Acta Mineralogica-Petrographica, Szeged, XLI, 151–154, 2000

THE MEASURING METHODOLOGY OF EXCESS RADIOACTIVE LOAD CAUSED BY COAL MINING IN THE VICINITY OF PÉCS (MECSEK MTS. - HUNGARY)

B. KÓBOR*

Department of Mineralogy, Geochemistry and Petrology, University of Szeged

ABSTRACT

Beside several other harmful effects of coal mining on the environment (destroying landscape, dust and noise pollution), we must lay a great emphasis on dealing with its excess radioactive load as well, since it is widely known that some coal types have a remarkably high radioactive element content. In Hungary the coal of the Tatabánya Coalfield (ZETHNER, 1958), the Cretaceous coal of Ajka (BODROGI ET AL., 1959) and the Liassic coal of the Mecsek Mts. are of that character. It is getting to be necessary to develop a measuring methodology that can be authoritative in land reclamation plans, environmental geological surveys on other Hungarian territories with similar problems and that corresponds to the directives of the IAEA (International Atomic Energy Agency). This measuring system involves "in situ" and laboratory analyses, and as a result of this, beside the actual environmental impact analysis it provides further information on the geological setting of the territory. With an informative purpose we also publish the preliminary results of the measurements that are performed on the coalfields of the Mecsek Mts.

INTRODUCTION

In Pécs and in its vicinity as a result of coal mining, that started two hundred years ago, a great amount of waste material has been already extracted. The excess radioactive load of this waste on the people of the area has not been examined in every detail yet. The high radioactive element content of these coals and their wastes is well-known for a long time. High values can be explained by the uranium accumulating effect of organic material and by the granitoidic base level of the clastic, sedimental rocks of the coal formation (PÁL MOLNÁR et al., 1999). The mean uranium-content of previously examined Liassic coal samples is 25 g/t, but in case of clay shales 150-220 g/t values are not rare either (SZALAY et al., 1959). According to estimations, the coal mining in the Mecsek Mts. has raised the radioactivity of the surface of the area approximately by 60 % (VADOS et al., 1999).

We can receive a total view of the radioactivity of the environment only by measurements that last at least for a year, since several parameters (e.g. falling dust, radon exhalation, aerosol activity) significantly depend on the meteorological situation. Thus, measurements are of full value only if the examination of variable parameters is extended to a whole year period.

* H-6701 Szeged, P.O.Box 651, Hungary

DISCUSSION

"IN SITU" MEASUREMENTS

In order to be able to make comparisons we have carried out field measurements at three locations of different character: a still working open cast mine, a covered waste heap and a reclaimed waste heap. Nevertheless, we examined geologically different areas that are not involved in mining to determine threshold values characterizing the wider surroundings.

Gamma dosage intensity measurements

We examine the intensity of gamma rays, that has the greatest penetrating ability regarding components of radioactive radiation, independently from the energy of the radiation components. On the examined territory measurements are carried out in a grid of 25x25 m frequency, 1 m (standardized height) above the ground, for 12 sec, with an energy independent analyzer (Eberline E6000, equipped with a plastic scintillation measuring head)(SZEDERKÉNYI ET AL., 1994).

Mean values of dosage intensities exceed the Hungarian average by 15-20 % (87 nGy/h)(xxx, 1991). On reclaimed waste heaps 100-140 mean values, while on heaps that are not reclaimed and in case of active mines one and a half times higher values are expected.

Field measurements of gamma-spectrometry

Measurements of this kind help in determining the main radioactive element content - K, U(Ra), Th - of the soil among field circumstances. (Actually, instead of the U-content the Ra-content is determined, and by assuming a radioactive equilibrium the concentration of the mother element is countable.)

Elements and decay families mentioned above emit photons of different energy level, thus, by the selective dating of these, concentrations can be determined.

At the measurements in the vicinity of Pécs we apply a device that is in accordance with the IAEA standards. The device is operating with a four channeled analyzer (NK484P) and with a scintillation detector containing a NaI(Tl) crystal. Measurements are carried out in the same points as in the case of gamma dosage intensity measurements, they last for one minute, whilst the detector is placed on the ground. Results are averaged from three measures.

On the basis of measurements carried out so far, the radioactive element concentrations on the uncovered waste heaps of the examined territory are the following: Th: 18-35 ppm, U(Ra): 5-10ppm, K: 1.8-2.25%. On reclaimed heaps we have got 25 % lower results, still, these are often two times higher than the results of the wider surroundings.

Determination of ^{222}Rn concentration and exhalation

The ^{222}Rn-content of free air can be explained by the Rn production of decaying U in the soil. In case of an average concentration the activity is 1-20 Bq/m^3, though, it varies quickly and whimsically as soil types, hydrogeological and atmospherical features change (VADOS et al., 1999). In order to determine concentrations we apply a low background radiation device, operating with a passive diffusional chamber. The device measures Rn concentrations in every ten minutes due to quickly changing influencing factors.

