# TRANSMUTATION OF CHEMICAL ELEMENTS AND ISOTOPE TRANSFORMATION WITH THE USE OF BIOTECHNOLOGY

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**Radioactive raw material containing radioactive chemical elements or their isotopes are treated with water suspension of bacteria Thiobacillus genus. Radioactive wastes from nuclear fuel cycles are used as radioactive raw material. The method allows artificially obtaining polonium, francium, radium, actinium, protactinium, artificial isotopes of thorium and uranium. The invention allows obtaining valuable radioactive elements and their isotopes, as well as inactivating nuclear wastes with conversion of dangerous for people radioactive isotopes into stable ones.**

Key words: innovation, technology, science

### 1.1. Introduction

Authors discovered an unrivalled method and technology of the cold transmutation of chemical elements and isotopic transients [1] with the minimum cost of production the most valuable chemical elements that comprise huge amounts of energy. These are chemical elements, such as hafnium, platinum, polonium, francium, radium, actinium, and a number of actinides, such as protactinium, curium, berkelium, californium, their isotopes, as well as many other transuranic elements.

The cost advantages and profits are huge, the economic effect of producing actinides will influence, both locally (at the national level) and globally (at the macroeconomic world level), practically all human economical activity, the market prices of all kind of energy and practically all market goods (oil, gas, coal, all metals, agriculture production, fertilizers, etc.) decreasing multifold.

Until now, almost all the above elements and isotopes (apart from uranium-235), such as polonium, actinium, protactinium, uranium-232, americium-242, berkelium, and californium, were produced in milligrams or, at best, in grams, which corresponds with today’s real performance of nuclear-armed countries, i.e. countries with well-developed nuclear industries.

All chemical elements, their isotopes, and by-products are produced nowadays by complex and hazardous traditional methods [2], by traditional nuclear reactions [3] in very small (sometimes – in micro scale) amounts not sufficiently enough for energy, technical, industrial, and scientific needs of people [4].

Described by authors microbiological method of transmutation of chemical elements and transformation of chemical isotopes allows obtaining of all mentioned above chemical elements and their isotopes in practically unlimited amounts by simple and safe for the staff and inhabitants ecologically pure method. This method uses minimum water, electricity, heat, solving herewith the energy, industrial, technical, and scientific problems of civilization.

### 2.1. Materials and Methods

Raw materials containing radioactive elements were treated with water solution of Thiobacillus bacteria genus, Thiobacillus aquaesullis or Thiobacillus ferrooxidans species; or their mixture in any proportion. Bacteria of Thiobacillus genus (iron- and sulphur-oxidizing bacteria as well as thermophilic and others) contributed to redox processes of metals were used. Solution pH was controlled by sulphuric acid with a normality of 10N, during the process pH was maintained at 0,8-2,5. Temperature of the process was 28-32 degrees centigrade. Redox potential

(Eh) of the solutions was 400-800mV. Stirring rate was 300 rpm. Solid to liquid phase ratio was 1:10 (100 g of water per one litre of a solution). pH and Eh of a solution, chemical elements and isotopes concentration, as well as microorganisms' vital activity were measured and traced every 24 hours (daily). Process duration was nine – twenty days. The following methods of water solution analysis were used: X-ray fluorescence method for elements' content determination (apparatus types: CYP–02 «Renom FV»; S2 PICOFOX); atomic adsorption method; mass spectrometric method for isotope composition determination.

