



Uranium resources in Poland- the past and present

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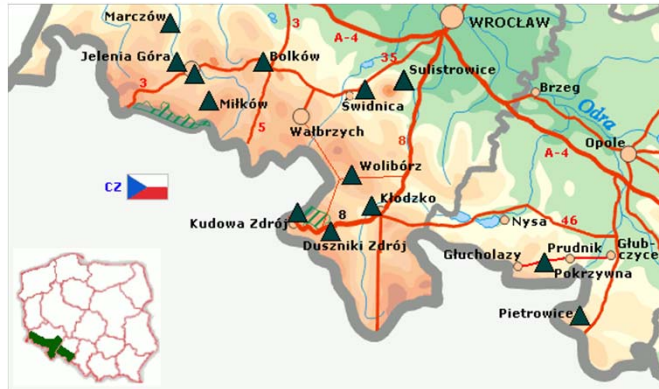
Poland 2012



Poland 1918-1939



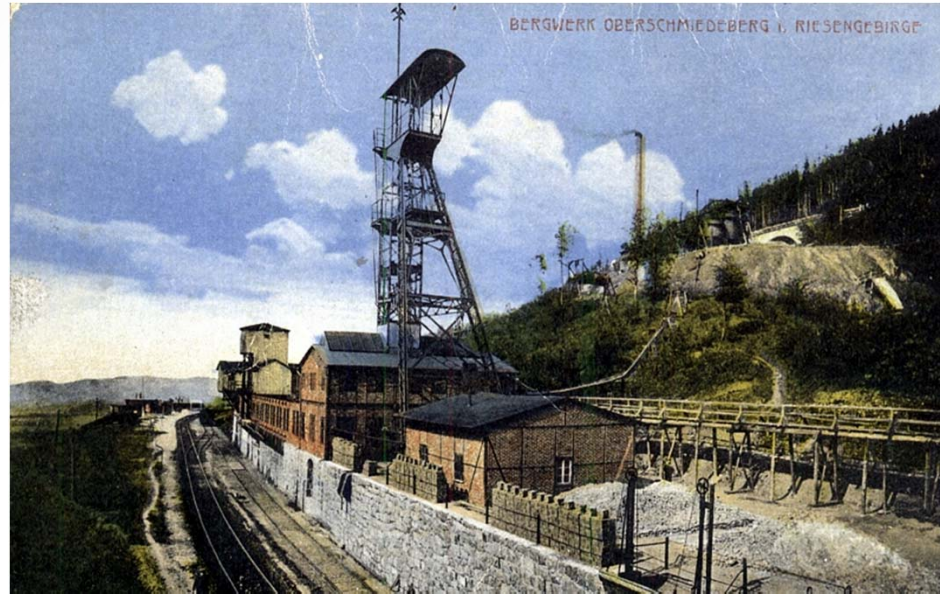
1853- uranophane was discovered
in cooper mine „Miedzianka" near Jelenia Góra



$\text{Ca}(\text{UO}_2)_2[\text{HSiO}_4]_2 \cdot 5\text{H}_2\text{O}$ is a rare calcium uranium silicate hydrate mineral that forms from the oxidation of uranium bearing minerals



1912-The highest U concentration found in iron ore mine „Bergfreiheit” in Kowary. (Pitchblende)



To the end of 1942 in the Sudetenland, mining about 100 tons "of uranium ore" in search of radium but uranium was treated as waste with no commercial value

1943-1944 - mining c.a. 72 tons of uranium ore for the purposes of Nazi German nuclear fuel

1945-Bombing of Oranienburg -the center of Nazi Germany's nuclear energy project

Mining and processing of uranium ore in Poland in the years 1948-1972

On 1 January 1948 under a special agreement established the Polish-Soviet enterprise called "Kowarski Mines".

It was to deal with the exploration and exploitation of uranium on Polish territory. The head office was taken over by the Russians in the mine "Freedom" in Kowary.

The exploitation of uranium ore were taken at existing mines, and so in the mine "Freedom" in Kowary and "Minerals" in Kletno and Miedzianka.

At the same time a group of geological examine all possible locations of uranium deposits.

