Gamma-natural radiation field in Mesozoic rocks and in Uranium-bearing Phosphate Mineralization of the Ionian zone, Albania.

A. Serjani , K. Onuzi, F. Dafa, A. Papuciu, E. Bedini

Geological Research Institute, Tirana, ALBANIA

Abstract. Three radiolithostratigraphical levels were distinguished in the Ionian zone. The most important are Middle Jurassic uranium-bearing phosphorites. Some theoretical studies and calculations of intensities of gamma-radiation of mineral body were performed and correlations between intensity of gamma-radiation field and useful compounds of phosphate ores discovered. Physical-geological and mathematical models for determining the coefficients “Ko”, “F”, radioactive equilibrium “C”, and emanation “a” were conducted.

Introduction

During a scintillometer Survey of Ionian zone in scale 1:50 000 (Nasi et al., 1970), measurements of natural gamma radiation intensity of carbonate-chert rocks were carried out. Characteristics of the distinctions of the values of gamma field in different sections were studied in details (Dafa, Serjani, 1987), compiling the radio-lithological-stratigraphical column of the Ionian zone. Three radio-lithostratigraphical levels were distinguished:

- Middle Jurassic uranium-bearing phosphorites, $I\gamma$= 30-300 μR/h
- Phosphate horizon of Coniacian, $I\gamma$= 18-50 μR/h
- Bituminous schists in Triassic-Jurassic boundary, $I\gamma$= 16-24 μR/h

The lower level of anomaly of the Triassic-Jurassic age is presented by transition pack build up from bituminous dolomites and thin bituminous beds. The second level of gamma radiation is linked with disconformities in sedimentation and uranium-bearing phosphorites formed during Middle Jurassic.

The Upper level shows the widest level of regional character. It belongs to the phosphate-carbonate-siliceous horizon of Coniacian widespread almost all over Ionian zone and was studied in details during prospecting works for phosphorite ores. Although the content of phosphate beds in this horizon sometimes is up to 30% P_2O_5, the uranium content is very low. Thus in this case phosphate beds contain the normal uranium amounts as the rest of phosphorites.

Uranium-bearing phosphorite mineralization is distributed in Ionian zone in Albania and in Greece (Stayropodis & Basjakos 1981). This mineralization is found in disconformities of sedimentation typically between massive dolomite limestones of Lower-Middle Liass at the bottom, and carbonate siliceous packs of Middle or Upper Jurassic on top.

Theoretical studies were performed and intensities of gamma-radiation for mineral bodies with non uniformity of distribution of radioactive matter were calculated. A correlation between intensity of gamma-radiation field and useful compounds of the phosphate ores were found. Some physical-geological and mathematical models for the determination of the coefficients "K_o", "F", of radioactive equilibrium "C" and emanation of "α" were conducted as well (Dafa 1989). Radiometrically the system is a simple: uranium is in equilibrium with radium with absolute absence of thorium and potassium.

Short Geological data on uranium-bearing phosphorites

In 1967 for the first time in Albania the uranium-bearing phosphate mineralization (Nasi et al., 1967) were discovered. Until 1990 many geological and geophysical prospection works and studies have been carried out. Some outcrops and two small deposits were found and prospected in Kurveleshi and Çika anticline belts. Almost in all outcrops and especially in Noraj (24 Maj) (fig. 1) and Bogazi (fig. 2) deposits were studied. Phosphate uranium-bearing ores of the Middle Jurassic are widespread almost all over surface of the Ionian zone in Albania and Greece.

Phosphate mineralization of the Middle Jurassic is found only in sections with disconformities. At the bottom of the disconformities in sedimentation always massive limestones of the Lower Liass "Pantocrator limestones" were found. The gap in sedimentation is not always co-associated with phosphate mineralization. In Ionian zone two small deposits and some outcrops of Middle Jurassic uranium-bearing phosphorites were prospected. These occurrences are widespread mainly to the northwestern Greece and to the Southwestern Albania. On Albanian territory Noraj ("24 May") an uranium-bearing phosphorite deposits (where uranium-bearing phosphate bed is up to 4 m thick), and Bogazi deposit of uranium-bearing phosphate veins, pockets, nets, and dissemination were detected. Many occurrences in Kurveleshi and Çika anticline belts were prospected as well. In most cases prospecting of above mentioned deposits and occurrences was done by drillings and galleries.

Uranium-bearing mineralization occurs in two morphological forms:

1. Bedded mineralization (stratiform phosphorites)
2. Mineralization of different morphological types (veins, pockets, nets) filling fractures and cracks of massive limestones of Lower-Middle Liassic.