### 3.1. Results and discussion

Uranium ores from Jordan, Northwest Africa, and Saudi Arabia, thorium sand from Indian Ocean coast, other ores and sands, as well as nuclear waste and other raw materials appropriate for a process were applied for transmutation of elements and obtainment of new elements and isotopes as inputs for microbiological treatment. In this paper a treatment of Jordan uranium ore is presented as an example. Microorganisms Thiobacillus halophilus were used. Time of the process was 9 days, medium pH 2,0 – 2,5. Analysis spectrograms of transmutation of chemical elements under microbiological treatment of Jordan uranium ore depending on process time after one day (24 hours); after 120 hours (5 days); after 192 hours (8 hours) are presented in Figures 1, 2, 3, correspondingly. Results of statistically handled experiments depending on the process time are collected in the Table. Analyses depicted in Fig. 1-3 and summarized in the Table show that at a first day (Fig. 1) the reaction medium contains uranium-238 presented in initial ore and then gradually turned into thorium 234, protactinium-234, protactinium-233, protactinium-232, protactinium-231, uranium-234, uranium-233, uranium-232, thorium--230, actinium-227, radium-226 (Fig. 2), polonium-210, polonium-209, polonium-208, and francium (Fig. 3).

Schemes (1-5) of radioactive decay of elements were derived from experimental data. Schemes of the reactions approved the theory of radioactive decay rather than conflict with it.

Scheme 1 . Receiving of protactinium-231($^{231}$Pa) microbiologically from uranium-238 ($^{238}$U) in two ways.

1-1. $^{238}$U (-α) → $^{234}$Th (-β)→$^{234}$Pa(-n)→ $^{233}$Pa(-β) →$^{233}$U(-2n)→$^{231}$U(+β) →$^{231}$Pa

1-2. $^{238}$U (-α) → $^{234}$Th (-β)→$^{234}$Pa(-2n)→ $^{232}$Pa(-β) →$^{232}$U(-n)→$^{231}$U(+β) →$^{231}$Pa

Scheme 2. Receiving of thorium-230 ($^{230}$Th) microbiologically from uranium-238 ($^{238}$U).

2-1. $^{238}$U(-α)→ $^{234}$Th(-β)→ $^{234}$Pa(-β)→ $^{234}$U(-α)→ $^{230}$Th

Then either the process is stopped (with the receiving of $^{230}$Th) if thorium-230 is a final purpose of the process; or it is continue till the receiving of valuable and rare radioactive isotopes of radium ($^{226}$Ra), radon, astatine, polonium, bismuth, and lead:

2-2.$^{230}$Th(-α)→$^{226}$Ra(-α)→$^{222}$Rn(-α)→$^{218}$Po(-β)→$^{218}$At(-β)→$^{218}$Rn(-α)→$^{214}$Po(-α)→$^{210}$Pb(-β)→ →$^{210}$Bi(-β)→$^{210}$Po

$^{210}$Po(-n)→$^{209}$Po

$^{210}$Po(-2n)→$^{208}$Po

Scheme 3. Receiving of actinium-227 ($^{227}$Ac) microbiologically from uranium-238 ($^{238}$U) in two ways.

3-1. $^{238}$U(-α)→$^{234}$Th(-β)→$^{234}$Pa(-n)→$^{233}$Pa(-β)→$^{233}$U(-2n)→$^{231}$U(+β)→$^{231}$Pa(-α)→$^{227}$Ac

3-2. $^{238}$U(-α)→$^{234}$Th(-β)→$^{234}$Pa(-2n)→$^{232}$Pa(-β)→$^{232}$U(-n)→$^{231}$U(+β)→ $^{231}$Pa(-α)→$^{227}$Ac

Scheme 4-1. Receiving of radium-226 ($^{226}$Ra) microbiologically from uranium-238.

$^{238}U(-\alpha)\rightarrow {}^{234}Th(-\beta)\rightarrow {}^{234}Pa(-\beta)\rightarrow {}^{234}U(-\alpha)\rightarrow {}^{230}Th(-\alpha \rightarrow {}^{226}Ra$

Scheme 5. Receiving of the most valuable and stable isotopes of polonium ($^{210}Po$,$^{209}Po$,$^{208}Po$) microbiologically from uranium-238 ($^{238}U$).

