NORM III Symposium

The Influence of Changing Scenarios in Exposure Assessments to Norm. The Brazilian Experience

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Questions to be Answered

- Do the non-uranium mining industries have the potential to cause environmental radiological impacts?
- If yes, what are the extent of these impacts?
  - Doses (individual, collective)
  - Pathways
- How to deal with the assessment of the problem?
- The role of changing scenarios

Points to be considered

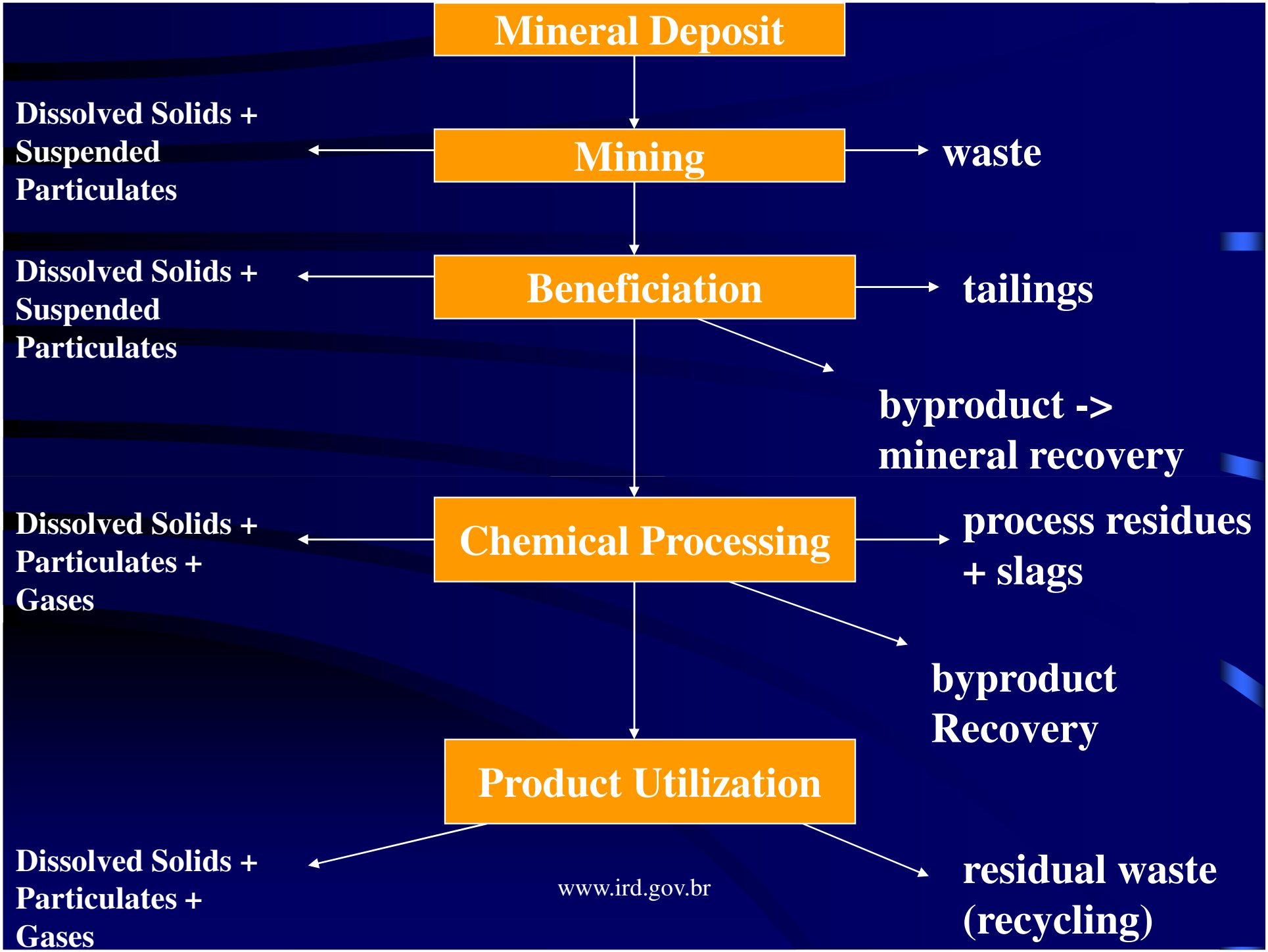
- 300 industries in the Brazil;
- Continental dimensions of the country;
- **Very different climatic, social and geographical characteristics from region to region;**
- **Different scenarios lead to different exposures to radiation**.

