NATIONAL COMMISSION FOR
NUCLEAR ACTIVITIES CONTROL

URANIUM MINING AND MILLING IN ROMANIA

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National Commission for Nuclear Activities Control - Romania

"Low Grade Uranium Ore"
International Atomic Energy Agency (IAEA)

29-31 March 2010, Vienna, Austria

STARTING OF URANIUM MINING IN ROMANIA

- 1950 – Setting up the "SOVROM KUARTIT" Joint Venture company between Romania and the Soviet Union, similar to other east European uranium companies
- main goal: supporting the soviet nuclear program

GEOLOGICAL SURVEY ACTIVITIES FOR URANIUM DEPOSITS DISCOVERY

- 1950 –1957 large geological survey works within the Banat county – SW of ROMANIA

- 1950 –1954 large geological survey works by gamma logging within the Bihor county -NW of Romania

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THE SURFACE MINING ACTIVITIES FOR URANIUM ORE DURING THE FIFTIES

- 1952 – start of mining for the uranium ore at the Bihor Branch within the "Baita Plai" open – pit
- first quantity of uranium ore was delivered to Soviet Union
- uranium content was 1-5% U in radiometric sorted material

UNDERGROUND URANIUM MINING DURING THE FIFTIES

- 1952 to 1960 – start of underground mining for uranium ore at:

  - the "Avram Iancu" mine (Bihor area), located at 6 km from the Baita open pit

  - the "Natra" and " Ciudanovita" mines – Banat area

END OF "SOVROM KUARTIT'S " ACTIVITY

- 1963 – the "Organizatia Expeditia Geologica" is the new company that follows the Sovrom Kuartit's activity
- end of Romanian- Soviet Union joint venture
- end of the delivery uranium ore to the Soviet Union
- total metal uranium in uranium ore delivered to Soviet Union was estimated more of 20000 t

GEOLOGICAL EXPLORATION WORKS FOR NEW URANIUM RESOURCES AND DEPOSITS IN ROMANIA

- after 1963, important geological exploration works were realized at many possible new uranium deposits
- 1963-1968 discovery of the "Crucea-Botusana"and "Tulghes-Primatar" uranium deposits
- 1968-1998 important drilling and mine works were done at these new uranium areas in order to establish the uranium reserves and prepare commissioning mines

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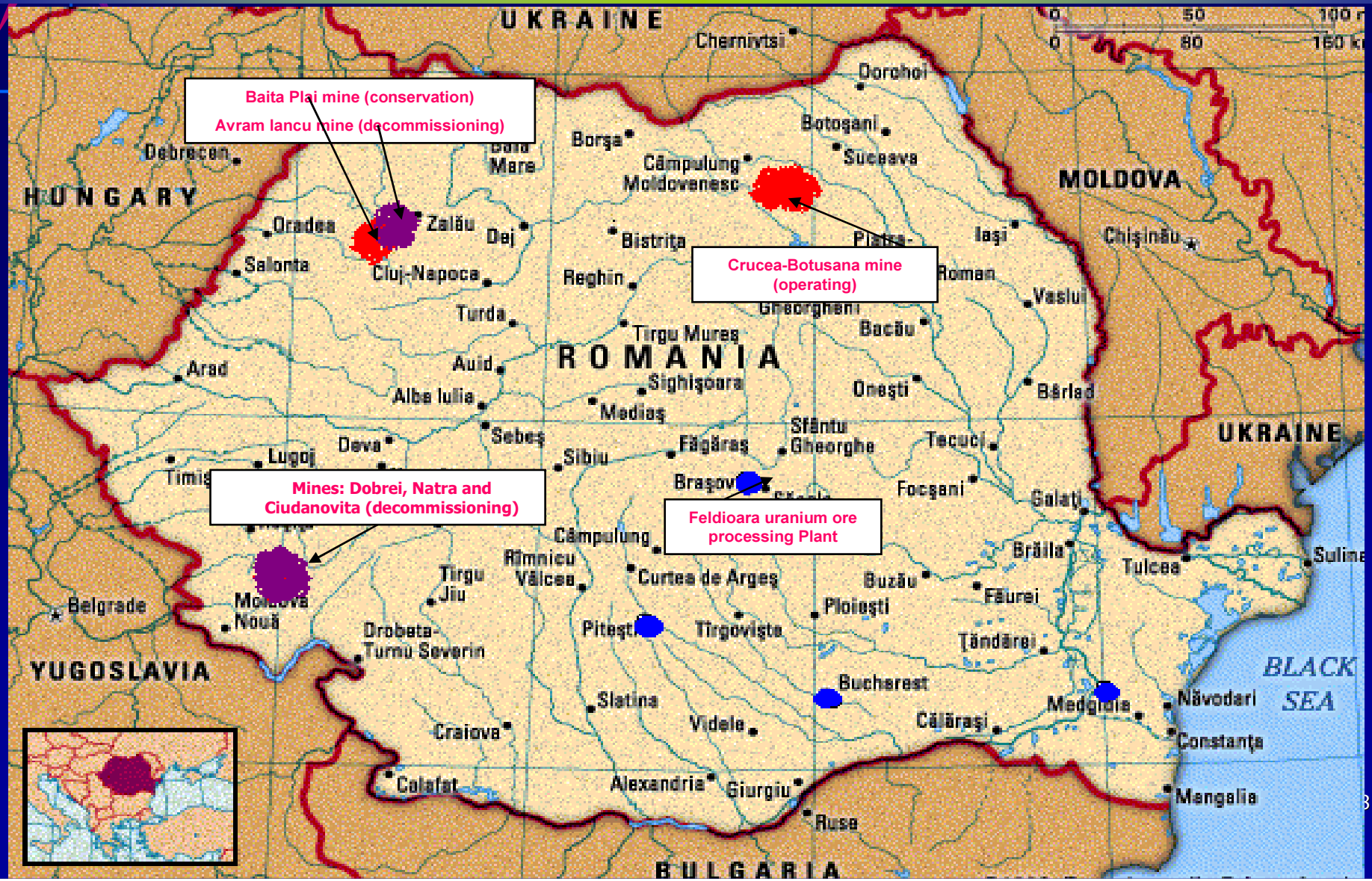
URANIUM MINES - MAP



URANIUM ORE PRODUCTION DURING THE 1963-1977 PERIOD

- Avram Iancu mine- continuous ore production with storage at the mine site
- Banat mines- commissioning of the Dobrei underground mines
- Underground works up to 700 m deep via 11 shafts at Banat mines
- Storage of mined uranium ore at the Banat mines

URANIUM ORE PROCESSING RESEARCH FOR A SUITABLE TECHNOLOGY TO URANIUM "YELLOWCAKE" PRODUCTION

- 1963-1977 many pilot tests were organized for uranium ore processing using samples of ores mined at the Romanian mines
- works at the pilot processing facility and laboratory in STEI town, within the Bihor branch
- first quantities and samples of uranium yellowcake ammonium diuranate of nuclear purity was produced

BEGINNING OF THE PROJECT FOR THE FELDIOARA URANIUM PROCESSING PLANT

- 1972-1976 work at the technical project for the Feldioara uranium processing plant - Brasov county
- Establishing the pressure alkaline leaching as the technology for Romanian ores processing
- Uranium recovery via the ion exchange, using "resin-in-pulp technology"

INDUSTRIAL PROCESSING OF URANIUM ORES

- 1977- beginning of uranium ore transfer from the Bihor and Banat mines to the new processing plant
- 1977-1978 commissioning of the processing Feldioara plant and Cetatuia tailings pond and the first industrial quantities of ammonium diuranate was produced in Romania

COMMISSIONING OF THE NEW URANIUM MINE CRUCEA - BOTUSANA

- 1983- commissioning of the Crucea mine in the Eastern Carpathian mountains
- 1985- commissioning of the Botusana mine close to Crucea mine
- start of uranium ore delivery to Feldioara plant by truck and railway transport-about 350 km

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TRANSPORT OF URANIUM ORE FROM CRUCEA MINE TO FELDIOARA PROCESING PLANT

THE NUCLEAR GRADE URANIUM DIOXIDE PRODUCTION

- 1986- commissioning of the "E" uranium refining plant within the processing Feldioara plant
- first batch of uranium dioxide powder heaving the nuclear grade quality for UO_2 powder used in CANDU-6 type fuel was produced at the Feldioara plant
- delivery of uranium dioxide to the nuclear fuel plant Pitesti

FELDIOARA PROCESSING PLANT

- Processing Plant Feldioara is located in Brasov county;
- It was commissioned in 1978;
- The main activities within the processing plant are: processing uranium ore received via railway from the uranium mines; refining uranium concentrate in order to manufacture nuclear grade uranium dioxide to be used to produce CANDU 6 type fuel bundles.

