such as interference or diffraction come into play.

Ionizing radiation can to cause DNA damage, and even a short burst of high energy radiation can permanently damage a cell. An extreme example of ionizing radiation would be that of an atomic bomb.

Non-ionizing radiation is low energy and some argue that it is safe because for that reason. However, health concerns such as cell damage, are not immediately seen with non-ionizing radiation exposure but are still very much a health danger. Some examples of devices that emit electromagnetic waves include cell phones, mobile phone stations, wireless routers, microwave ovens, industrial technologies for thermal treatment, remote controls, telemeters, electric networks and transformers, radio relays and translators, civil and military devices and radars. In this paper we present only experimental data on ionizing irradiation, and we will present in a future paper also data on non-ionizing irradiation in the area

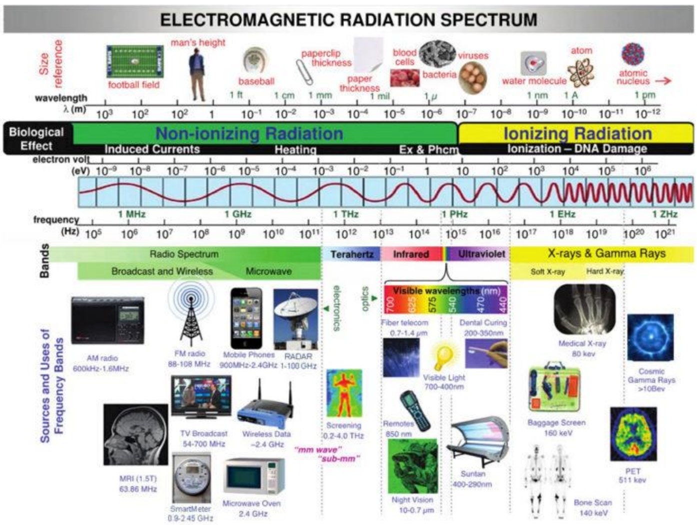

Figure 1 Electromagnetic radiation spectrum

Experimental

For measurements we used the mobile laboratory presented in the paper [Goloșie & Zaharie, 2011]. 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 AD 23 – thermoluminiscent, radio stations, system GPS Garmin, kit of tests for various chemical substances, portable chemical sets for decontamination, weather station (Figure 2).

We used for measurements MIP 21 equipped with the NaI probe type SG2 with photomultiplier. The sensitive surface of the crystal is 8 cm^2 and has an efficiency of: ≥ 15% (2 π) for ^{60}Co , respectively ≥ 30% (2 π) for ^{137}Cs. The background noise is less than 2 Cps and has an energy limit of less than 30 KeV. With MIP 21 we are working very easily, allows quick change of the probe type, the reading is simple, displays both the peaks and the average of the levels, and the sampling time is very short. Although it allows working with multiple units of measure we work only in Cps (Bq) for the fact that the domain is only relevant to the activity of sources-ores.

The measurements the results of which are presented in this work were carried out in the period 2006-2008. The investigated area is part of a "triangle" (the counties AB-HD-BH) with considerable mining exploitation (Figure 3). We find that the mining works were abandoned or partially ecologized in the area. Gold, iron and copper were exploited, and in the last period (1950) uranium. They developed in the field of access routes between mines where mining and major localities were used. It also built a working colony city. In the Biharia area, there are 7 – 8 galleries (23rd of August, the Leucii valley, at Criscior, Libarzu,...). A map of the mining holdings in the area is shown in Figure 4. After the years 1990, exploitation reduces its activity, its approximate being under the coordination of the Institute of rare and radioactive metals in Bucharest. After the closing works from the year 1992, greening works were started after the year 2000. These greening works had several stages:

- realization of pre-feasibility and feasibility projects;
- completion of proper closure projects
- realization of greening works.

In the course of operating and closing works there were special problems with the provision of aeration in galleries, which caused an alteration of the state of health of those involved in these activities. It Is quite difficult to make a proper study on the health of the population in the area for various reasons (the miners do not have a personal observation sheet, many have left the area, some have died, etc.)