Methodology

- analysis of the operational process of the industry and interfaces with the environment;
- radiological characterization of the wastes generated in the operational process and environmental samples collected;
- calculations of the total activity generated by the operational process and accumulated/released into the environment.

Methodology

- **identification of the potential mechanisms involved on the radionuclides mobilization from the solid waste storage areas;**
- **risk estimation of the environmental impacts,and those related to the use of by-products;**
- **examination of the need for intervention/remediation or additional studies concerning the area for unrestricted use.**


Mineral Deposit
Mining
Dissolved Solids + Suspended Particulates
waste
Beneficiation
Dissolved Solids + Suspended Particulates
tailings
byproduct -> mineral recovery
Chemical Processing
Dissolved Solids + Particulates + Gases
process residues + slags
byproduct Recovery
Product Utilization
Dissolved Solids + Particulates + Gases
residual waste (recycling)
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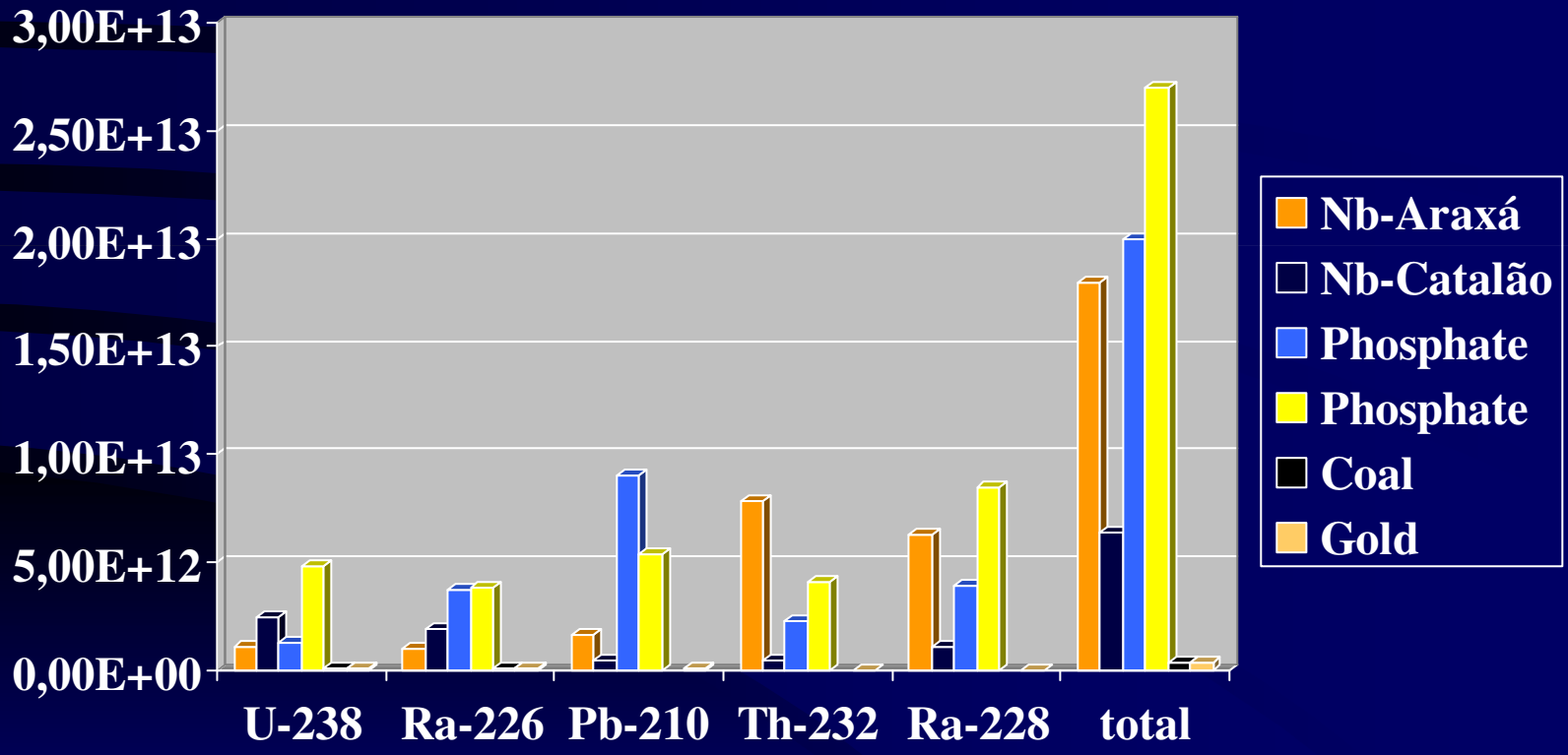
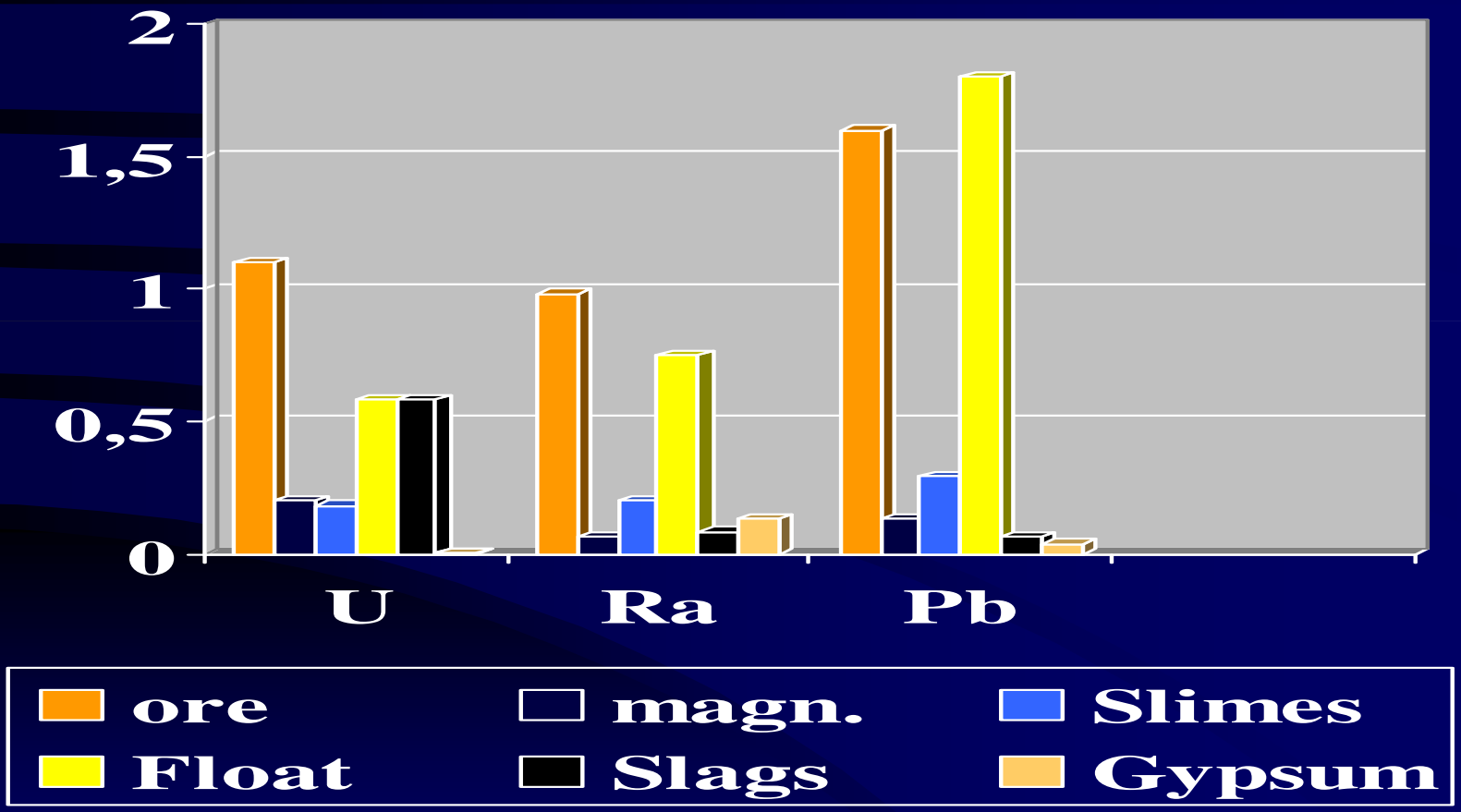
Radionuclide Concentrations in the Run of Mine (Bq/kg)