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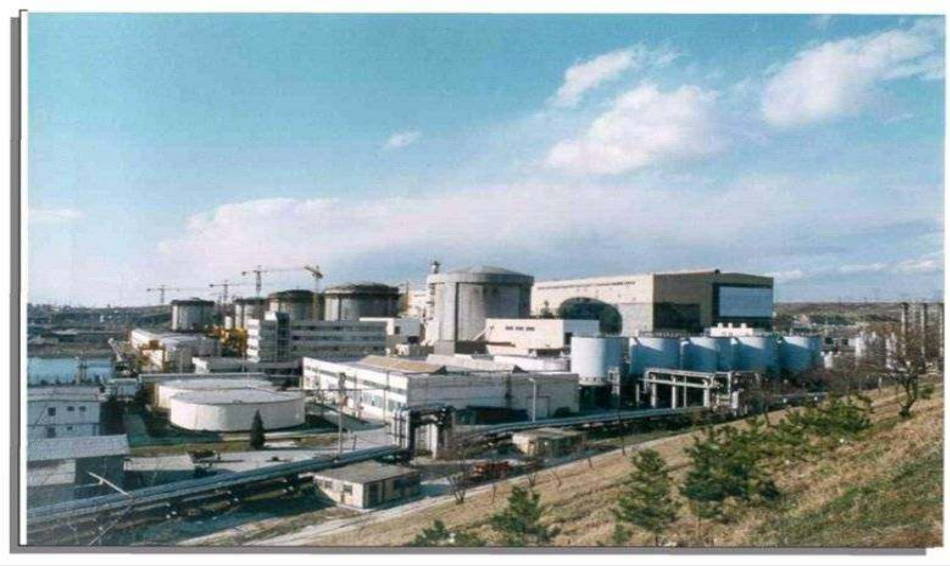
CANDU FUEL FABRICATION PITESTI PLANT

- Nuclear fuel plant Pitesti is since 1995 the CANDU fuel supplier from outside Canada recognized by AECL as an authorized CANDU fuel manufactured

THE USE NUCLEAR OF URANIUM DIOXIDE IN CERNAVODA NUCLEAR POWER PLANT

- 1996- nuclear fuel using Romanian uranium dioxide is used for the first time in the Cernavoda NPP-CANDU reactor
- 1997- to present - all the nuclear fuel used at NPP was produced in Romania

CERNAVODA NUCLEAR POWER PLANT



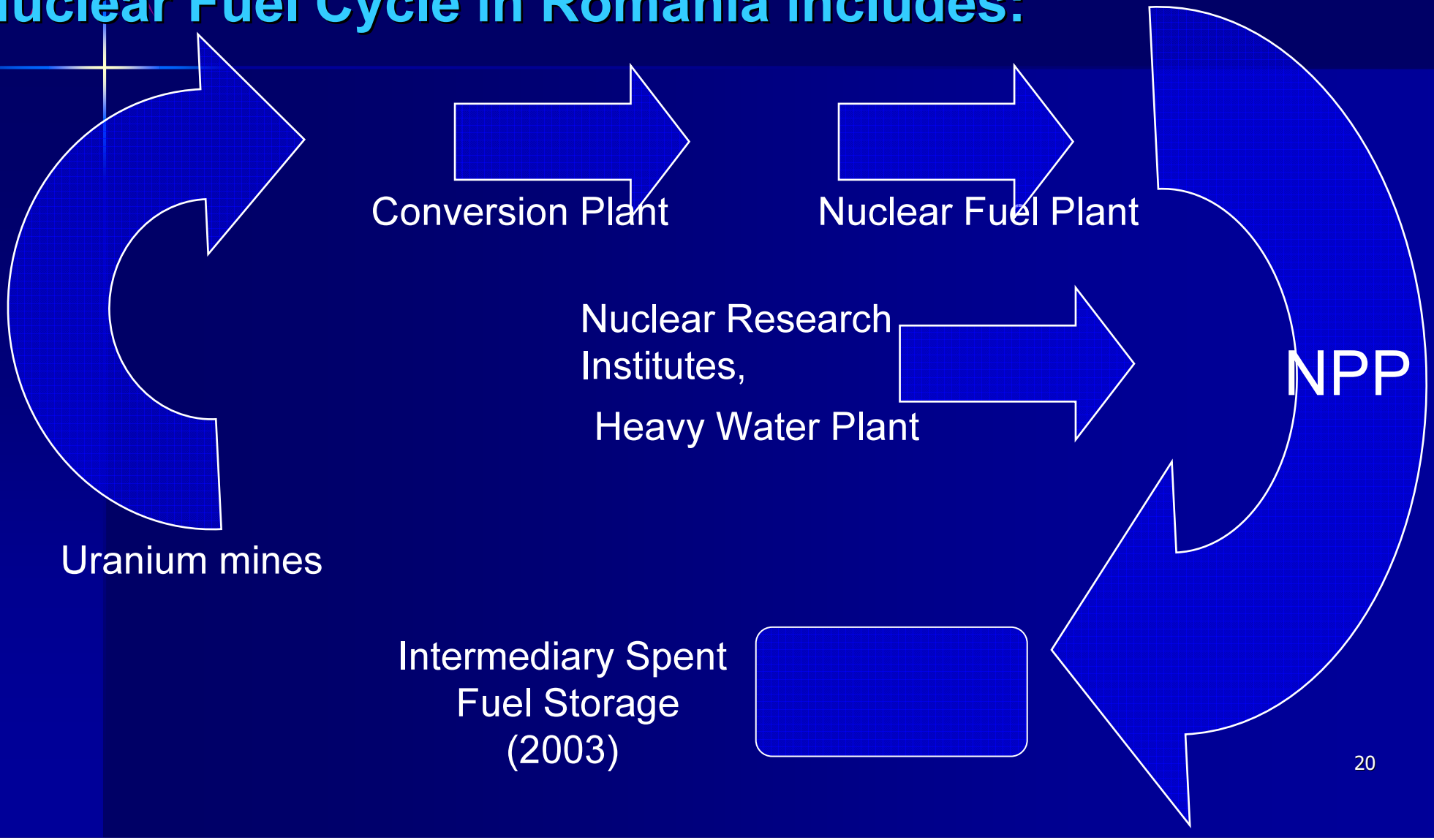
1995 – commissioning of the first power CANDU reactor (Unit 1) at NPP Cernavoda; NPP-CANDU reactor

2005 – commissioning of the first module for spent fuel interim dry storage at NPP Cernavoda

2007 - commissioning of the second power CANDU reactor (Unit 2) at NPP Cernavoda;

2008-2009 – administrative and financial arrangements in order to resume the construction at Unit 3 and Unit 4 from NPP Cernavoda. The commissioning of Unit 3 and Unit 4 is planned for period 2014-2015

Nuclear Fuel Cycle in Romania includes:



