



MINING AND METALLURGY INSTITUTE BOR
TEHNICAL FACULTY BOR, UNIVERSITY OF BELGRADE



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International October
Conference

**47th International October Conference
on Mining and Metallurgy**

PROCEEDINGS

Editors:

**Ana Kostov
Milenko Ljubojev**

**4th – 6th October 2015
Hotel “Jezero” Bor Lake, Serbia**



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and



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DEPOSIT OF THE LISINA PHOSPHATES LIKE THE BASE OF RAW MATERIALS FOR PRODUCTION THE NATURAL MINERAL FERTILIZERS

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ABSTRACT

Deposit of the Lisina phosphates is in the southeast of Serbia, on the territory of the community Bosilegrad, close to Serbian-Bulgarian border. Genetically, the deposit of the Lisina phosphates belongs to the metamorphic deposits. Narrow area of the deposit is built by metamorphic formations with intensive presence of granitoid rocks. Phosphorites are in the contact zone of the Meta sandstone which is the floor of sericite-chlorite slates with intercalations of marble and kalkshist in the roof. Raw phosphates can be applied as fertilizers with the positive effects on the territory of Serbia where are mostly the acid soils on more than 50% of the territory.

Keywords: deposit Lisina, phosphates, nature mineral fertilizers

INTRODUCTION

Phosphorite layer inside the deposit is discovered according its extending in the Valley of Bozicka River, 5.5 km long, and it is from Bosilegrad on the southeast to Lisina on southwest. The thickness, based on the results of exploration works, is 16 to 32 m. The ore layer declines to the northeast by the angle of 20-30 degrees. Contents of P_2O_5 vary in the wide range and it is 15-19%. The ore horizon is represented with metamorphic quartz sandstones where like the main content appears quartz, carbonate, biotite with chlorite, small grain size epidotic, organic material, limonite and hematite. Phosphoric material is present in the form of apatite.

The co-operators of ITNMS from Belgrade a few years before together with agriculture Faculty from Zemun, studies the effects of application the nature phosphates (apatites) like fertilizers in agriculture. About that an about the deposit Lisina we shell talk in the further part of the text.

1 GEOLOGY CONSTRUCTION OF THE DEPOSIT

During 1999. Year from ITNMS started initiative for opening and exploitation of deposit Lisina, in the frame of acute Serbian needs for the raw materials for production the simplex fertilizers. Exploration the deposit Lisina and calculation the reserves were made by Geo Zavod.

Narrow area of the deposit is built of the metamorphic formations with intensive presence of granitoid stones. Phosphorates appears in the contact zone of Meta sandstones which makes the floor and sericite chlorite slates with intercalations the marble and kalksists in the roof. In the deposit came to granitisation the highest levels of the floor Meta sandstones, so in the floor of phosphorates are granitoid stones. Between the phosphorates and floor granitoides is clear concordance relation.



Phosphorite layer is opened along the spread in the valley of the Bozicka river in length 5.5 km, and it spreads from Bosilegrad on the southeast to Donja Lisina on northwest. Its thickness according to the exploring works is 16-32 m. Ore layer, and parts of metamorphic series declines to northeast by the angle of 20-30 degrees. Contents of P_2O_5 vary in the wide range and they are 15-19%.

In the northwest and central part of the deposit, in the middle part of phosphorite horizon, there is a layer of marble whose thickness is 2-6 m, which marked the position of productive parts of ore level. Productive parts of the phosphorite horizon lies just under the marble and their thickness is 2-20 m. In the southwest part of the deposit, marbles omits. Floor border of the phosphorates and granitoides stones is not sharp, already it is marked by the crossing zone in which appears granitized phosphorite. Roof contact according to the sericite chlorite slates is gradual. Refer level is sulphide level which consists from the impregnations of the sulphide minerals and magnetite in the highest levels of phosphorates. Thickness of this zone is from 0.5 to 4 m.

Genetically, the deposit Lisina belongs to the metamorphic, primary massive sand type of phosphorite deposits. The ore horizon is presented with metamorphed quartz sandstones where like the main content appears quartz, carbonate, biotite with chlorite, small grain size epidote, organic material, limonite and hematite. Phosphoric material is present in the form of apatite. During the forming of sandstones, phosphate is tailed like cement material. By later processes of regional metamorphism and acting the impressed masses of granitoides came to precrystallization of phosphate material and forming the apatite which is useful component now.

1.1 Petrological-mineralogical characteristics of the mineral raw material

Phosphorates which are discovered in this area are presented by weak metamorphed sandstones in which the important component is apatite. Mineral composition of the metamorphed apatite sandstones is following: quartz, sericite, apatite, biotite with chlorite, small grain size epidote, tourmaline, non transparent minerals –organic material, limonite, and hematite.