5-1. $^{238}U(-\alpha)\rightarrow{}^{234}Th(-\beta)\rightarrow{}^{234}Pa(-n)\rightarrow{}^{233}Pa(-\beta)\rightarrow{}^{233}U(-2n)\rightarrow{}^{231}U(+\beta)\rightarrow{}^{231}Pa(-\alpha)\rightarrow$

$\rightarrow{}^{227}Ac(-\beta)\rightarrow{}^{227}Th(-n)\rightarrow{}^{226}Th(-\alpha)\rightarrow{}^{222}Ra(-\alpha)\rightarrow{}^{218}Rn(-\alpha)\rightarrow{}^{214}Po(-\alpha)\rightarrow{}^{210}Pb(-\beta)\rightarrow$

$\rightarrow{}^{210}Bi(-\beta)\rightarrow{}^{210}Po$

$^{210}Po(-n)\rightarrow {}^{209}Po$

$^{210}Po(-2n)\rightarrow {}^{208}Po$

5-2. $^{238}U(-\alpha)\rightarrow{}^{234}Th(-\beta)\rightarrow{}^{234}Pa(-2n)\rightarrow{}^{232}Pa(-\beta)\rightarrow{}^{232}U(-n)\rightarrow{}^{231}U(+\beta)\rightarrow{}^{231}Pa(-\alpha)\rightarrow{}^{227}Ac\rightarrow$ further the ways of transformation of elements and isotopes till $^{210}Po$,$^{209}Po$,$^{208}Po$ are identical to scheme 7-1.

5-3.$^{238}U(-\alpha)\rightarrow{}^{234}Th(-\beta)\rightarrow{}^{234}Pa(-\beta)\rightarrow{}^{234}U(-n)\rightarrow{}^{233f}U(-\alpha)\rightarrow{}^{229}Th(-\alpha)\rightarrow{}^{225}Ra(-\beta)\rightarrow$

$\rightarrow{}^{225}Ac(-n)\rightarrow{}^{224}Ac(+\beta)\rightarrow{}^{224}Ra(-\alpha)\rightarrow{}^{220}Rn(-\alpha)\rightarrow{}^{216}Po(-\alpha)\rightarrow{}^{212}Pb(-\beta)\rightarrow{}^{212}Bi(-n)\rightarrow{}^{211}Bi(-\beta)\rightarrow \rightarrow{}^{211}Po(-n)\rightarrow {}^{210}Po$

$^{211}Po(-2n)\rightarrow {}^{209}Po$

From Table data, spectrograms, and derived schemes (1-5) one can see that microorganisms initiate and enhance alpha decay (-α), beta-minus (-β), and beta-plus (+β) decays (electron capture). Microorganisms capture protons, alpha-particles (two protons and two neutrons) and electrons (beta-minus decay) in nuclei of heavy elements (mostly in any f-elements and heavy s-elements), moving captured protons, alpha-particles, and electrons to other elements (mostly to d- and p- elements, e.g., at arsenic and iron). Microorganisms can transfer protons, alpha-particles, electrons, and positrons to other elements, e.g., to f-element ytterbium if is presents in the medium.

Thus, bacterial capture and detachments of proton, alpha-particles, and electrons occur for alpha- and beta-radioactive isotopes of f-, s-, and p- elements which are naturally alpha- or beta- radioactive. Bacteria therewith initiate and million- and milliard-fold enhance alpha- and beta- decay processes.

**4. Conclusions:**

4-1. Bacteria of Thiobacillus genera (e.g., Thiobacillus aquaesulis or Thiobacillus ferrooxidans species) initiate and enhance natural processes of radioactive decay and isotopic transitions of radioactive elements. Duration of natural nuclear reactions and isotopic transitions is enhanced thousands-, million- and milliard-fold depending on natural half-life period of one or another chemical element.

4-2. During treatment of radioactive raw materials containing radioactive chemical elements or their isotopes with suspension of bacteria of Thiobacillus genera a transmutation of chemical elements along with transformation of isotopes of chemical elements occur.

4-3. During transmutation of chemical elements and chemical elements isotopes transformation valuable chemical elements are obtained: polonium, francium, radium, actinium, protactinium, artificial isotopes of thorium and uranium.

4-4. Described microbiological method of transmutation of chemical elements and transformation of chemical elements isotopes solves the problem of energy and rare deficient material supplement of various branches of industry, science and technology.