Ore	^{238}U	^{226}Ra	^{210}Pb	^{232}Th	^{228}Ra
Niobium	930	805	1330	6390	5176
Niobium	4550	3390	7890	904	2040
Coal	359	457	754	33	68
Phosphate	880	700	990	753	1550
Phosphate	114	330	800	204	350
Gold	114	136	169	49	<42

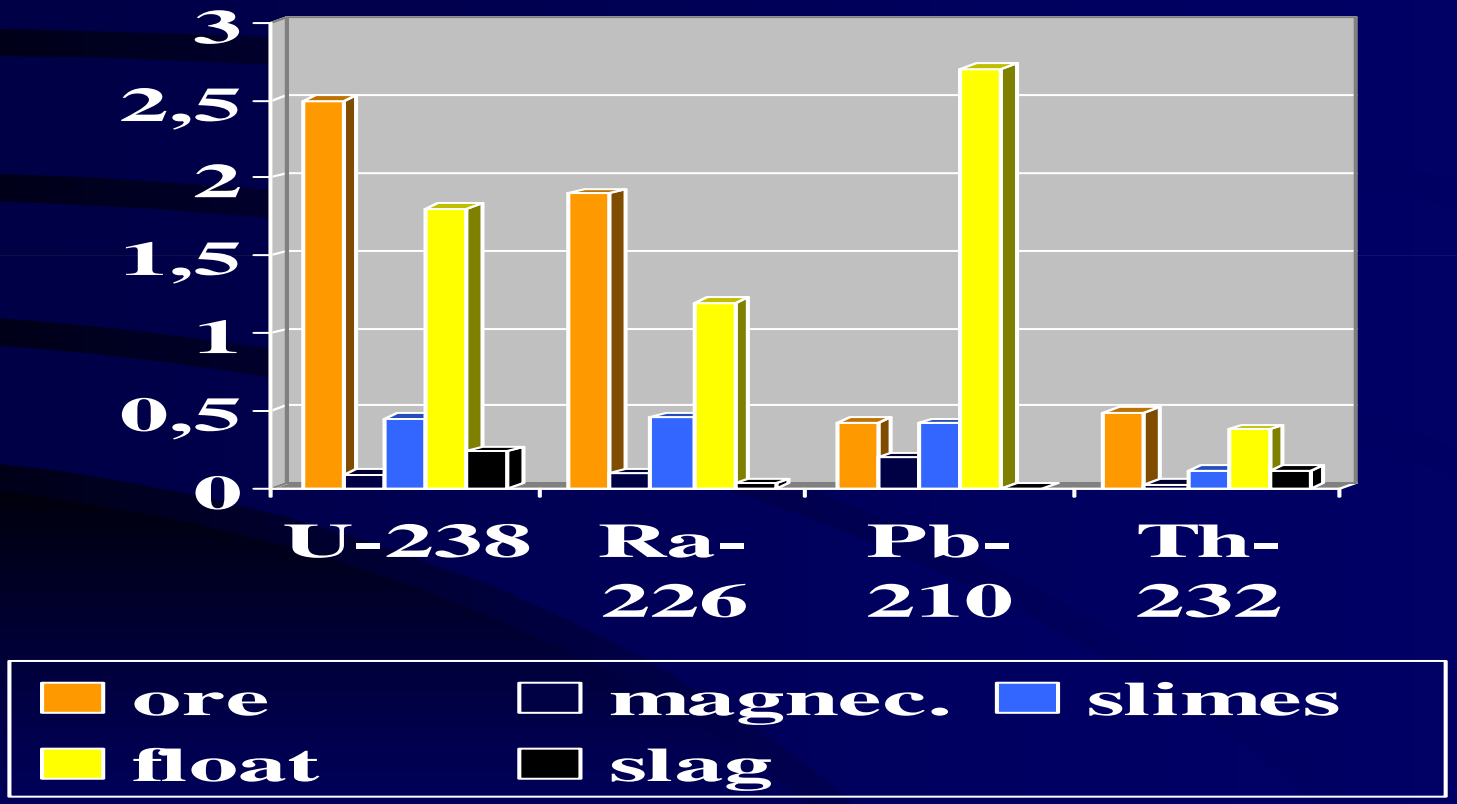
Fluxes of Radioactivity (Bq/year)



