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# RAW MATERIALS USED FOR THE PHOSPHATE FERTILIZER PRODUCTION IN ROMANIA - NEW RADIOMETRIC DATA

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**Abstract** Uranium, thorium and potassium were measured by low background gamma spectrometry in natural apatites used as raw materials in the phosphate fertilizer industry. The results confirmed that the phosphates of sedimentary origin (i.e. the samples from Jordan and Morocco) have higher concentrations of uranium (98-119 ppm) and lower concentrations of thorium (21-31 ppm), while phosphates of magmatic origin (i.e., Kola Peninsula, Rajasthan) are thorium-richer (40-117 ppm) and uranium-poorer (24-35 ppm).

**Key-words:** phosphates, uranium, thorium, sedimentary, magmatic

## 1. Introduction

The nature of phosphate fertilizer produced by sulfuric acid attack and the nature of phosphogypsum as technogenic by-product are directly determined by the type of the phosphate ore used for the production of phosphoric acid. The phosphate ores used in the industry of phosphate fertilizers are generally of sedimentary origin, rarely of igneous origin and exceptionally of metamorphic origin. Sedimentary phosphates (phosphorites), represent about 85 % of the phosphate rock used for the production of phosphoric acid (Habashi, 1980), which is also the case of the producers in Romania.

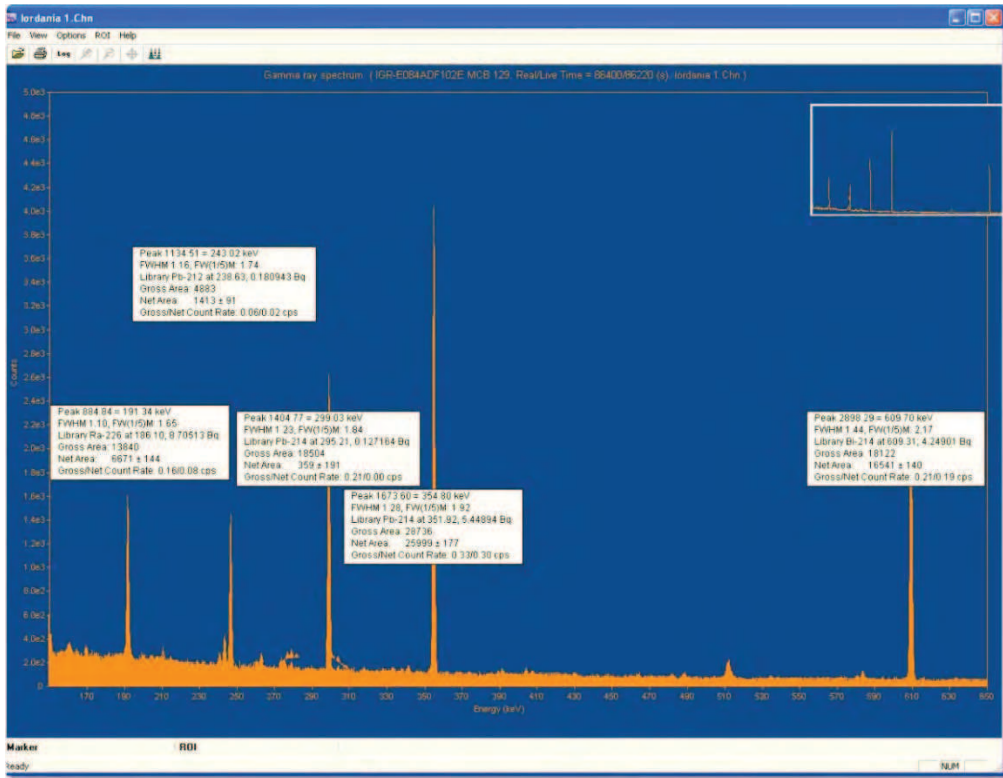
In fact, the composition and quality of the base phosphate ores clearly indicates their genesis. In most of the phosphate deposits, apatite is the main P-bearing mineral (Lehr and McClellan, 1972) and has a relative chemical homogeneity. The mineralogy is rather simple, the main constituent of the deposits being apatite-(OH) in the case of the sedimentary ores and apatite-F in the case of the magmatic ones.