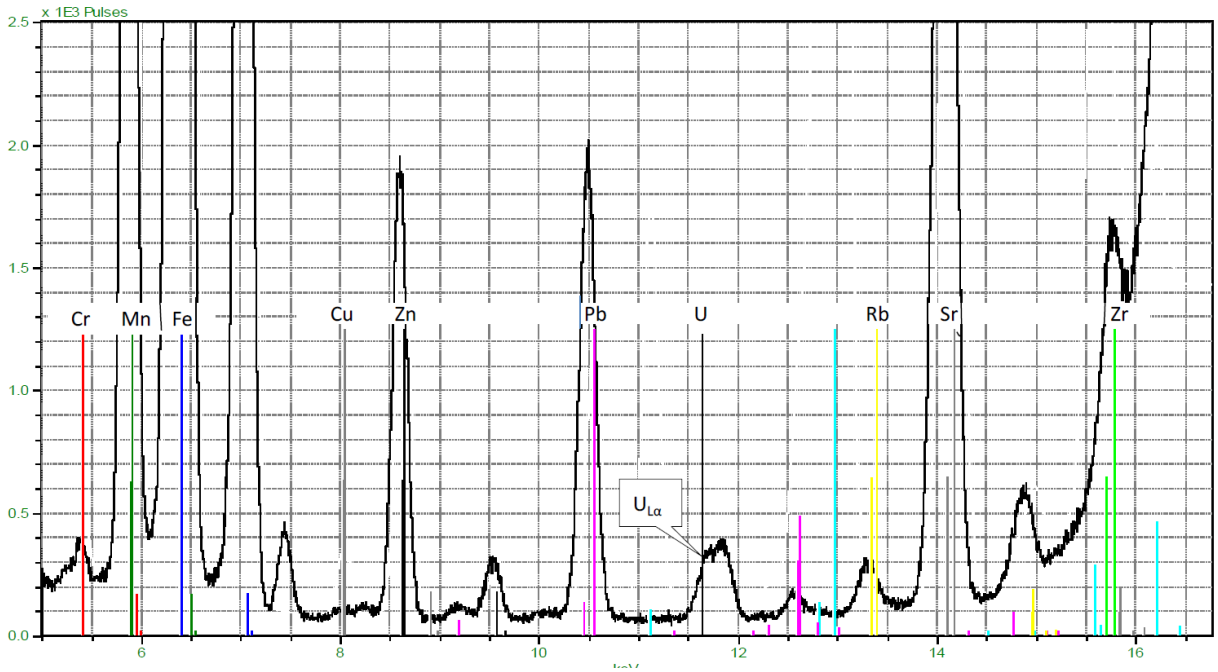


Fig. 1. Transmutation of chemical elements under microbiological treatment of Jordan uranium ore (first day of the process).