Radionuclide Fluxes in the Niobium Industry of Araxá (x 10^{12} Bq/y)

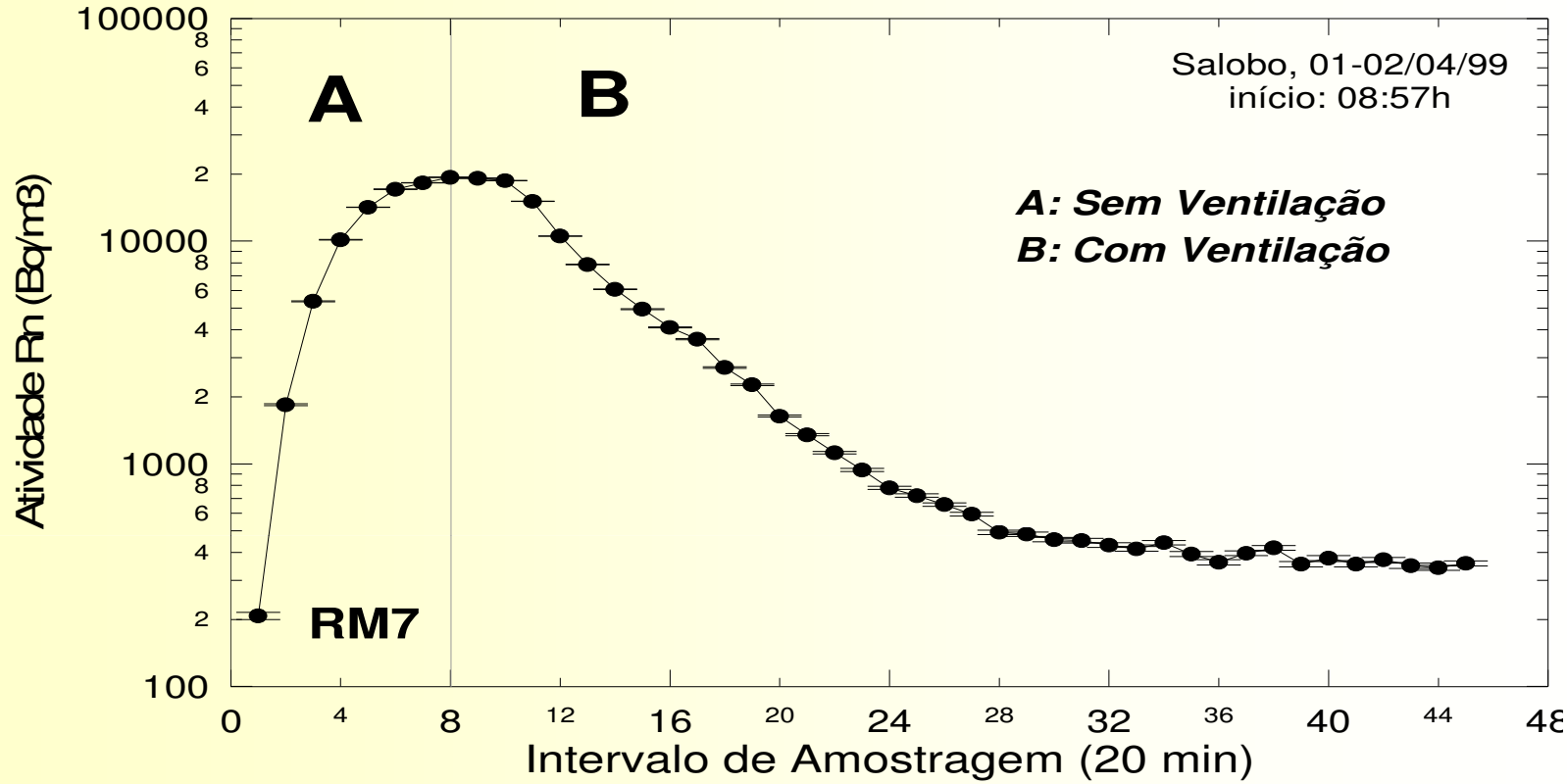


Radionuclide Fluxes in the Niobium Industry of Catalão (x10^{12} Bq/y)



Conclusions About Process

- Similar processes of the same ore can give rise to different radionuclide distribuitons in the generated wastes,
- Diagnostics shall be made in a case-by-case basis.



Radon in an underground Copper Mine