Phosphate bed contains up to 20-25 % P_2O_5 and 0.01-0.005 % U (intensity of gamma-radiation varies from 80 up to 200 Mkr/h). Bedded mineralization occurs rarely and phosphate beds are usually very thin (0.2 up to 1-2 m). It lies some meters above the contact of disconformities within bedded limestones of Dogger, and is intercalated with thin chert layers. There are found a lot of macrofauna type *possedonia* in the phosphate bed.

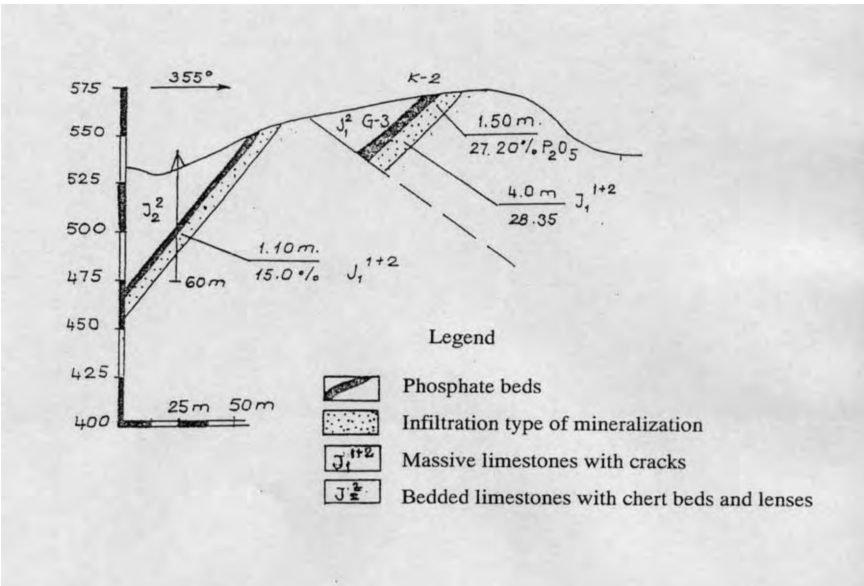

Fig. 1. Geological section of Noraj (24 Maj) uranium bearing deposit (after Husi R. and Serjani A., 1980)

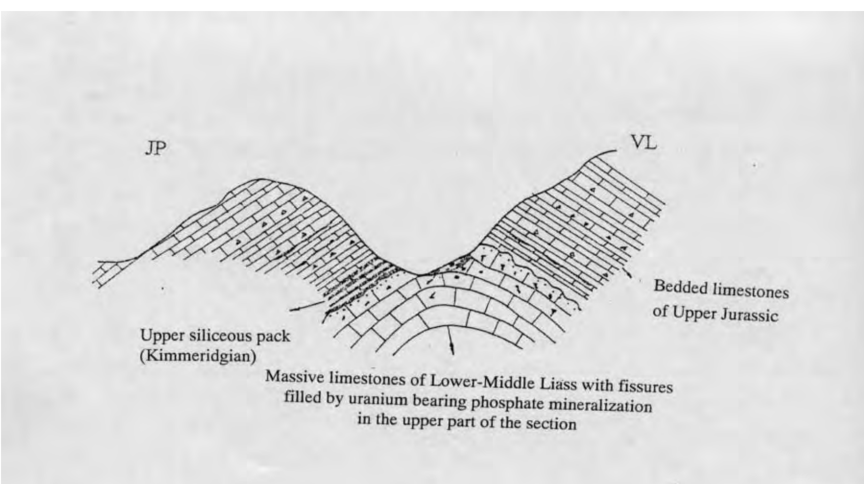

Fig. 2. Geological section of Bogazi anticline (after Nasi et. al. 1969)

The second morphological type of mineralization (infiltration) is more widespread in the Ionian zone and especially in Kurveleshi and Çika anticline belts. This type is characterized by high content of P_2O_5 and U (2-3 % up to 24 % P_2O_5, whereas the intensity of gamma-radiation varies from 30 up to 3000 Mkr/h, but the mineralization is spread into massive limestones and it is difficult to do exploitation and beneficiation with economic profit (Serjani A., Dafa F., 1993). This mineralization is more intensive next to the contact of the gap in sedimentation.