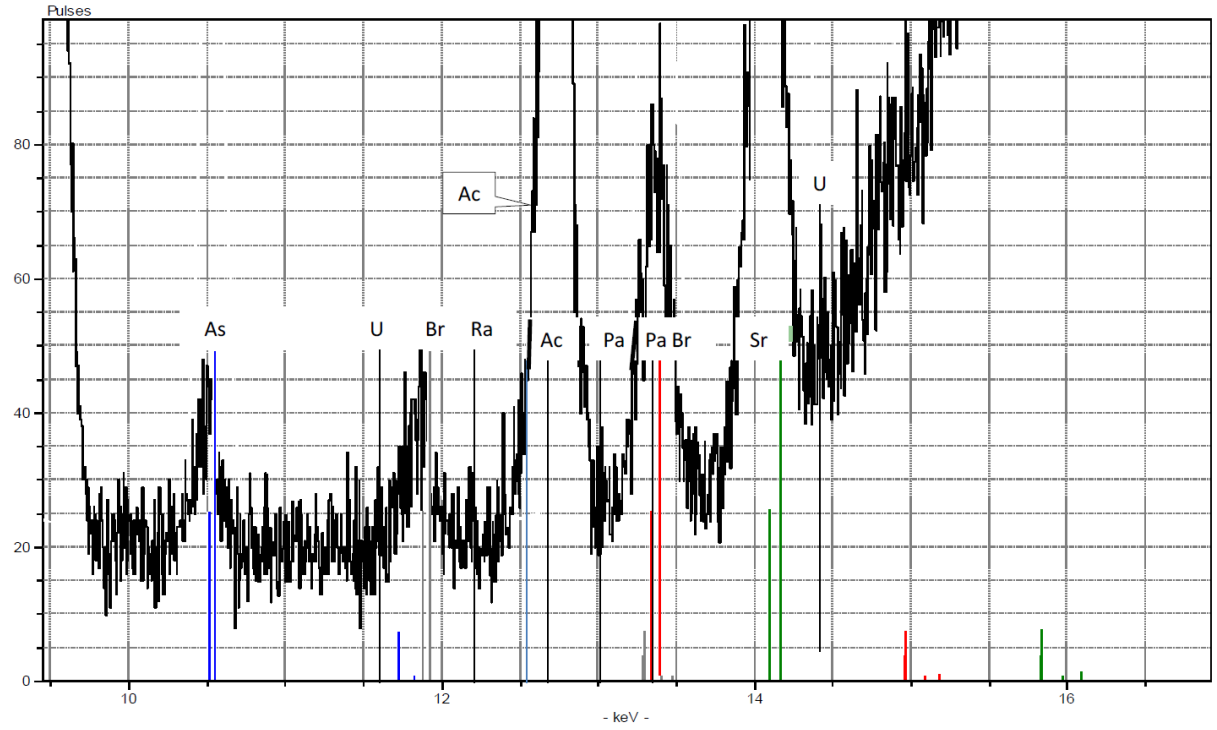


Fig. 2. Transmutation of chemical elements under microbiological treatment of Jordan uranium ore after 120 hours (five days in process).