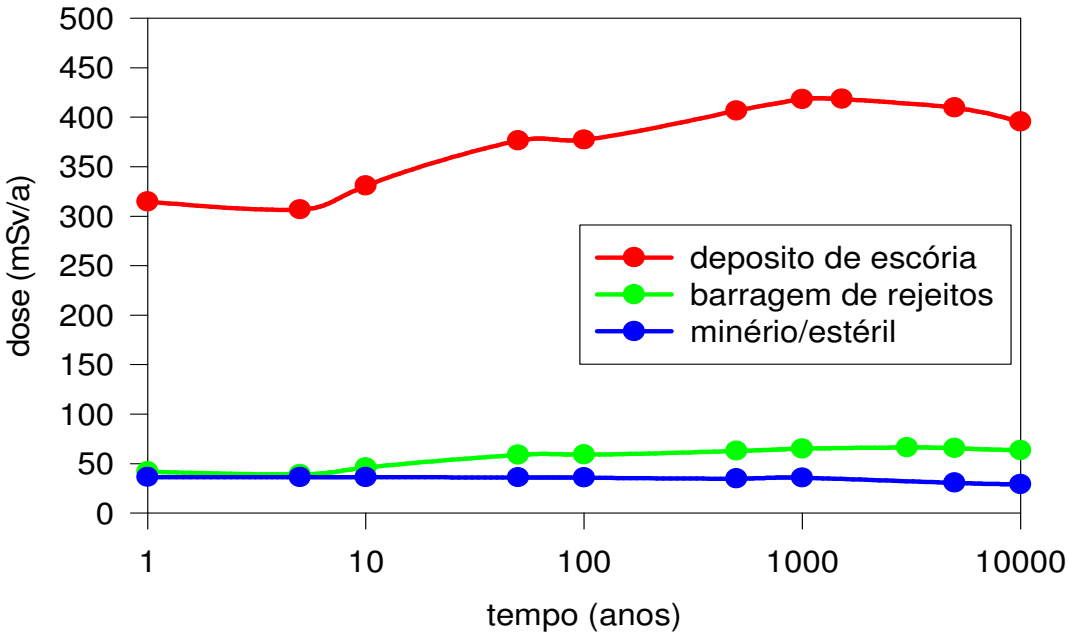
Conclusion about Radon Exposure

- The determiantions of the gas concentration in working places of non-uranium underground mine galleries have proved that there a several potential cases that need some attention,
- Guidance need to be given to the operators of these facilities to reduce radon gas concentrations and reduce radiological doses.