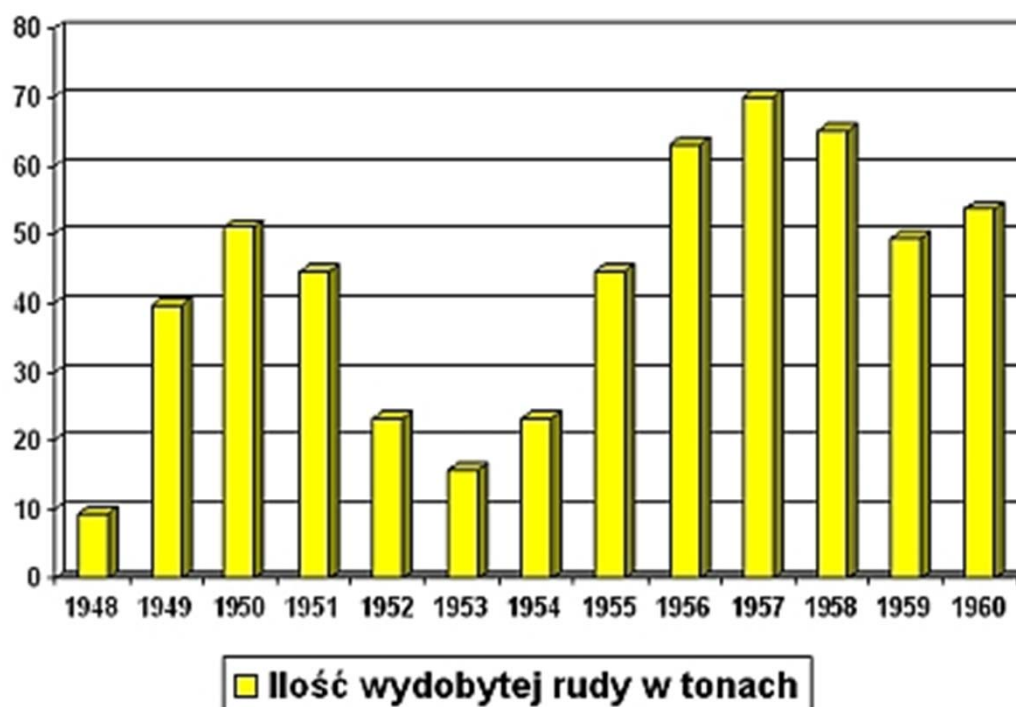
As a result of the work carried out in the Sudetenland was discovered nearly 70 places of occurrence of this element.

Fifteen have been recognized as deposits, including eight worn at the stage of identification.

Mining and processing of uranium ore in Poland in the years 1948-1972

1948-1962 the extraction and export of ore containing 0.2% uranium to the Soviet Union.

From nine mines and many points mainly Jelenia Gora region, Wałbrzych and Kielce extracted and transported to Soviet Union c.a. 600 tons of uranium ore.



Selected uranium ore deposits exploited in Poland in 1945-1967

Uranium deposit	Initial resources (t)	Amount of extracted ore (up to 1967) (t)	Exploited resources (%)
Wolność	94	94	100
Miedzianka	14.7	14.7	100
Podgórze	280	199	71.07
Rubezal	0.5	0.5	100
Mniszków	4.5	4.5	100
Wiktoria	0.28	0,28	100
Majewo	0.96	0	0
Wołowa Góra	2.5	2.5	100
Radoniów	345	214	62.03
Wojcieszyce	14.4	12.3	85.42

Mining and processing of uranium ore in Poland in the years 1948-1972

1967- Department of Uranium Concentrate Production

Systematic decrease in uranium content in the ore, the cost increase



January 1973- closing "Industrial Plants R-1. National Company"