Fig. 2 The mobile laboratory

Fig. 3 The geographic map of the area investigated

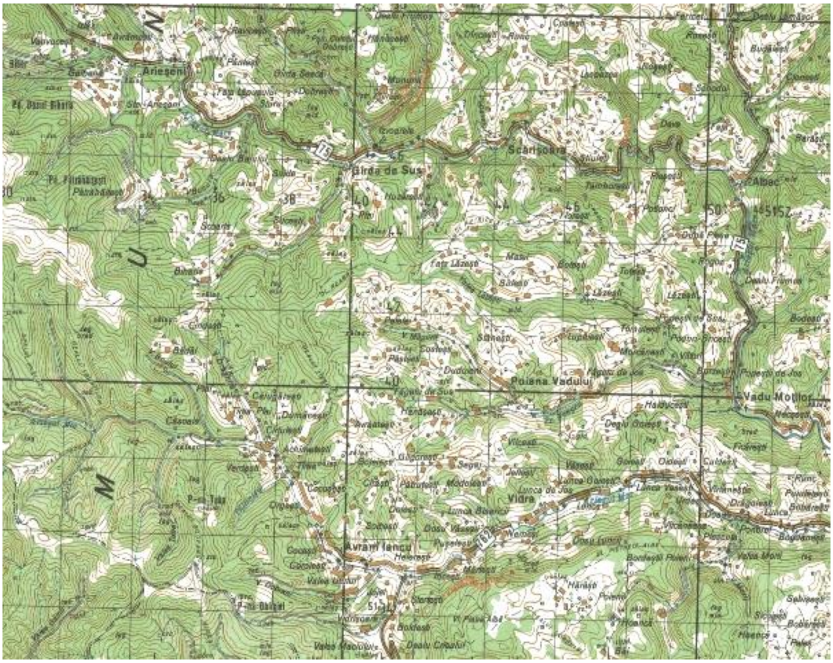

Figure 4 A map of the mining holdings in the area

We found that the greening work was summarily executed: the ore was not introduced back into the gallery, the dumps were not revegetated, mechanical stabilization through the billons is not enough, the signal of the flagging of danger of collapse and radiation is lacking, etc.

From a radiometric point of view, in the area we found values in the following intervals:

- Areas with reduced activity of the natural fund (values 10 – 12 Cps are the majority)
- Areas with activity of the upper natural fund (values of 120 – 160 Cps)
- Areas where the values of the natural fund are amplified by the technological works (700–1100 Cps).

There are whole areas where no mining works were executed but the values found were 45 – 50 Cps. We performed radiometric measurements in areas representative of tourists and forestry access (in areas where the forest is in an advanced state of regeneration):

- Gombos valley: 12 – 14Cps at ground level as well as H=1m; the PH of the water in the creek = 6;
- Tarsa village, the intersection of Draghita: 55 – 58 Cps on the ground and H = 1 m;
- Cornel House (permanent occupied dwelling): 40 – 52 Cps in the foundation and in the walls;
- The silvic canton: 0 – 66 Cps. The canton is at an altitude of over 800 m. Upper levels are in the foundation. The spring near canton has a much higher level of 70-75 Cps (values measured in clay at spring).
- Micoaia valley – upstream: 45 – 55 Cps are constant value
- Downstream Micoaia Valley: 40 – 42 Cps at ground level.
- The cottage demolished on the road to mine galleries: 38 Cps
- Vegetation Norway Spruce: 124 – 146 CPS in the Spruce root area. The Natural background values

are low at 50-80 FPS level. In the area, there are interesting slopes that contain fossilized shells, which are still in a good state of conservation. It would represent a certain topic of study, especially as they are found at relatively high altitude

- The hunting observatory of the Norway Spruce vegetation is found at an altitude of over 1200 m and presents values of 45 – 50 Cps as a natural background, both at ground level and at H = 1 m. Along the way you can see different types of rocks, the majority being the basic ones.
- The Road that reaches the mining area shows already much higher values starting with 79 – 86 Cps.

Higher Values are homogeneous, being quite different from one area to another. I mention that the road is built with the concrete resulting from the mine galleries.

- The Road that descends to the level of the river shows increasing values. In the river area were

found values of 700 – 905 Cps. Values are non-homogeneous: There are surfaces of several square meters with higher values, others are with lower values (80 – 100 Cps). No radiometric assessments have been made throughout the mining area, particularly in the upper part of the works.