Use of products

- Assumptions.
  - Use of the wastes as building material,
  - Constructions of houses over contaminated areas,
  - Simulations performed by means of RESRAD

Dose estimation in function of time due to the use of solid waste of the niobium industry I

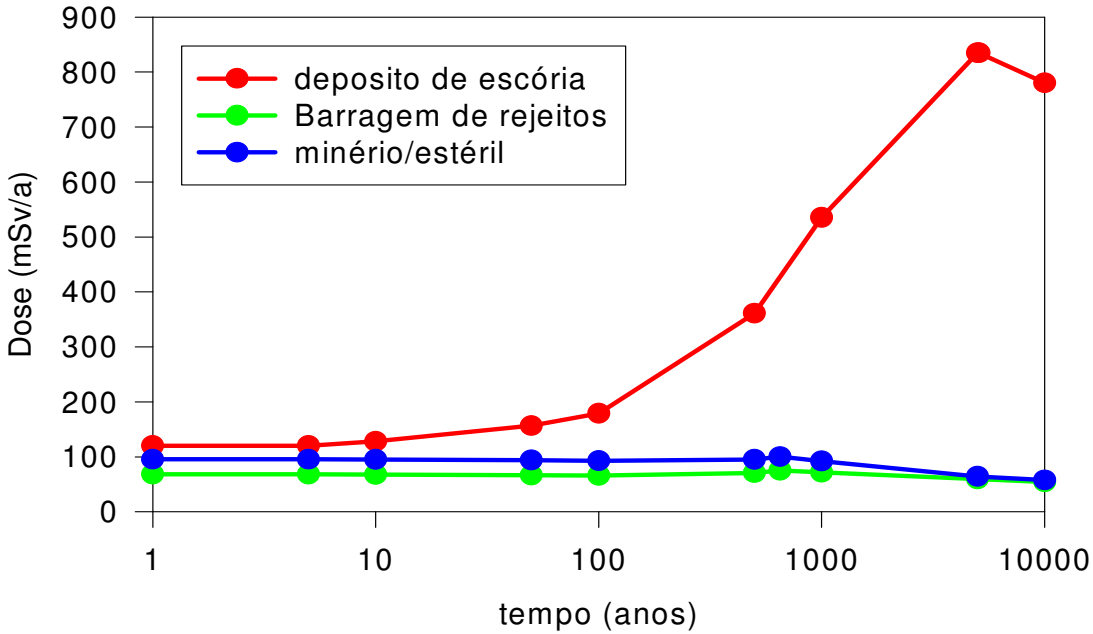


Contribution to the total dose by pathways and by radionuclides of the solid waste from the niobium industry I

	Mining waste	Tailing	Tailing	Slag	Slag
Pathway	t = 0 **	t = 0	t =3024**	t = 0	t =1522**
External dose	48	55	58	64	60
Radon	51	40	35	33	29
Ing. of water	-	-	5	-	7
Nuclide					
Ra-226	54	38	3	36	11
Ra-228	16	4		14	
Th-228	29	55		48	
Th-230			35		26
Th-232			62		62

* t (years) after the decomissioning
** time of maximum dose

Dose estimation in function of time due to the use of solid waste of the niobium industry II