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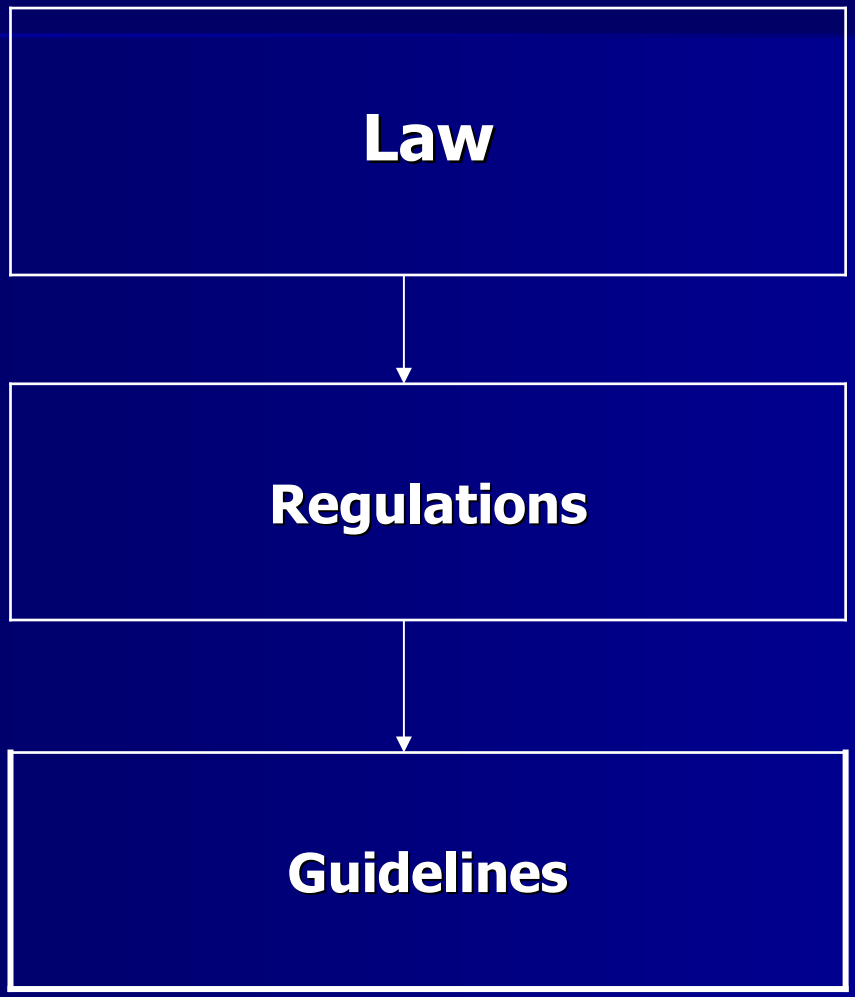
HIERARCHY OF LEGAL BASIS FOR URANIUM MINING (1)



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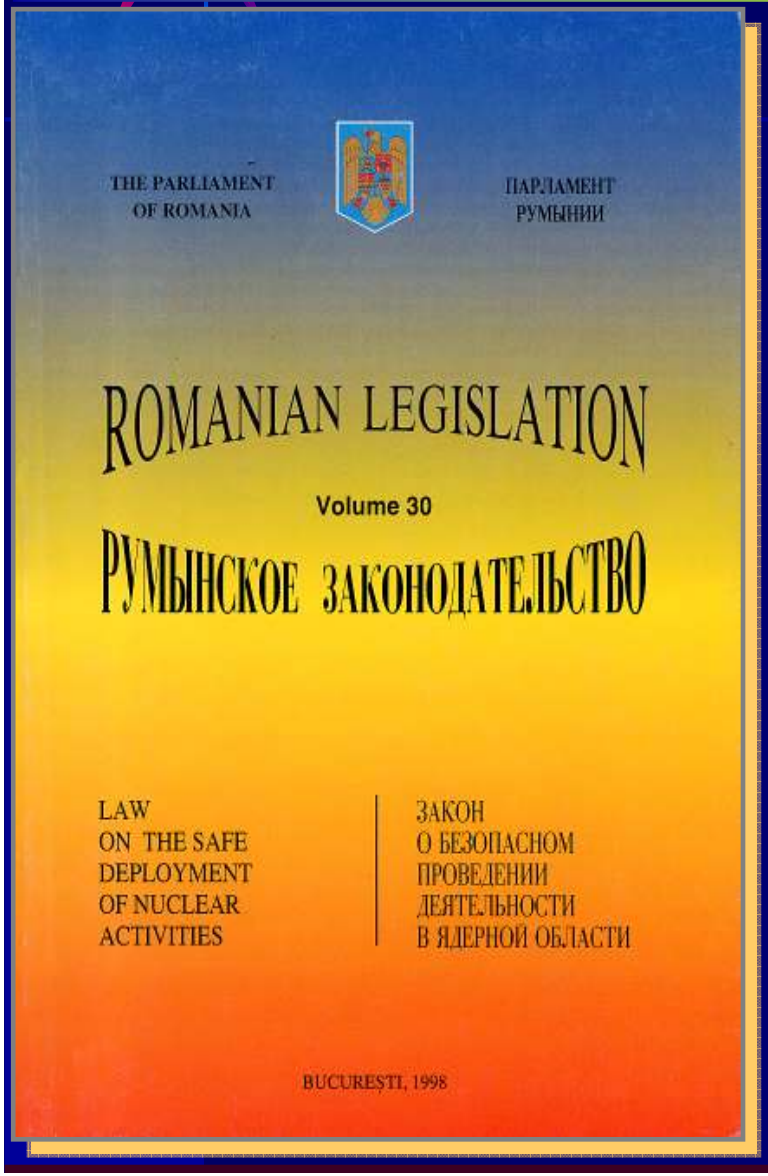
HIERARCHY OF LEGAL BASIS FOR URANIUM MINING (2)

Law no. 111/1996 on the safe deployment, regulation, authorization and control of nuclear activities, republished

Radiation Protection Fundamental Norms

- Radiological Safety Norms for Occupational Radiation Protection in Uranium and Thorium Mining and Milling
- Radiological Safety Norms on the Management of the Uranium and Thorium Mining and Milling Radioactive Waste
- Radiological Safety Norms on the Conservation and Decommissioning of the Uranium and/or Thorium Mining and Milling Facilities
  - Guidelines on the recommended parameters for the Estimation of the effective doses on all ways of exposure
  - Guidelines on the Criteria of release from authorization regime of CNCAN in order to use for other purposes of the buildings, materials, facilities, dumps and areas contaminated following the activities of mining and milling of uranium and/or thorium ores
  - Guidelines on the technical for design, sitting, construction , operation, closing and decommissioning of storage of uranium ore facilities and decommissioning of the uranium and thorium milling waste disposal areas
- Radiological Safety Norms – Authorization Procedures of the Uranium and Thorium Mining and Milling



Law no. 111/1996 on the safe deployment, regulation, authorization and control of nuclear activities

- Published in 1996
- Republished in 1998
- Amended and completed by Law 193/2003
- Amended and republished in Romanian Official Law Bulletin No. 552/2006

OBJECTIVES OF NUCLEAR LEGISLATION IN URANIUM MINING AND MILING FIELD

The purpose of Romanian nuclear legislation in uranium mining and milling field is:

- **To ensure that the mine or mill workers, the public and the environment are adequately protected against radiological hazards while the mine or mill is in operation;**
- **To provide protection before the opening of the mine (during the period of exploration) and after the closure of the mine or mill;**
- **To ensure that waste rock (from the operation of the mine) and mill tailings are treated as radioactive waste.**

Law 111/1996, on the safe deployment, regulation, authorization and control of nuclear activities, republished in 2006, states:

Chapter I, General Provisions, art. 2 b)

The provisions of the present law shall apply to the following activities and sources:

design, possession, sitting, construction-assembly, commissioning operation, conservation and decommissioning of the mining and milling facilities for uranium and thorium ores and of the waste management facilities of the waste resulted from the mining and milling thorium ores.