2 QUALITY OF MINERAL RAW MATERIAL – RESEARCH TECHNOLOGY

In 1999, the ITNMS started initiative for opening and exploitation the deposit Lisina. Exploration of the deposit Lisina and calculation the reserves was made by Geo Zavod –IMS.

After the detailed analysis of the existing geology documentation and in accordance to the mentioned criteria, it was found out that the surface exploration will be possible on the part of scion zone Lisina, on the location Panjevica(Ledine).

Locality Panjevica is on the right side of the Bozicka River, 2 km from Donja Lisina via Bosilegrad. It is non-erosion part of the synclinal of this softly rugged area, so it is kept the area from about 5 km² of Meta sandstones which are not under the granitization process. From that area, about 1.2 km are phosphorates which are practically on the surface, because the all series on this part declines under the angle of 20 degrees. These are meta-sandstones enriched by apatite by petrology position. The layer of phosphate is under the relatively thin (0.2-1 m) diluvium cover, covered by the forest, so location is ideal for the opencast mine.



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During the calculation the ore reserves in 1999 (locality Panjevica), the ore reserves of B category were obtained of 1 231,331t with 13.94 P₂O₅% that will be explored by the future opencast mine.

Technology characteristics of the ore are studies continuously in all phases of the research. The preliminary laboratory testing was made in 1960 in Department for Mineral processing at the Faculty of Mining and Geology in Belgrade. The sample had the following composition:

P ₂ O ₅	11.47 %
Fe ₂ O ₃	3.79 %
Al ₂ O ₃	9.90 %
CaO	17.59 %
Lost by frying	3.72 %
Non-dissolved residue	60.28 %

It was proved by the tests of concentration that with flotation procedure the following balance can be obtained: with the input raw material with content of 11% P₂O₅, concentrate can be obtained with 33 % P₂O₅ while the recovery is 93.70 %.

Concentrate had the following chemical composition:

P ₂ O ₅	33.00 %
Fe ₂ O ₃	1.97 %
Al ₂ O ₃	1.02 %
CO ₂	2.15%
ClO	47.30 %
F	3.85%
None dissolved residue	11.28 %

As it can be seen, the content of malicious additives (oxides, carbon dioxide and non dissolved residue) is in the allowed limits, and concentrate with such quality is favorable for production of super phosphate.

In 1994, the specialists from the ITNMS took a sample of apatite of 10 t from the locality Bele Vode which was prepared in the plants for making the vegetation experiments of Institute and it would be added to the soil like dozer of phosphor.

Chemistry composition of these samples of the phosphates is following:

SiO ₂	39.20-47.20%	
Al ₂ O ₃	9.22-10.54%	Damaged elements:
Fe ₂ O ₃	2.33-5.31%	F - 0.226 -0.282%
CaO	17.24-21.61 %	Pb - < 20 ppm
P ₂ O ₅	12.83-18.2%	Cd - < 20 ppm
Mo	- 20 ppm	Sn - < 20 ppm
Co	- 20 ppm	Ni - 26-35 ppm
Cu	- 17-28 ppm	As - 10.0 ppm
Zn	- 87-91 ppm	U - 6.0 ppm
Mn	- 456-476 ppm	
Se	- 2-3 ppm	

Based on the research results of the Lisina phosphates - apatite, it is possible to say that they are used as the phosphoric fertilizers because of:

- high content of phosphor (P₂O₅ from 12, 8 – 18, 9), almost like in super phosphates



- very low content of damage elements (Pb, Cd, Sn, Ni, As), especially uranium and flour – which is much bigger in imported phosphates
- content of nutritive elements (Fe, Zn, Co, Cu, Se, Mn)

Quantity of apatite that was taken (from 10t) is milled to granulation 0.1 mm and 11 samples are defined, and every of them have determined content of P_2O_5 . These samples of phosphate fertilizers are applied on the acid soils at many locations (Guča, Kragujevac, Mladenovac, Šabac, Salaš); during making the vegetation test experiments on many agricultural cultures (corn, potato, bean).

When the study is based on yield (there are exactly data – literature 4- which are not the topic of this paper), the applied phosphate fertilizer LIFOS is the obvious. It increases the pH of acid soils (especially in combination with pure calcium carbonate) and increases the yield of experimental agricultural cultures.

Such results is a attention of many institutions and companies in our country as well as the one of the famous company - Geology Institute of Serbia that makes the additional geology exploration of the deposit for fully observing and defining the parts of the deposit which are suitable for the opencast mining of the mineral raw material.

CONCLUSION

Territory of the Republic of Serbia has mostly the acid soils ($ph < 6$ on more than 50% of the territory) that need the application of the nature and simplex mineral fertilizers in a large quantity to increase the yield of all agricultural cultures. Deposit of the Lisina phosphates with its reserves of apatite, and qualitative characteristics, makes possibly a long-term exploitation and satisfying the domestic market with this mineral raw material.

ACKNOWLEDGMENTS

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