- Around the galleries were detected and low values of 50 – 70 Cps at ground level. But at the height

of H = 1m were detected higher values, of 70 – 95 Cps, possibly due to radioactive gas accumulations in the valley.

A few measurements of the pH of the water was. The results were with values in the range 4 -5. Considering that measurements have been made in a period with prolonged drought it is possible that the pH values will change when the area is affected by precipitation. Then the drainages in the mine galleries can be amplified by the drainage in the mining areas, where to be cumulated with the rainwater that will wash the surfaces of the halds near the stream or the area of the tributaries. Also, the natural springs from the downstream of mining works should be identified in order to make periodic measurements, in various climatic conditions of the pluviometric regime. It is possible that underground works affect by draining groundwater all the groundwater in the area. The migration of radionuclides can also be amplified by any bodywork drilling, which has not been blocked, according to the procedures.

An interesting case was studied in the locality of Goesti, at a spring located a few hundred meters from the road, at an altitude of over 700 m. The natural fund measured at the ground level was 50 – 60 Cps, quite homogenous. But in the area of the roots of fir trees, with an appreciable diameter, so also with a large age, were found values of 70 – 75 Cps. It is known that these conifers have high enough capacity to increase the degree of migration of radionuclides from deep mainly as they have and the root pivoting of the conifers in comparison with the hardwood. The pH of the spring water was neutral, 6 – 6.5, at a temperature of 15oC of water and the overall gamma radioactivity level did not exceed the natural fund of 50 – 60 Cps in the water drain area in the source.

Considering that in the valley of the small Ariesului, the Avram Iancu, area started the infrastructure works for tourism – vacation homes, hostels, started the form of hunting and silvotourism tourism - we suggest that radiometric evaluations should be continued according to normatives,

We have not evaluation in Sv (Sievert) absorbed collective dose. It's a measurement system with significant genetic connotations. Because it is not known who is exposed, how long, to what factors the exposure is made, the evaluation in these units, would create a place of discussion. We were interested in identifying their sources and potential for contamination.

In order to correctly calculate the actual effective dose of exposure, it should be known within one year: the beta dose and gamma the range of exposure, the dose of the incorporated radionuclides, the inhalation exposure of radon or waste, the consumption of the products of animal origin or vegetable.

To correctly assess the dose at which a tourist visiting the area is exposed, it would be necessary to know:

- the levels due to existing natural radioactive materials,
- the way of penetration into the body (through drinking water, dust, food),
- the inhalation of air with radioactive aerosols (from buildings, in caves),
- the study of the types of radionuclides established or result from continuous disintegration

It would be useful if we know more, for every tourist:

- the already inhaled dose in the body
- the dose that is inhale during stationary in the area and especially in the exposed areas.

Considering that all sources of exposure must be taken into account, any natural source is quite dangerous. According to the normatives are considered maximum values for a tourist 0.3mSv/an → 0.15 µSv/h, and for a local can be 1.0 mSv/an → 0.5 µSv/h, in accordance with the latest recommendations of the International Commission on Radiological Protection (ICRP).

Returning to the measured values and the Cps unit, we consider that the values over 200 Cps can become dangerous. A level of the natural fund of 25 – 35 Cps is used in "clean" areas. A building, due to construction materials, must not present values higher than 125 Cps. If exposure to external irradiation can be avoided, exposure to radioactive gases is a complex problem. In order to make a correct assessment, it is advisable to establish the degree of risk to which the population, tourists or workers are subject – road and forestry workers:

- ❖ the risk level for the radioactivity is:
  - external irradiation – significant,
  - internal irradiation – important,
  - environmental pollution – the importance
- ❖ the degree of risk due to rocks (halds, decoperes) near the deposit:

- external irradiation – significant,
- internal irradiation – important,
- pollution of the environment – significance of the water in the gallery and the surface, contaminated
- environmental pollution – significant.