Chapter II, Authorization conditions, art. 8 paragraph (1)

The activities and sources stipulated under Article 2 require an authorization issued by the Commission in compliance with the authorization procedure typical of each kind of activity or source, and with the provisions of Art. 5

REGULATIONS

Based on the Art. 5 (1) provisions of Law 111/1996 on the safe deployment, regulation, authorization and control of nuclear activities, republished in 2006, the National Commission for Nuclear Activities Control issued a group of Radiological Safety Norms for Uranium and Thorium mining and milling, as it follows:

1. Radiological Safety Norms on Occupational Radiation Protection in Uranium and Thorium Mining and Milling

2. Radiation Safety Norms on the Management of the Radioactive Waste Resulted from Uranium and Thorium Mining and Milling

3. Radiological Safety Norms on Decommissioning of Uranium and Thorium Mining and Milling Facilities

4. Radiological Safety Norms – Authorization Procedures for Uranium and Thorium Mining and Milling

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GUIDELINES

1. Guidelines on the recommended parameters for the estimation of the effective doses on all ways of exposure

2. Guidelines on criteria for release from CNCAN authorization regime for use in other purposes of buildings, materials, facilities, dumps and lands contaminated by mining and milling of uranium and thorium ores

3. Guidelines on technical requirements for design, sitting, construction, operation, closing and decommissioning of storage of uranium ore facilities and decommissioning of the uranium and thorium milling waste disposal areas

Dose Limits

Exposures of workers are controlled by the application of occupational dose limits

Effective dose from external exposure and committed effective dose from intakes (ingestion and inhalation) shall be limited to:

Adults:

- Effective dose of 20 mSv per year

Apprentices:

- Effective dose of 6 mSv per year

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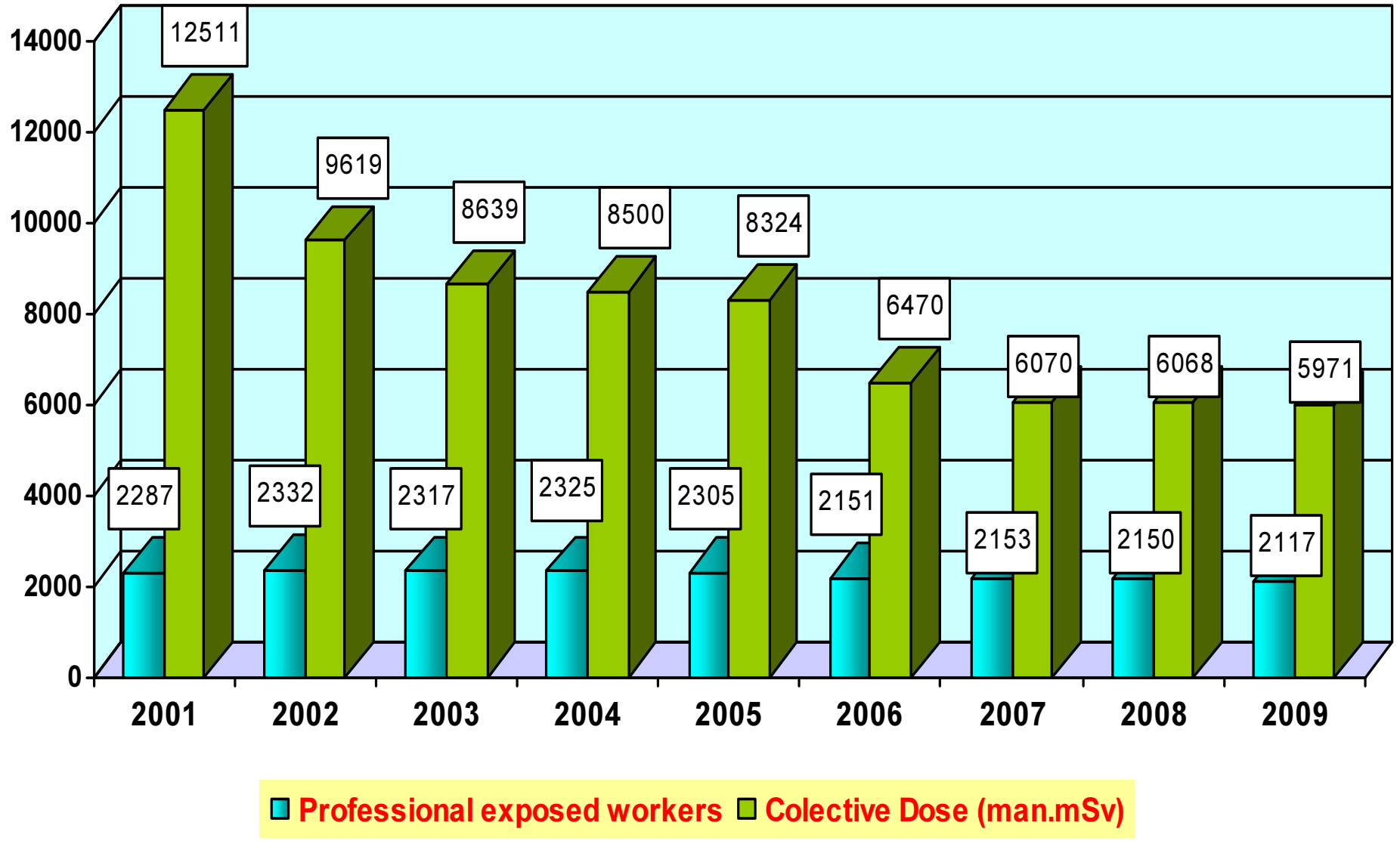
THE TREND OF PROFFESIONAL EXPOSED WORKERS AND OF THE COLECTIVE DOSE IN URANIUM MINING AND MILLING ACTIVITIES



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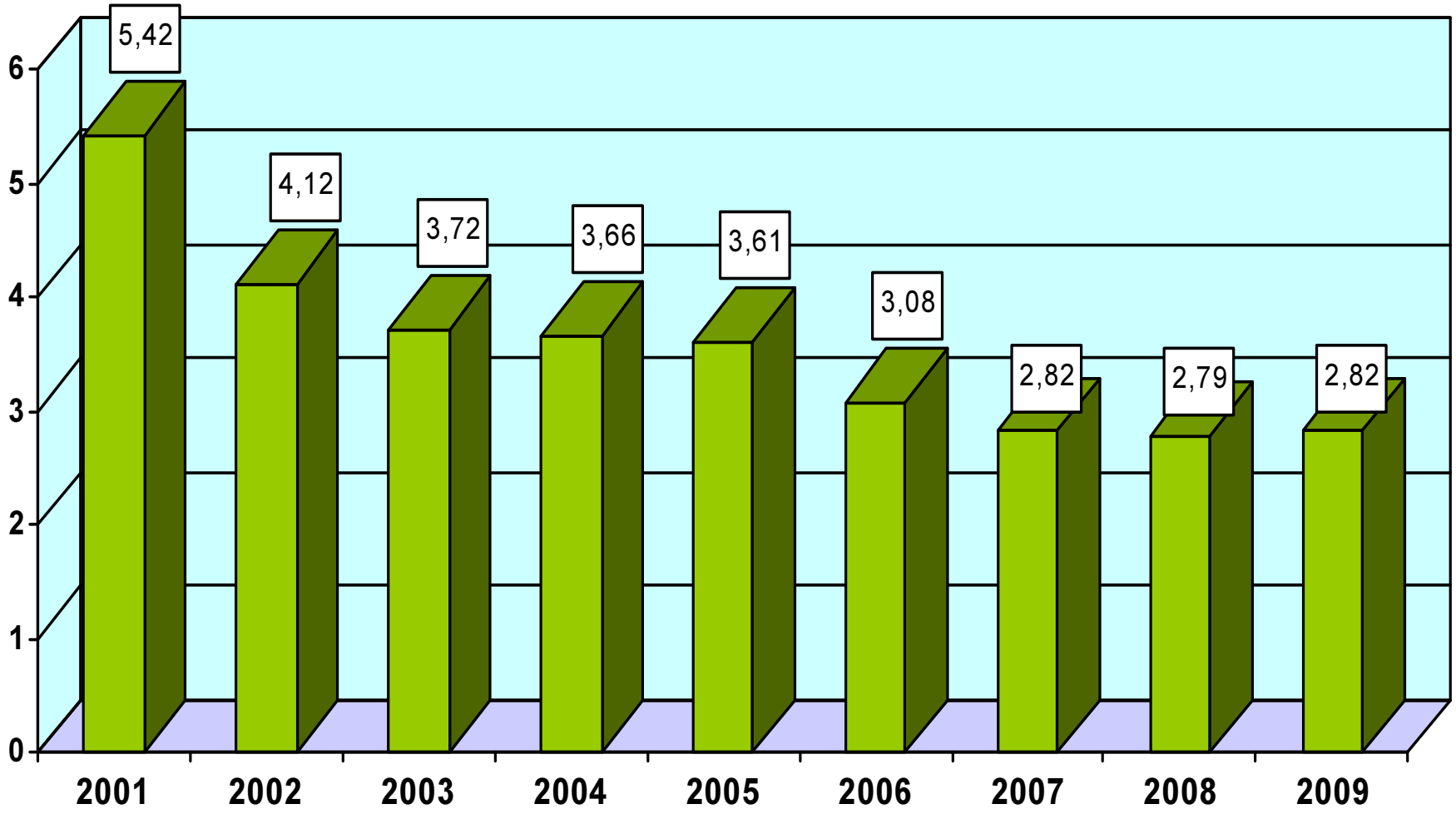
THE TREND OF INDIVIDUAL AVERAGE DOSE RECEIVED OF PROFFESIONAL EXPOSED WORKERS IN URANIUM MINING AND MILLING ACTIVITIES