During Rn exhalation analyses we measure the activity of ^{222}Rn that is exhaled through a given surface during a given time (mBq/m^2s). In an average situation the value of Rn

exhalation is 20-60 mBq/m^{2}s, however, due to the above mentioned factors there can be significant deviations.

Analysis of falling dust

Dust particles get back on the ground in a solid form or in the form of solution by precipitation. For measurements a funnel-shaped measuring bowl, that has a 0.5 m^2 opening and that is filled with distilled water, has to be placed at least in a 1.5 m height in a vegetation-free area. The sample, that is gained through a long collecting period (1-2 months), is put under gamma spectrometric analyses after evaporation and ignition. The measuring time is long (100-200 thousand sec) due to the small concentrations.

The analysis of the radioactivity of aerosols

Aerosols can easily enter the body, thus, they can be responsible for a large proportion of radioactive load on humans. On the basis of the measuring technique, the components affecting biological life can be divided into two groups:

- short term ^{222}Rn components
- long term alpha radiation components

After filtering out the aerosol-content of air with the adequate filter disk both groups can be determined. The radioactivity of components of quick decay has to be measured right after the preparing of the sample, while that of components of slow decay has to be measured after the required length of time.

LABORATORY MEASUREMENTS

Determination of specific activity and gamma-spectrometry of solid samples (coal, waste, soil)

The collection of samples, weighing 2 kg, is carried out in a grid of 25x25 m frequency in order to exclude significant deviations of point-like sampling that is caused by the inhomogenousness of waste heaps. After drying and grinding the collected samples are kept in a so called Merinelli-bowl to ensure their radioactive equilibrium. For measurements a highly sensitive scintillation detector that is attached to a NP424 analyzer is used (SZEDERKÉNYI et al., 1994). Results are values of radioactivity (Bq/kg) of the mass unit of a given sample.

On the basis of results received so far, on the coalfields of the Mecsek Mts. the mean specific activity of covering soils, sandstones - aleurolites and coals - coaly clays is 140-190, 180-190 and 220-380 Bq/kg, respectively.

Gamma spectrometric measurements are performed on samples prepared the same way as mentioned above with a multi-chanelled nuclear amplitude analyzer. These measurements on Mecsek samples have provided the following results:

- covering soils: U(Ra): 5-10 ppm, Th: 15-22 ppm, K: 1.8-2.2 %
- coals, coaly wastes: U(Ra): 13-18 ppm, Th: 12-38 ppm, K: 0.5-1.6 %

Analyses of specific beta radioactivity of plant samples

During the radiological examination of an area there is a good reason for analyzing plant samples, since the vegetation can easily absorb radioactive elements from the soil, water and air. It is important that the plant has to be collected after a year long growing period when it is fully developed. Samples collected from surfaces of the same size are washed an burnt to ashes. This is followed by the measurement of beta activity, which is expressed in ^{226}Ra equivalent.

REFERENCES

BODROGI, F., UPOR, E., VADOS, I. (1959): Zárójelentés az ajkai szénmedencében 1956-57. években végzett földtani és radiológiai kutató munkáléatokról. MÉV adattár, Kővágószőlős, J-0143.

PÁL MOLNÁR, E., VADOS, I., GERZSON, I., KÓBOR, B. (1999): Natural radioactiv element content of the old crystalline rocks in Southern Transdanubia (SW Hungary). Acta Miner.Petr., XL., 121-138. Szeged.

SZALAY, S., ALMÁSSY, GY., PESTY, L., LOVAS, I. (1959): Magyarország egyes fontosabb kőszénterületeinek átvizsgálása uránium nyomelőfordulás szempontjából. ATOMKI Közl., 1, 7.

SZEDERKÉNYI, T., PÁL MOLNÁR, E., VADOS, I.(1994): A radioaktivitás környezetvédelmi vonatkozásai, Egyetemi jegyzet, JATE, Szeged.

VADOS, I., VÁRHEGYI, A. (1999): Pécs-Nagybányarét tervezett külfejtési terület és környezete radiológiai vizsgálata. Jelentés a P.E. Rt. részére.

ZETHNER, GY. (1958): Jelentés az 1957. évben a tatabányai szénmedencében végzett radiológiai kutatásokról. MÉV Adattár, Kővágószőllős, J-0028.

xxx (1991): OSSKI. Tanulmány a MÉV külszini rekultivációja sugárvédelmi követelményeinek meghatározásáról, az ezzel kapcsolatos elméleti és gyakorlati feladatokról. Budapest.

Manuscript received: 10. Oct. 2000.