## 2. Methods

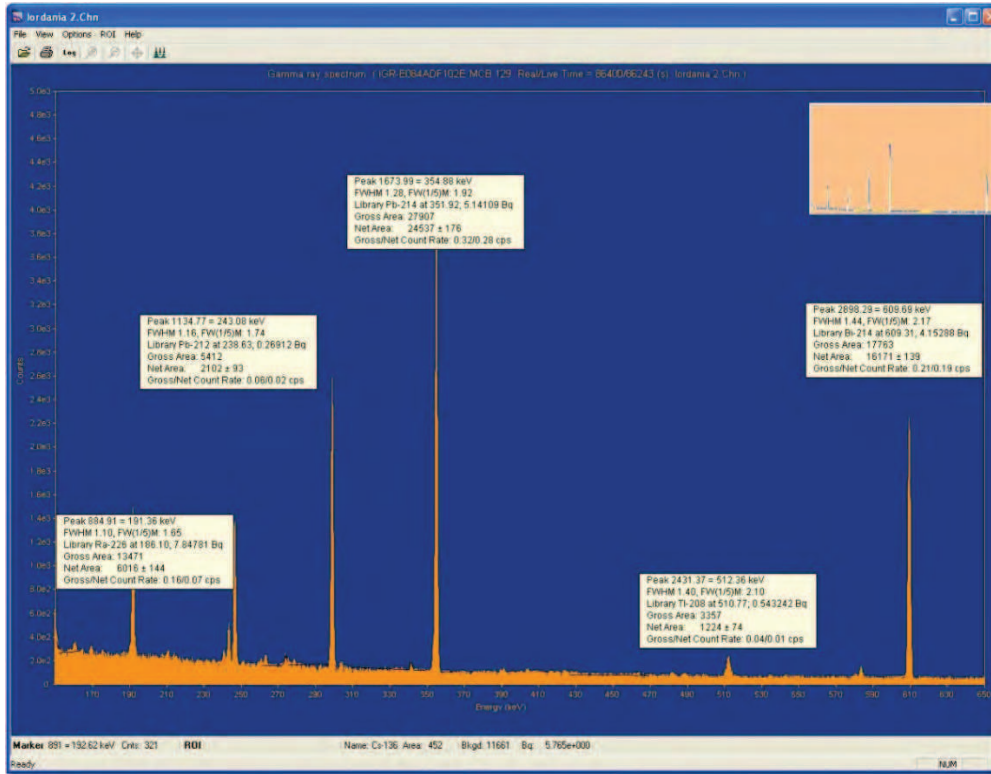
The determination of uranium, thorium and potassium by low background gamma spectrometry with HPGe detector is a simple and nondestructive method that requires a simple preparation of the sample. The method allows the selective determination of uranium, thorium and potassium, up to very low limits (under 0.1 ppm). The Gamma spectrometric equipment used for analysis included a DSPEC jr. 2.0 device, with 16684 channels, digital multi-channel analyzer, HPGe detector model GEM-25 pop-top (relative detection efficiency of 26 %, resolution ranging from 1.8 keV to 1332 keV for Co-60 and 0.8 to 122 keV for the cobalt line in the standard, peak/Compton ratio of 56/1). The device uses electromechanical cooling (X-cooler II), a protection of Pb screen-type and a HPGe detector of ORTEC type.

The gamma spectra of the apatite samples was performed with a standard spectrometric equipment using the following work conditions: the energy calibration was done with Eu-152 and Cs-137 radioisotopes, for the optimal energy range between 50 and 2000 keV, the channel width for measurements was of about 0,5 KeV, the counting time was of 86400 s. Both the samples and the standards were measured under the same conditions of geometry and time.

Radiometric determination was performed on five apatite samples from four different locations namely: two apatite samples from Jordan, one sample from Morocco, one sample from the Kola Peninsula and one sample from Rajasthan (India).