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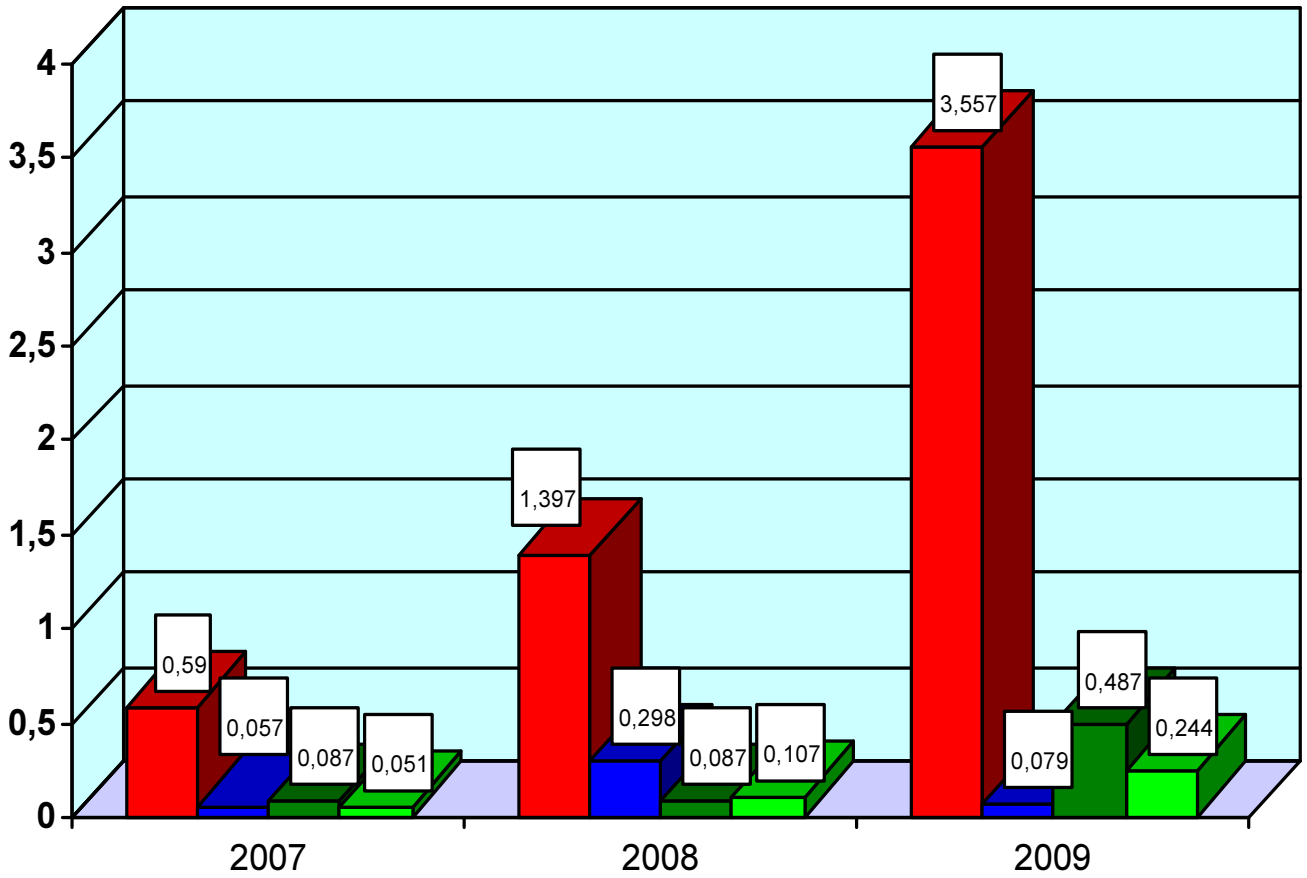
THE TREND OF URANIUM CONTENT IN MINE WATER AND RUNNING SURFACE WATER - BANAT MINING AREA



- Input Treatment Station Lisava Banat (mgU/l)
- Outlet Treatment Station Lisava-Banat (mgU/l)
- Lisava River at 100 m downstream from industrial area Banat (mgU/l)
- Lisava River at entrance in Bradisor village (mgU/l)

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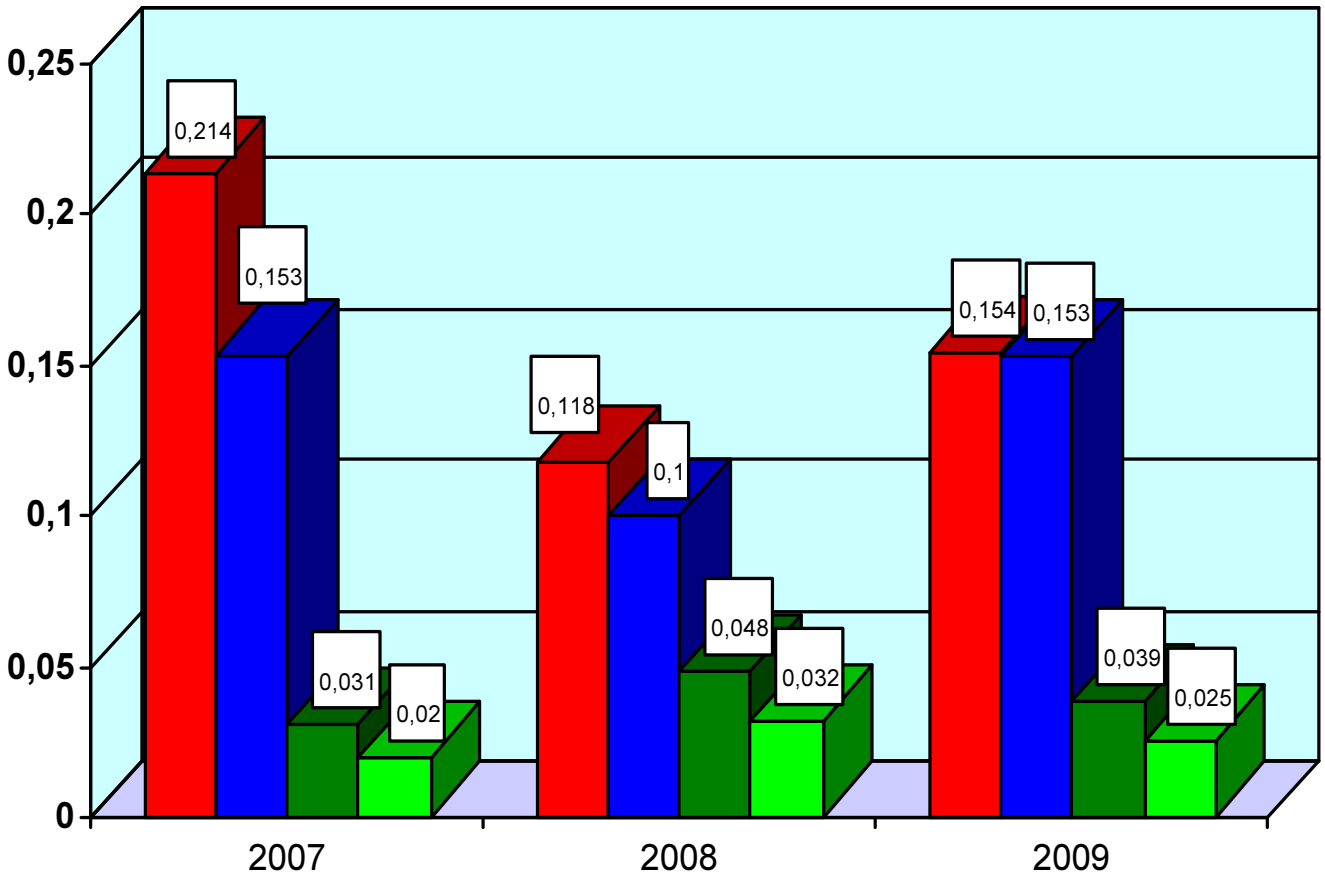
THE TREND OF RADIUM-226 CONTENT IN MINE WATER AND RUNNING SURFACE WATER - BANAT MINING AREA