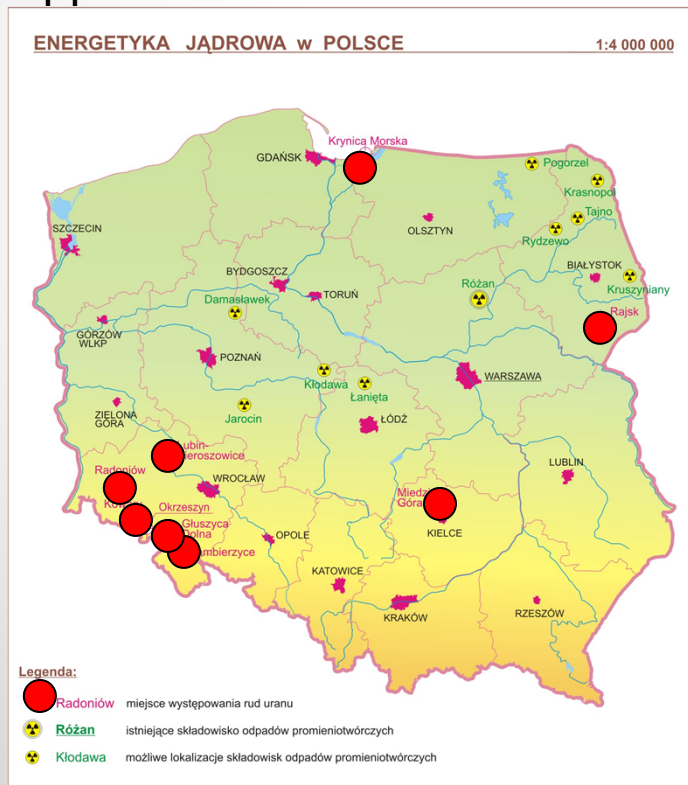


The present

Conventional resources

Currently in Poland does not work any uranium mine. However, we have some resources, whose potential meaning with increasing U prices on the world market, would be profitable.

Polish uranium ores include from 250 to 1100 ppm [1 ppm - 1 gram per ton] of uranium. Uranium deposits operated in the 50s typically contain about 2000 ppm.



Our deposits are indeed the poor, but some of them (Wambierzyce, Grzmiąca, Okrzeszyn) have a particular advantage. The deposits are on-board with a narrow single character, allowing them to operate as a regular for decades

Uranium ore in Poland (projected resources at depths greater than 1000 m) by the OECD NEA Red Book, 2008:

Region	identified resources	projected resources	U content in ore
	Tons U nat	Tons U nat	ppm
Rajsk	5320	88 850	250
Okrzeszyn	940	?	500-1100
Grzmiąca	790	?	500
Wambierzyce	220	2 000	236
Baltic Sea region	?	10 000	?
TOTAL	7 270 t > 45 y service NPP 1000 MW	100 000 t > 625 y service NPP 1000 MW	

Uranium as a byproduct of copper mining.

In Poland, there are uranium deposits in the basin Lubin-Sieroszowice. The uranium content of the ore is, there are over 60 ppm and the copper content of 2%. Total ore is 2400 million tons, 48 million tons of copper and 144 000 tons of uranium.



Current annual production in the basin Lubin Sieroszowice is about 569 000 tons of copper, and the amount of uranium dropped on the dump is about 1700 t/year.

=

Annual fuel for 10 nuclear power plants with total capacity of 10 000 MW.

An additional advantage would be the reduction of the radioactivity of the waste from the treatment of copper.



Uranium in coal and ash

In 2008, 147 samples from 13 coal mines located in the Polish three basins (Upper and Lower Silesia, Lublin) were investigated .



Uranium content,ppm	Upper Silesian Coal Basin	Lower Silesian Coal Basin	Lublin Coal Basin
Minimum	0.1	0.4	0.2
Maximum	8.5	3.1	8.3
Mean	1.9	1.9	2.2

Bojakowska I., Lech D., Wołkiewicz S., 2008, Uran i tor w węglach kamiennych i brunatnych ze złóż polskich. Gospodarka Surowcami Mineralnymi t. 24, z. 2/2, s. 53-65.

Uranium in coal and ash

1980'