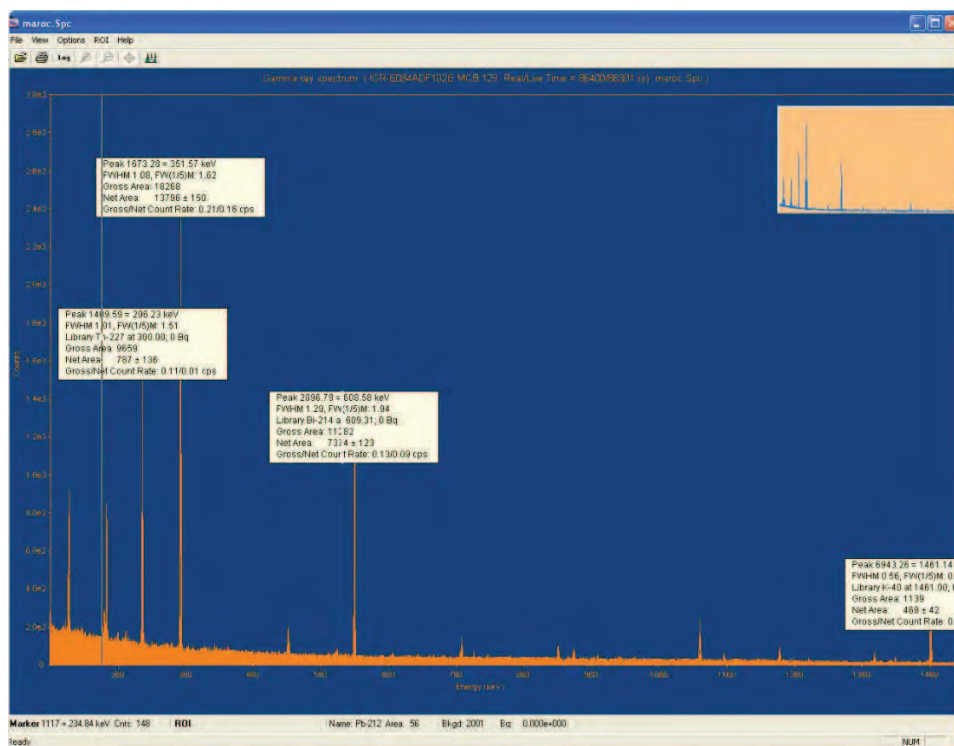


A



B

**Fig. 1.** A. Gamma-ray spectrum of Jordan 1 apatite sample. Note the high content in U-238; **B.** Gamma-ray spectrum of Jordan 2 apatite sample. Note also the high content in U-238; **C.** Gamma-ray spectrum of an apatite sample from Morocco. Note also the high content in U-238.



C  
Fig. 1. – continued.

### 3. Results

The results of radiometric analyses on the five apatite samples used in the production of phosphoric acid and phosphogypsum are given in Table 1.

**Table 1.** Radio isotopes in the apatite samples used for the manufacture of phosphoric acid

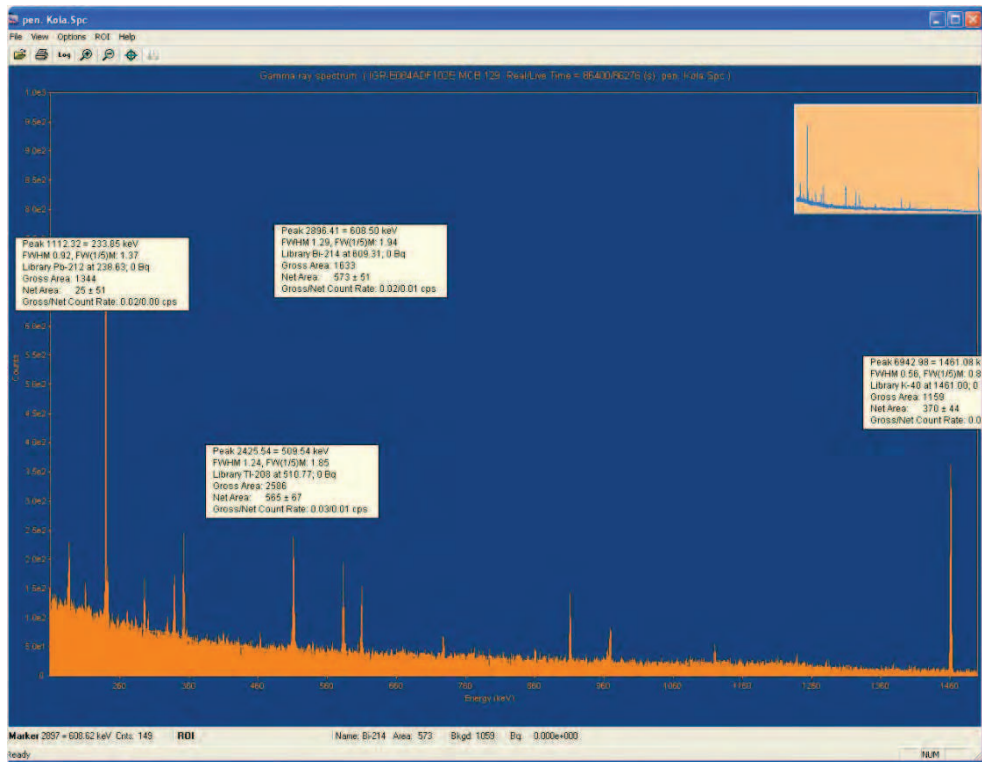
<i>Sample location</i>	<i>U-238 (ppm)</i>	<i>Th-232 (ppm)</i>	<i>K-40 (%)</i>
<b>Jordan 1</b>	100.45	30.12	0.023
<b>Jordan 1</b>	119.35	20.75	0.031
<b>Morocco</b>	98.21	31.12	0.12
<b>Kola Peninsula (Russia)</b>	24.12	117.48	0.17
<b>Rajasthan (India)</b>	34.74	40.12	1.04