- Input Treatment Station Lisava Banat (Bq Ra-226/l)
- Outlet Treatment Station Lisava-Banat (Bq Ra-226/l)
- Lisava River at 100 m downstream from industrial area Banat (Bq Ra-226/l)
- Lisava River at entrance in Bradisor village (Bq Ra-226/l)

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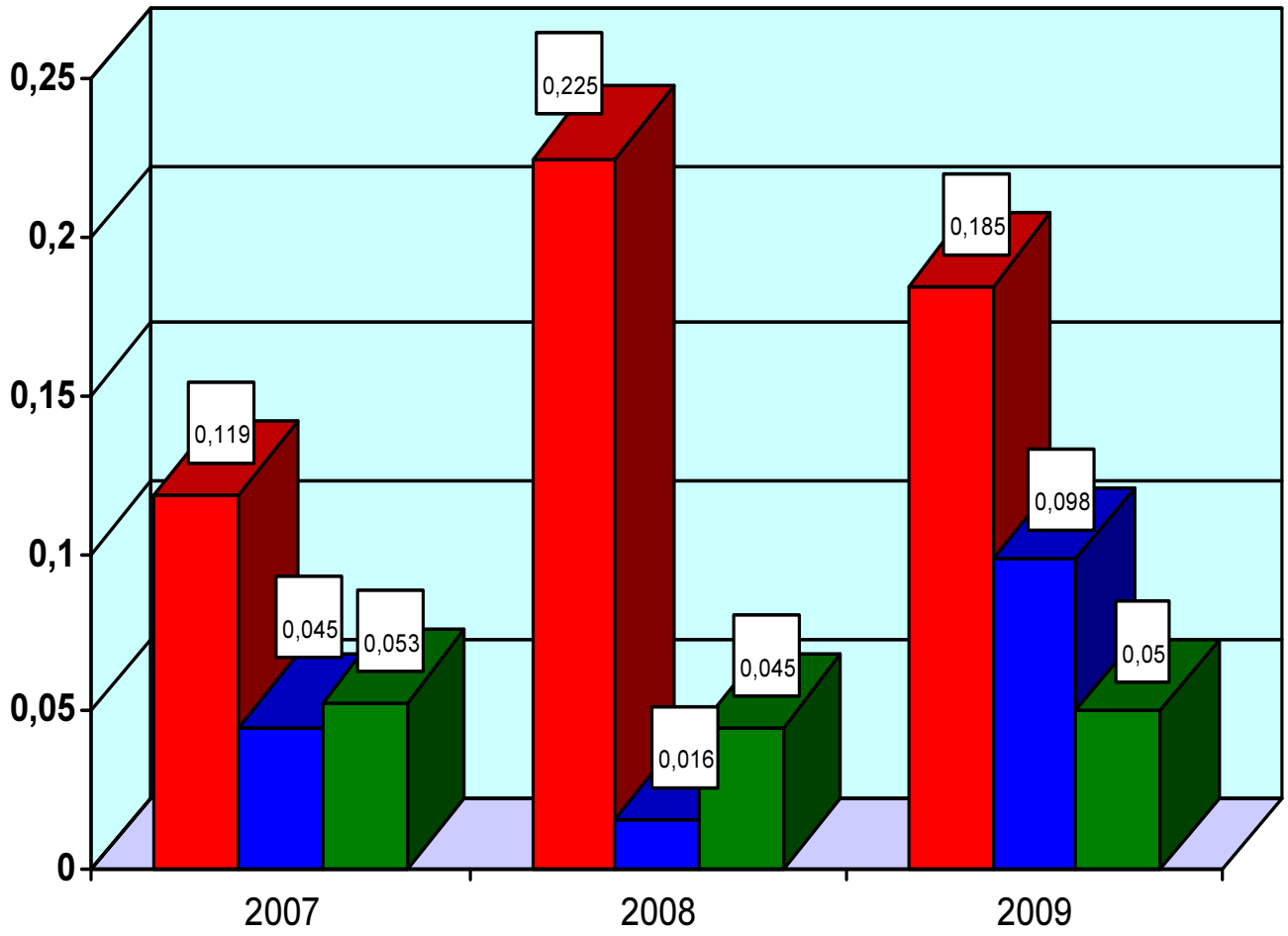
THE TREND OF URANIUM CONTENT IN MINE WATER AND RUNNING SURFACE WATER - BIHOR MINING AREA



- Mine water at outlet Noroc Bun gallery -Avram Iancu Mine (mgU/l)
- Crisul Negru River at 100 m downstream from uranium mining area Avram Iancu (mgU/l)
- Valea Plaiului River at 10m downstream from uranium mining area Baita(mg U/l)

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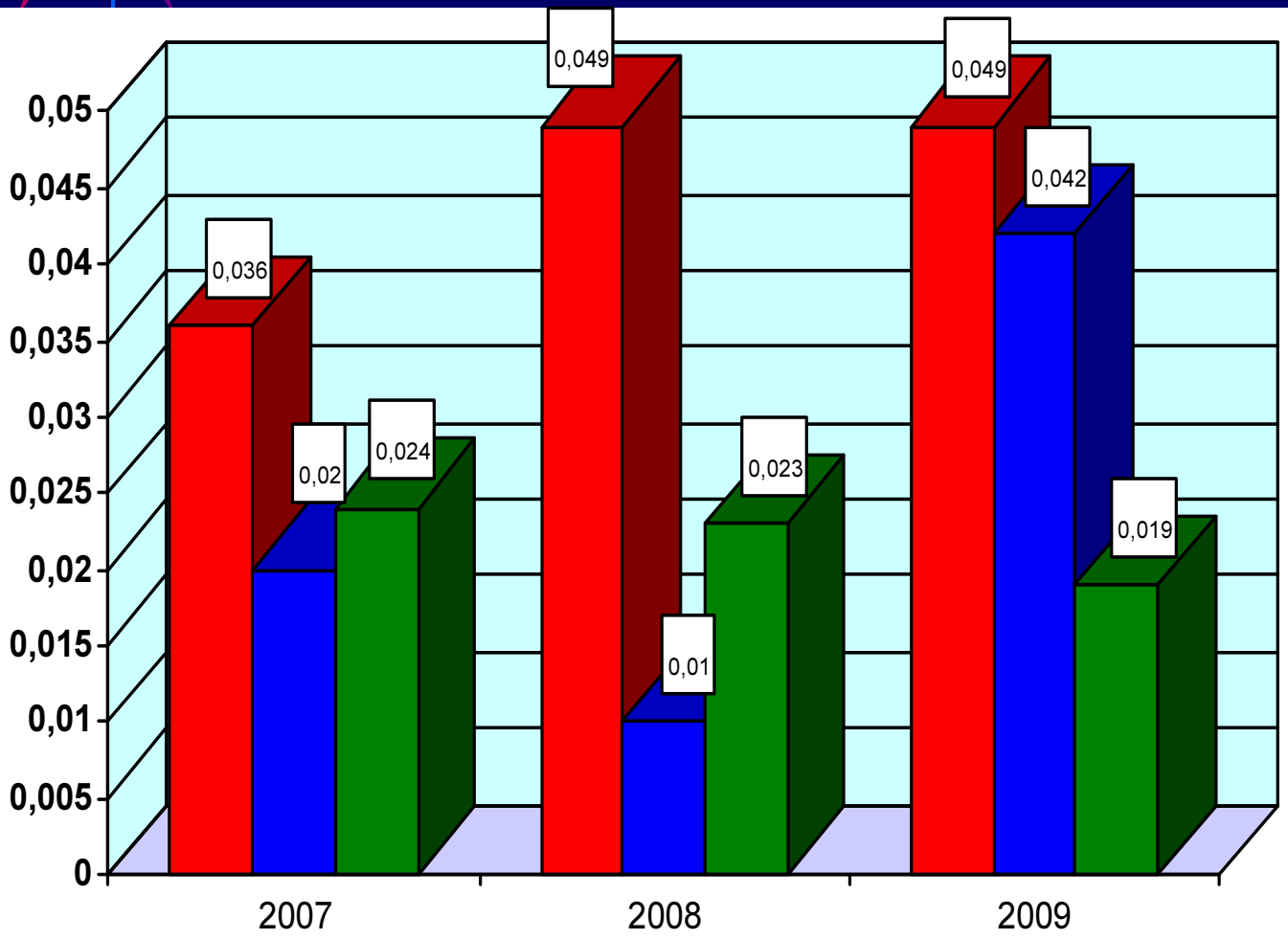
THE TREND OF RADIUM-226 CONTENT IN MINE WATER AND RUNNING SURFACE WATER - BIHOR MINING AREA