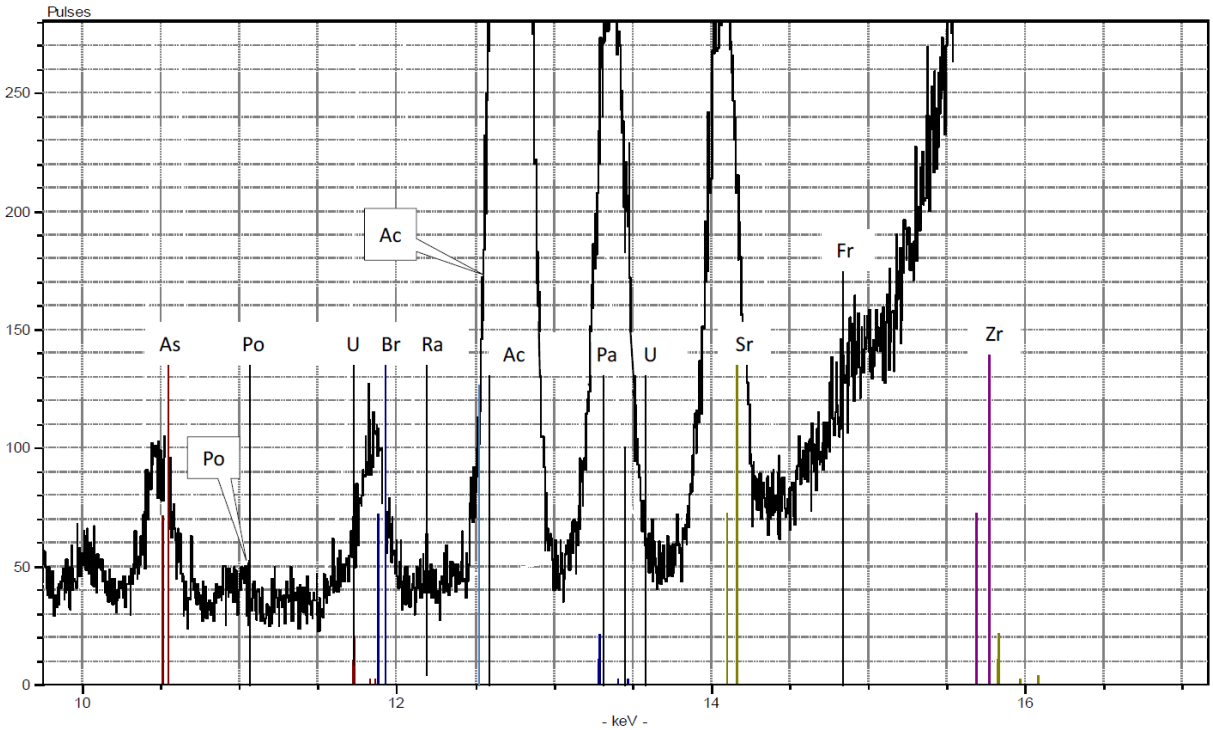


Fig. 3. Transmutation of chemical elements under microbiological treatment

of Jordan uranium ore after 192 hours (eight days in process).

Table. Results of transmutation of chemical elements and transformation of isotopes under microbiological treatment of Jordan ore

| Elements | Half-life period $T_{1/2}$ | Content of elements in 100 g of ore, mg | Content of mg of elements in 1 litre of solution per 100 g of ore, mg of element/100 g of ore in 1 l of solution. (Jordan ore, mass fraction $^{238}U$=387,5g/tone) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Days | | | | | | | | |
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| $^{238}U$ | $4,5x10^{9}$ , years | 38,78 | 38, 78 | 27,25 | 10,75 | 2,62 | 0 | 0 | 0 | 0 | 0 |
| $^{234}Th$ | 24,1 days | 0 | 0 | 6,87 | 10,38 | 7,37 | 0 | 0 | 0 | 0 | 0 |
| $^{234}Pa$ | 6,66 hours | 0 | 0 | 4,48 | 1,16 | 0 | 0 | 0 | 0 | 0 | 0 |
| $^{233}Pa$ | 27 days | 0 | 0 | 0 | 2,00 | 2,25 | 2,32 | 0 | 0 | 0 | 0 |
| $^{232}Pa$ | 1,31 days | 0 | 0 | 0 | 3,41 | 4,14 | 1,25 | 0 | 0 | 0 | 0 |
| $^{231}Pa$ | $3,43 \times 10^{4}$ years | 0 | 0 | 0 | 0 | 6,37 | 12,64 | 17,74 | 11,87 | 6,06 | 5,49 |
| $^{234}U$ | $2 \times 10^{16}$ years | 0 | 0 | 0 | 5,71 | 6,28 | 4,16 | 3,97 | 3,86 | 2,87 | 1,32 |
| $^{233}U$ | $1,62 \times 10^{5}$ years | 0 | 0 | 0 | 4,77 | 4,95 | 3,83 | 0 | 0 | 0 | 0 |
| $^{232}U$ | $8x10^{13}$ years, 74 years | 0 | 0 | 0 | 0 | 2,84 | 3,03 | 0 | 0 | 0 | 0 |
| $^{227}Ac$ | 21,6 years | 0 | 0 | 0 | 0 | 0 | 9,80 | 10,32 | 13,37 | 19,74 | 21,58 |
| $^{230}Th$ | $8 \times 10^{4}$ years | 0 | 0 | 0 | 0 | 1,09 | 0 | 0 | 0 | 0 | 0 |
| $^{226}Ra$ | 1617 years | 0 | 0 | 0 | 0 | 0 | 0,37 | 0,42 | 0,51 | 0,59 | 0,67 |
| $^{210}Po$ | 138,4 days | 0 | 0 | 0 | 0 | 0 | 0 | 0,72 | 2,49 | 3,01 | 6,74 |
| $^{209}Po$ | 103 years | 0 | 0 | 0 | 0 | 0 | 0 | 0,49 | 1,59 | 1,92 | 4,23 |
| $^{208}Po$ | 2,93 years | 0 | 0 | 0 | 0 | 0 | 0 | 0,27 | 0,39 | 0,56 | 1,7 |

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