Radiometric anomalies, which represent uranium-bearing phosphate ores, are often interrupted in strike. They possess sizes from 50-100 m up to 600-800 m. Thickness of mineral zones with phosphate uranium-bearing veins, pockets, nets, disseminations is of about 10-20 m and rarely 30-40 m. The content of mineral ores (mineral zones) varies from 3-5 % up to 20-25 P_2O_5, whereas the intensity of gamma-radiation varies from 30 up to 300 Mkr/h. In Jurassic uranium-bearing phosphorites of Ionian Zone were analyzed showing rare earth elements rates of 0.04 - 0.07 %, as well as Pb, Zn and Ag. Rose diagrams of gamma-natural radiation and fissures show the existence of two systems of cracks correlated to uranium-bearing phosphate mineralization. The first system parallel to the plane disconformities is more important for concentration of mineralization. (Dafa, Papuçiu, 1984). The uranium ore does not contain Thorium. The situation of radioactive equilibrium is stable up to 0.8-1.2. According to the studies of different physical-geological models coefficients of correlation between P_2O_5 and U content and gamma radiation were calculated.

Phosphate beds were formed during Middle Jurassic age by biogenetic sedimentaion. The mineralization of vein type was formed epigenetic during infiltration of phosphate solution into massive limestones of the Lower-Middle Liassic. The phosphorites were formed in the photic zone on submarine mountains whereas black shales in basins a few hundred meters deep (Chiotis, Vechios, 1992).

Geological and geophysical studies bear witness about good perspective of second type of mineralization mainly in central part of Kurveleshi Anticline Belt and in southern part of Çika Anticline Belt. The most interesting geological structures in Albanian territory for study and geological prospecting we consider the following areas:

- Çiflig-Bogaz-Dishat-Janjar-Sajatha to the southern direction in Greece.
- Northern direction of Sotira overturned anticline.
- Deep levels and eastern flank of Noraj (“24 Maj”) deposit.

Some analytical-mathematical achievements in prospection of uranium-bearing phosphorites

Theoretical aspects were studied about regularities of distribution of natural gamma-radiation field of uranium bearing phosphate bed and especially of infiltration types of mineralization which is more widespread. Correlations between intensity of gamma-radiation field and useful compounds of the phosphate ores were discovered by Dafa (1989).

Considerable resources of phosphate bearing beds and especially bodies, veins, disseminations, nets of the mineralization of infiltration type are available. Sizes of ore bodies and the content of useful components in two deposits and in many outcrops were estimated.

Application of geophysical methods such as radiometric testing and documentation, quantitative interpretation of gamma-lodging diagrams made it possible to assess the quantity of ores and the quantity of chemical analysis necessary for the evaluation of deposits respectively. Fig (2) displays the distribution of mineralization in combination with measurements of natural gamma-radiation of fissure systems in massive limestones. Geological-radiometrical survey on scale 1:25 000 and 1:10 000 accompanied by follow up survey at scale 1:2 000 up to 1:500 was done to provide the necessary information on the distribution of natural gamma-radiation.

Theoretical solutions and mathematical models for uranium-bearing mineralization with very irregular distribution convinced us to use radiometry for quantitative evaluation and run physical-geological models. According to the studies of different physical-geological models coefficients for evaluation of mineralization and reserves of ores were determined:

"K_o" = 52 MR/h which represent the intensity of gamma-natural radiation for content of 0.01 % U in equilibrium with Ra.

"F" = 37 MR/h which represent the intensity of gamma-natural radiation, corresponding to the content of 4 % P_2O_5.

Conclusions

1) Three lithostratigraphical markers in Mesozoic formations of the Ionian Zone were distinguishes by means of radiometric methods:

- Bituminous schists in contact between dolomites of Upper Triassic and massive dolomitic limestones of Lower Jurassic.
- Uranium-bearing phosphate mineralization of the Middle Jurassic.
- Upper Cretaceous phosphate horizon.

2) Radiometric anomalies helped to explore uranium-bearing mineralization of Middle Jurassic age in two types:

- Bedded mineralization
- Infiltration type of mineralization which is widespread in Ionian Zone.

3) Uranium is in equilibrium with radium with absolute absence of Thorium and Potassium.

4) Rose diagrams of gamma-natural radiation and fissures show the existence of two systems of cracks correlated to uranium-bearing phosphate mineralization. The first system parallel to the plane disconformities is more important for concentration of mineralization than the other one.
5) Two deposits and many outcrops of uranium-bearing phosphorites ores were prospected. Geological and geophysical studies bear witness about good perspective of this mineralization in Central part of Kurveleshi anticline Belt and in Southern Part of Çika anticline Belt. The reevaluation of the uranium-bearing phosphate deposits in Ionian Tectonic Zone is recommended

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