Brown coal fly ash from power station Turów

Uranium content: 10.5 $\mu\text{gU}/1\text{g}$ ash

Hard coal fly ash from power station Siersza

Uranium content: 13.0 $\mu\text{gU}/1\text{g}$ ash

Bioleaching of U by *Thiobactillus ferrooxidans*, isolated from coal mine water

Brown coal fly ash , 21 days, **65% recovery of U**

Hard coal fly ash, 34 days, **92 % recovery of U**

Uranium from phosphoric acid and fertilizer production

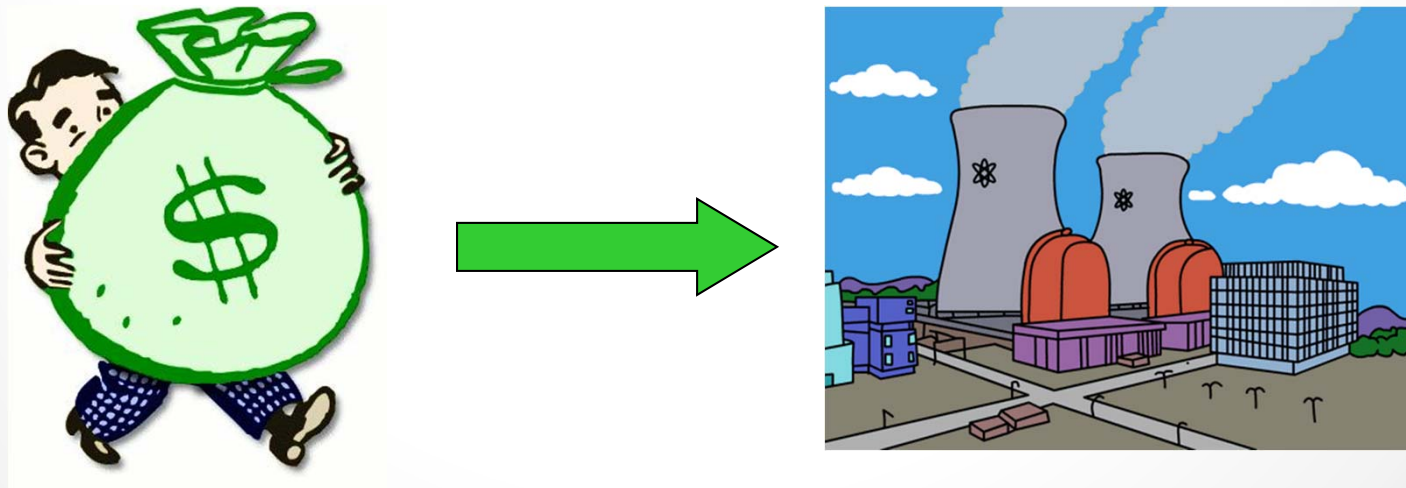
Material	Marokko II (% U)	Florida 68 BPL (% U)
30% P ₂ O ₅	0.012-0.014	0.011-0.013
Fertilizer NPK (8:24:24)	0.009-0.011	0.0055-0.010
Phosphogypsum	0.0017-0.0028	0.0015-0.0023

Technologies supporting Development of Safe Nuclear Power Engineering

2005 - Polish Energy Policy until 2030

Analysis of the possibility of uranium supply from domestic resources

Meeting the Polish nuclear power engineering's demand for fuel – fundamental aspects



Analysis of the possibility of uranium supply from domestic resources.

Expected in the design solutions are complex:

the assessment of national resources including uranium waste materials from industry,

detailed description of mineralogical and chemical analysis of raw materials,

develop methods for uranium oxide in the form of U_3O_8 , useful for energy applications.



set of synthesis and analysis used to
• leach uranium from uranium ore



Uranium membrane distillation/ extraction

The exploration conducted by Polish Geological Institute resulted in discovery of uranium mineralization in the Ordovician Dictyonema Shales in the Podlasie Depression and the Lower and Middle Triassic sediments (sandstones) in the Peribaltic Syncline



Elemental analysis of sandstones.

Element	Mean content from 45 samples [mg/kg]	Range [mg/kg]
U	256	3.3 - 1316
Th	5.91	2 - 16
Cu	42.1	14-111
Co	68.8	3.6 - 176
Mn	970	105 – 3 050
Zn	38.6	10 - 100
La	29.1	4-53
V	220	37-770
Yb	2.17	0.5-3.2
Mo	4.81	0.6-9
Ni	33.3	6.3 - 100
Sb	0.42	0.1- 4.1
Fe	22390	2 930-180 000

Elemental analysis of dictyonema shales.

Element	Mean content from 78 samples [mg/kg]	Range [mg/kg]
U	94.1	15 – 1 480
Th	14.7	2.7 - 27
Cu	212	8-927
Co	32.2	9.4 - 137
Mn	218	24 – 2 493
Zn	4 028	69 – 19 980
La	44.5	22 - 91
V	1 250	256 – 2 374
Yb	3.72	1.5 - 9.6
Mo	83.6	0.75 - 674
Ni	183	55 – 1 370
Sb	8.0	2.1 - 21
Fe	29 370	10910 – 91 790

Leaching of dictyonema shales with acidic solutions:

The leaching tests were carried out by using 10% H_2SO_4 , at 80°C and ambient pressure, for 8 hours.