The resulting gamma ray spectra of the five samples are depicted in Figs. 1 and 2. They are represented in terms of counts (number of pulses/unit time) versus energy.

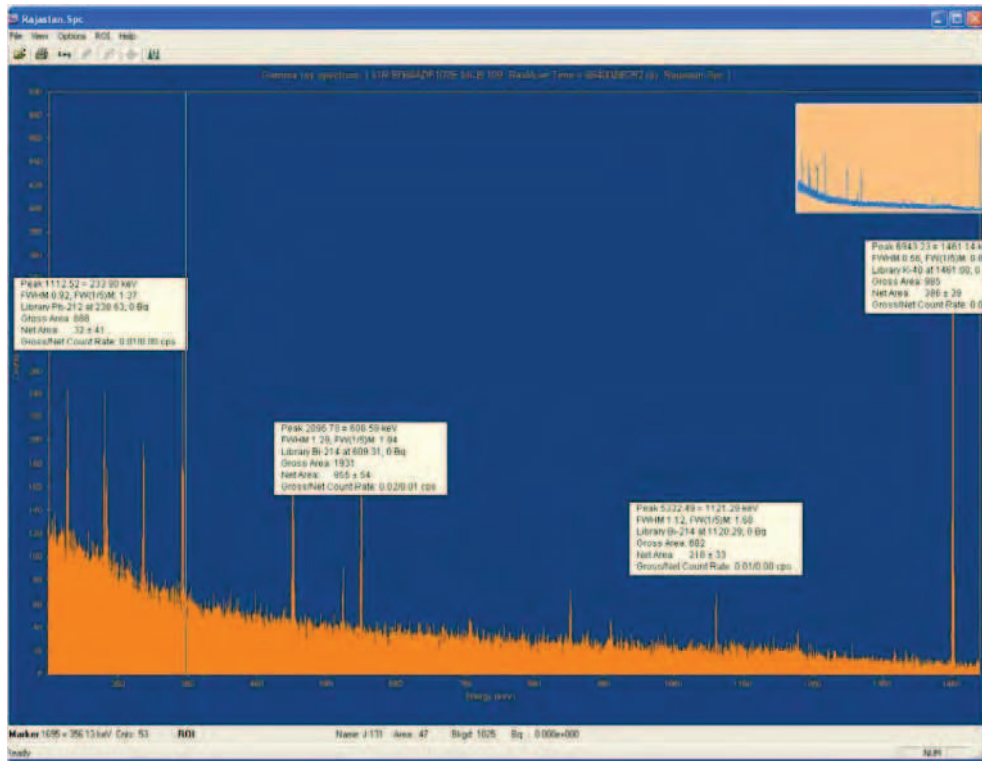
When the radiation is monoenergetic and its energy is completely absorbed by the detector, the spectrum is represented by a line (theoretical spectrum). In reality, the bands in the experimental spectra are not lines but complex peaks of different extension, because their amplitude is a factor of the fluctuations in the absorption of the radiation of the same energy. Broadening of the bands is amplified by other instrumental factors. The peak shape is similar to a Gaussian curve and the apex location indicates the radiation energy.

### 4. Conclusions

The radiometric study of the natural apatites used as raw materials in the phosphate fertilizer industry is an easy method for the determination of their origin. Our study confirms that the phosphates of sedimentary origin (i.e. the samples from Jordan and Morocco) have higher concentrations of uranium and lower concentrations of thorium, as proved by the frequency of the radioactive U-238 isotope. Phosphates of magmatic origin (i.e., Kola Peninsula, Rajasthan) are, on the contrary, thorium-rich, as proved by the high contents in Th-232.



A



B

**Fig. 2.** A. Gamma-ray spectrum of a sample of magmatic apatite from Kola Peninsula. Note the high content in Th-232; B. Gamma-ray spectrum of a sample of apatite from Rajasthan. Note also the high content in Th-232, which suggests its magmatic origin.

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