- Mine water at outlet Noroc Bun gallery -Avram Iancu Mine (Bq Ra 226/l)
- Crisul Negru River at 100 m downstream from uranium mining area Avram Iancu (Bq Ra-226/l)
- Valea Plaiului River at 10m downstream from uranium mining area Baita (Bq Ra-226/l)

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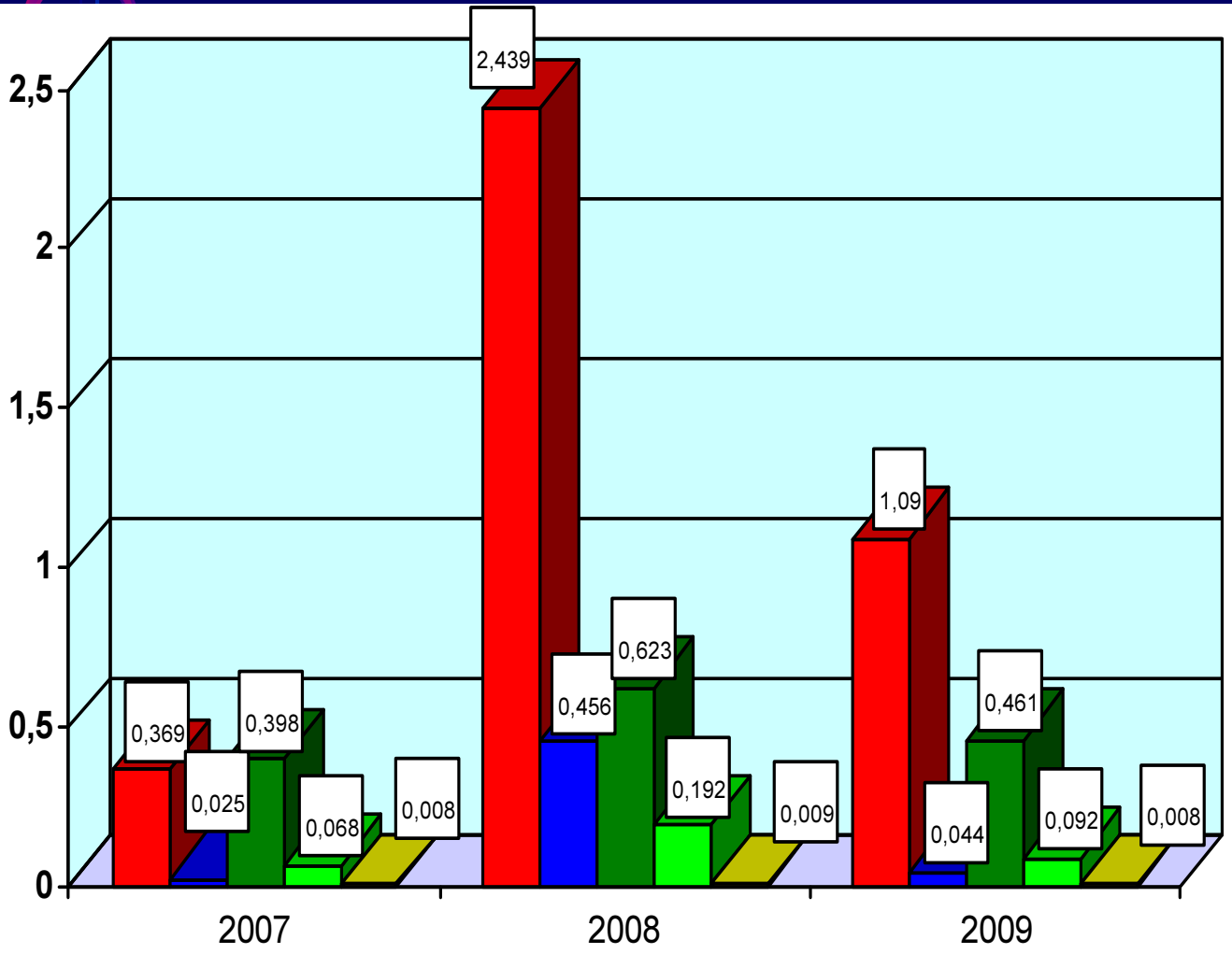
THE TREND OF URANIUM CONTENT IN MINE WATER AND RUNNING SURFACE WATER - CRUCEA MINING AREA



- Input Treatment Station Crucea (mgU/l)
- Outlet Treatment Station Crucea (mgU/l)
- Troaca Gavanului River at exit from mining area Crucea (mgU/l)
- Crucea River at 500 m upstream from junction with Bistrita River (mg U/l)
- Bistrita River at 1000 downstream from jonction with Crucea River (mg U/l)

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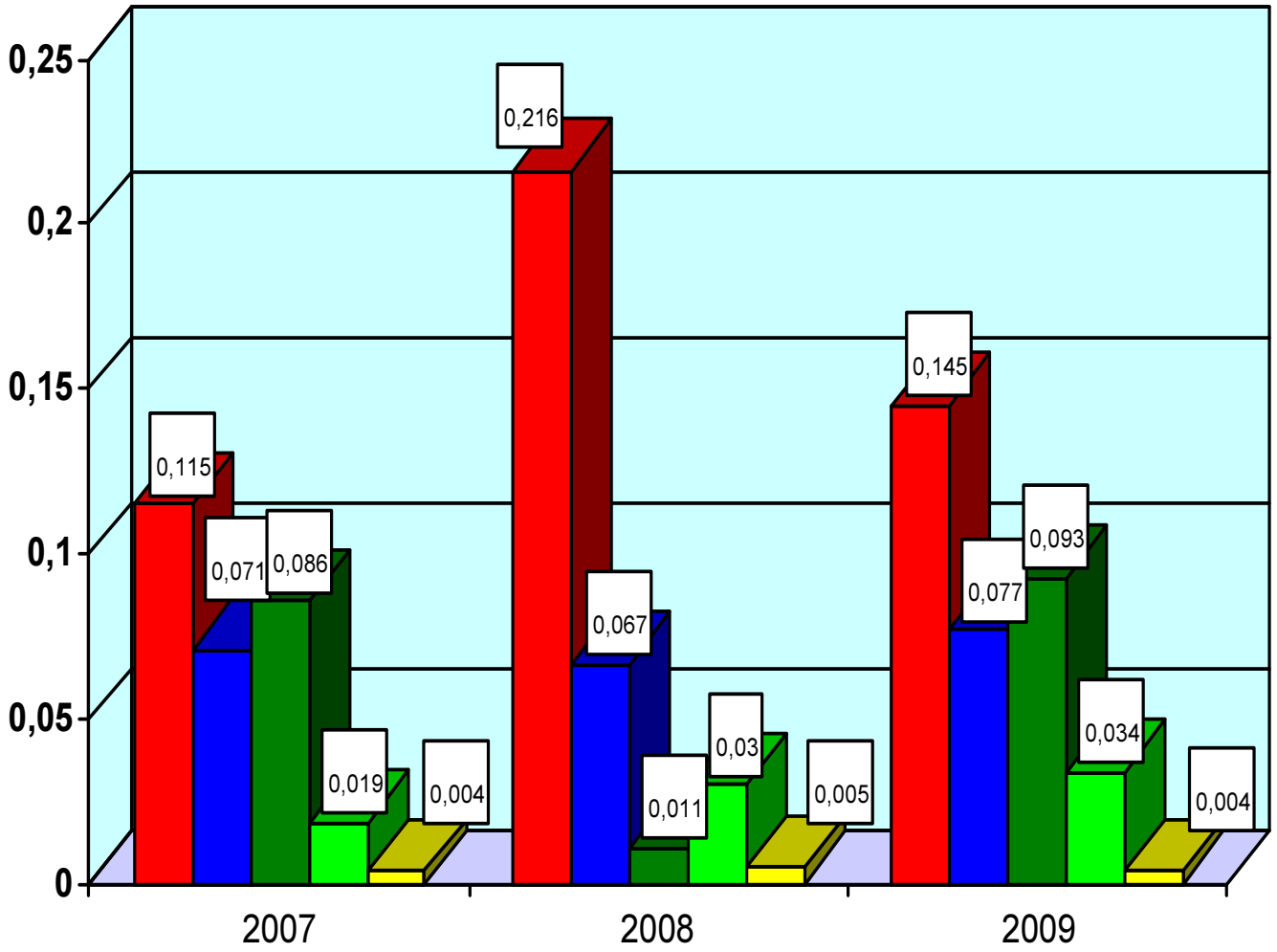
THE TREND OF RADIUM-226 CONTENT IN MINE WATER AND RUNNING SURFACE WATER - CRUCEA MINING AREA