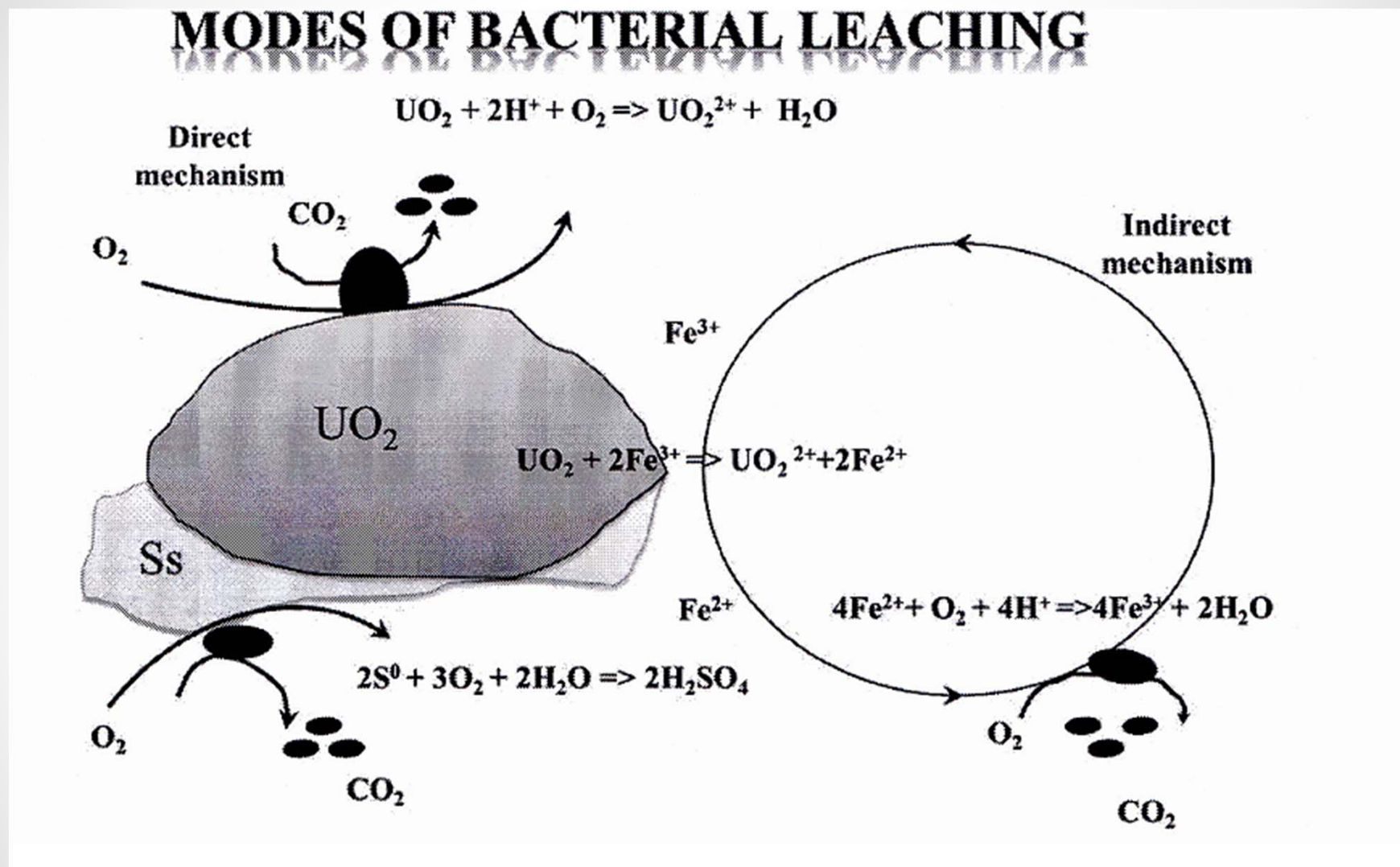
Sample notation	Deposit notation	U [%]	V [%]	Mo [%]	Cu [%]	La [%]	Th [%]
3224	Rajsk JG-1	72	33	66	33	60	80
3227	Rajsk JG-1	64	30	51	29	59	78
3226	Rajsk JG-1	68	44	78	52	62	77
3233	Rajsk JG-1	78	25	59	41	66	67
3276	Hacki JG-5	81	52	33	28	31	76

Meeting the Polish nuclear power engineering's demand for fuel – fundamental aspects.