In the perimeter of the dumps with radioactive elements is more dangerous the contamination by inhaling radioactive dust (SiO2 is a good carrier) than by radioactive elements (which are below 1%). Also the concentration of radioactive gases on the valleys or in the nearby galleries and caves are very dangerous. Radon is the only element in gaseous condition that is radioactive. It is formed by successive disintegration of radium isotope (which is part of the family of Thorium and Uranium): 238 U → 226 Ra → 222Rn, 235 U → 223Ra → 219 Rn, 238 Th → 234 Ra → 220 Rn.

Only Rn 222 is considered to affect most health. It is quite unstable, with a half-time of 3.82 days, emitting alpha particles. The half-life is short, the alpha particles have passed short, low energy, so it should be harmless. Only with inhalation the problem changes. Some of the Radon descendants, especially 218 Po and 214 Po (Polonium), attach cigarette dust and smoke and create radioactive aerosols. The circulation of these gases is greatly influenced by local weather conditions. From studies in the area we found that radon comes from several sources:

1. construction materials (sand, stone, especially granite taken from halde, clay) contain many naturals radioelements
2. plasterings, which are made of "waste" from phosphatic fertilizers factories.
3. water which comes from both the creek and the few fountains, some even small depth.

In this water, the radium and the radon, the radioactivity can reach between 100Cps/m^3 up to 10^4 Cps/m^3 (there are areas, where it can reach at 10^8 Cps/m^3). However, other problems may be cumulable:

- construction of a foundation that does not seal the base of construction (shows cracks, it is not continuous)
- the existence of gaps in the floor (place of passage of pipes and other installations)
- continuous non-ventilation of rooms and especially basements (cellars)

Radon reduction solutions exist - we do not have to think now that we have to give up and make another home! In order to make a correct assessment it is necessary to apply the CNCAN normative with reference to radon. Not only high doses of radiation are harmful but also the low doses, because they are cumulative. UNSCEAR reports take into account a low dose of 200 mSv (or a dose flow below 0.1 mSv / min). This is for the first time the problem of small doses has arisen. It is now considered that low doses can have serious consequences that can only be detected by epidemiological studies exploring large sections of the population. Congenital malformations are phenomena that occur if the rules are not met (congenital malformations are morphological abnormalities, early products in intrauterine life, embryonic developmental disorders). These malformations are present at birth and are irreversible. Most of the times these malformations are attributed to factors that have nothing to do with radiation, but only work in the mining industry (smoking, coffee, alcohol, medicines) or certain demographics.

Conclusions

The following conclusions are drawn from the above:

• monitoring the environment and air from living rooms, to detect possible emanations and accumulations of radioactive gases from basements.

• a great deal of attention must be given to the use of natural building materials originating in the area, especially the rocks (at the extraction are harsh, but to exposure to light and moisture, they become in short time friable) or those containing ore radioactive.

• involvement of family physicians in the area to correctly assess the health of former Miners as well as their descendants.

References

[1] S. N. Ahmed, *Physics-and-Engineering-of-Radiation-Detection*, Academic Press Inc. Published by Elsevier, 2007

[2] M. Golosie, I Zaharie – *Radioactivity of some Underground and Ground Waters*, Nuclear 2011, IRNE Mioveni (on CD)

[3] A. Martin, S. Harbison, K Beach, P.Cole, *An Introduction to Radiation Protection*, 6_Edition, Hodder Education , 338 Euston Road, London NW1 3BH, 2012

[4] A. Russ, C. Burns, S. Tuler, O. Taylor, *Health Risks of Ionizing Radiation: An Overview of Epidemiological Studies,* A Report by the Community-Based Hazard Management Program George Perkins Marsh Institute Clark University March 2006

[5] electromagnetic-spectrum-chart.jpg on google.com (https://www.google.com/search?q=electromagnetic-spectrum-chart.jpg&tbm=isch&source=iu&ictx=1&fir=yGWuxglCRUQrpM%253A%252Cb2jyh5-fxtDFoM%252C_&vet=1&usg=AI4_-kTkdjUFhjXLI7S-DRpsF3koXZq1cQ&sa=X&ved=2ahUKEwjA2MDnuY7hAhXHLlAKHVMyBHwQ9QEwAXoECAAQBg#imgdii=o0dlWnP21NhgMM:&imgrc=yGWuxglCRUQrpM:&vet=1)

[6] UNSCEAR Reports

NOTES ON THE AUTHORS

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