- Input Treatment Station Crucea (Bq Ra-226/l)
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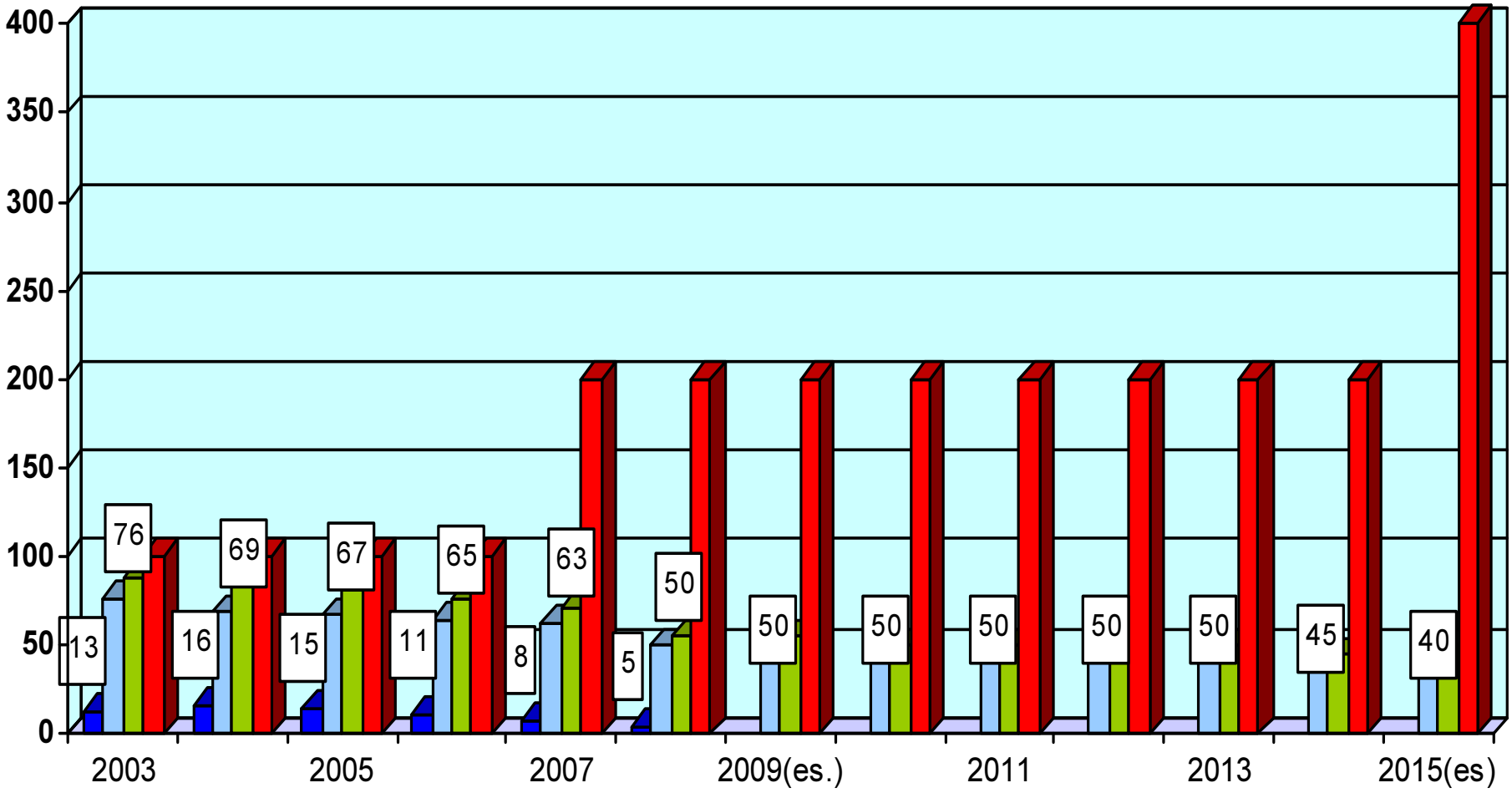
THE TREND OF URANIUM METAL IN URANIUM ORE EXPLOITED AND THE TREND OF URANIUM CONSUMPTION IN NPP



THE PERSPECTIVES FOR URANIUM MINING IN ROMANIA (1)

- Currently, the annual quantity of uranium metal in extracted ore is on the wane given the exhaustion of geological uranium ore reserve at the Baita and Crucea-Botusana deposits

- However, the uranium quantity needed for the normal life cycle of those two CANDU reactors from NPP Cernavoda is ensured by the U_3O_8 and diuranate ammonium (DUA) stocks previously produced and stored at Feldioara processing Plant

THE PERSPECTIVES FOR URANIUM MINING IN ROMANIA (2)

- According to nuclear energy development strategy in Romania, the construction of Units 3 and 4 at NPP Cernavoda will be resumed, latest in 2011. The units will be commissioning latest in 2014-2015.
- A new uranium deposit containing a few thousands tones of uranium metal was identified in Tulghes area, but the mining exploitation is under question due to difficulties to obtain local community accord and environmental agreement.

THE PERSPECTIVES FOR URANIUM MINING IN ROMANIA (3)

- At the same time a new type of uranium mineralization was discovered in Highis-Drocea Mountains (west of Romania)

- Main features of the new uranium mineralization are:
  - type of mineralization: a complex oxide containing uranium, titanium, iron, vanadium and lead;
  - size of uranium mineral ranges between a few millimeters and a few centimeters
  - uranium concentration in mineral: 1-5%;
  - titanium concentration in mineral: 25-30%;
  - uranium mineral is hosted in a dyke of syenite porphyry intruded in crystalline schist;
  - thickness of mineralized dyke is 0.8 -1.2 m
  - uranium concentration in geological trace samples, transversal on mineralized dyke: 0.1-0.4%;
  - the distance between extreme mineralized is 2 km approximately;
  - there are not information regarding the development of mineralization in depth.

THE PERSPECTIVES FOR URANIUM MINING IN ROMANIA (4)

- **In the pessimistic scenario we are expecting that at the commissioning of Units 3 and 4 at Cernavoda NPP, the uranium mining in Romania will provide a maximum of 12 percent of the uranium metal needed in the four CANDU units, if uranium deposit Tulghes will be not put into operation.**

THANK YOU!