- possibility of biological exploitation of uranium postmining wastes deposits
- some dumps contain up to 0.15 % U
- bioleaching economic on an industrial scale $<0.03\% \text{ U}_3\text{O}_8$
- October 2011-2014



Direct and indirect bacterial leaching of uranium



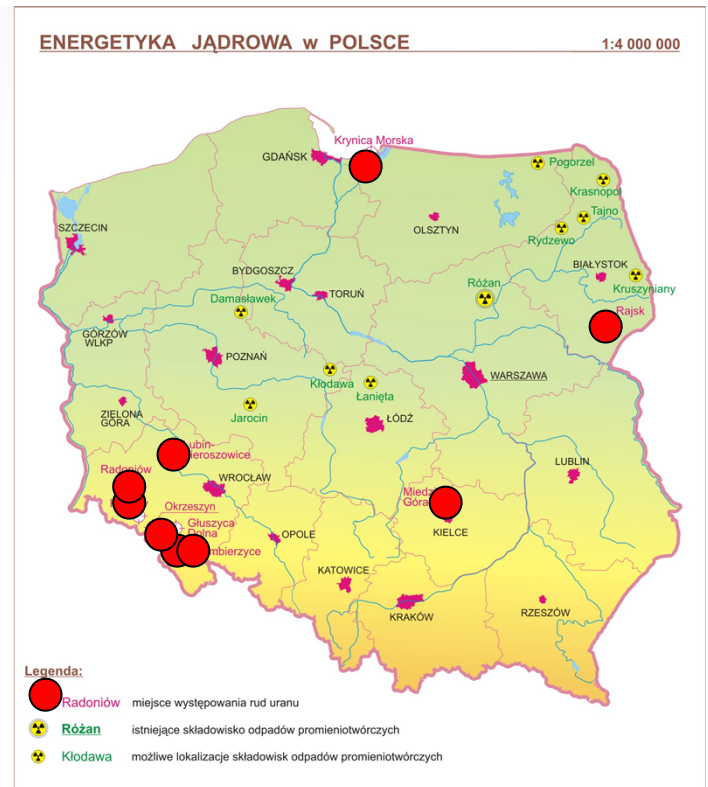
**Uranium concentration, pH and dose rate in materials deposited
in selected piles of Kłodzko and Jelenia Góra Valleys**

	Sample	pH	μS/h	Background μS/h	U, ppm	Fe, wt %
1.	Grzmiąca	4.2-5.8	0.51-1.94	0.14	20.5-113	2.4-3.6
2.	Kopaniec	6.1	2.8	0.22	733-2400	6.6
3.	Radoniów	5.8-6.0	1.5-4.4	0.22	306-801	1.9-2.5
4.	Okrzeszyn	6.1	2.5	0.22	86-130	2.0-3.6

Conclusions:

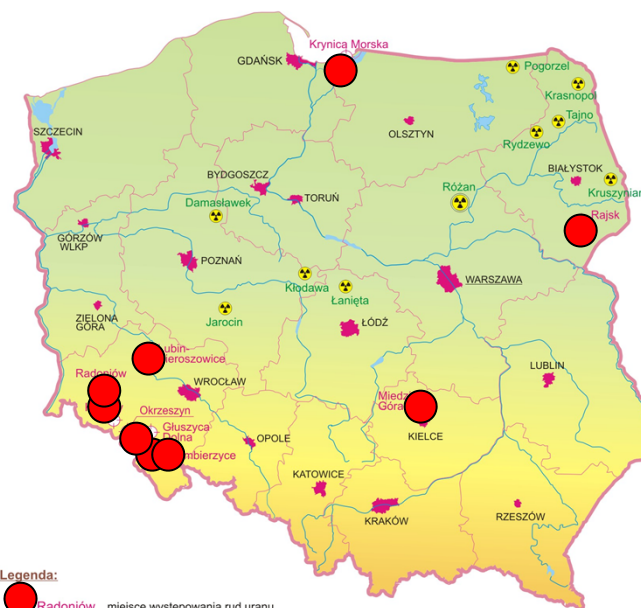
It could be stated:

- Total identified U resources are estimated > 7 000 tons
- The „old” Sudetic deposits are of historical importance
- The U concentrations known from Upper Carboniferous and Lower Permian rocks (Grzmiąca, Wambierzyce and Okrzeszyn deposits) should be treated as areas with anomalous uranium contents
- U concentrations in the Podlasie Depression are characterized by low grade uranium mineralization and occurrence at depths of over 400 m
- The Triassic rocks of Peribaltic Syneclise represent possible U deposit of the sandstone type



Conclusions:

- Polish uranium resources seem to be very promising for biotechnological applications.
- The economic efficiency may be significantly improved by the recovery of rare metals (e.g. lanthanides) present in wastes and ores.



Legenda:

- Radoniów miejsce występowania rud uranu
- Różan istniejące składowisko odpadów promieniotwórczych
- Kłodawa możliwe lokalizacje składowisk odpadów promieniotwórczych

Thank you for your attention