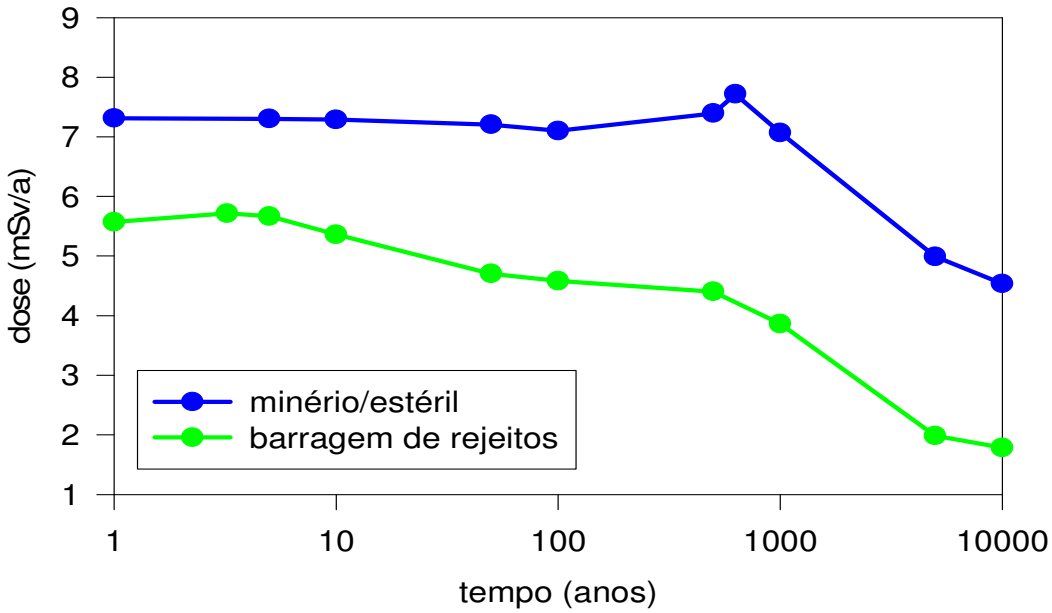


Contribution to the total dose by pathways and by radionuclides of the solid waste from the niobium industry II

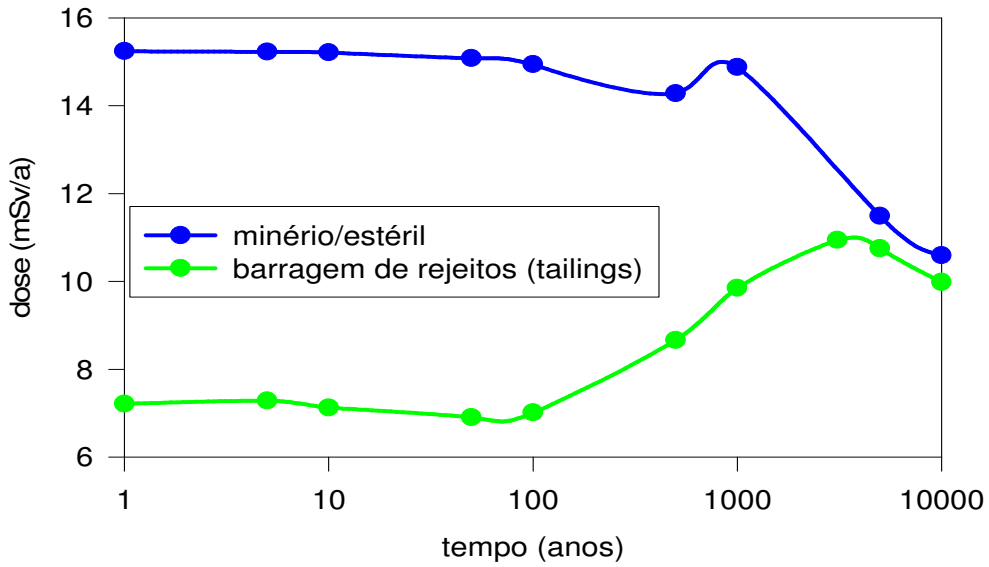
	Mining waste	Mining waste	Tailing	Tailing	Slag	Slag
Pathway	**t = 0**	**t = 652****	**t = 0**	**t = 652****	**t = 0**	**t=5082****
External dose	14	11	14	11	34	13
Radon	85	69	85	69	66	74
Ing. of water	-	19	-	17	-	11
Nuclide						
Ra-226	97	73	94	67	73	
Th-228	2		3	-	22	
Th-230		22		27		93

* t (years) after the descomissioning
** time of maximum dose

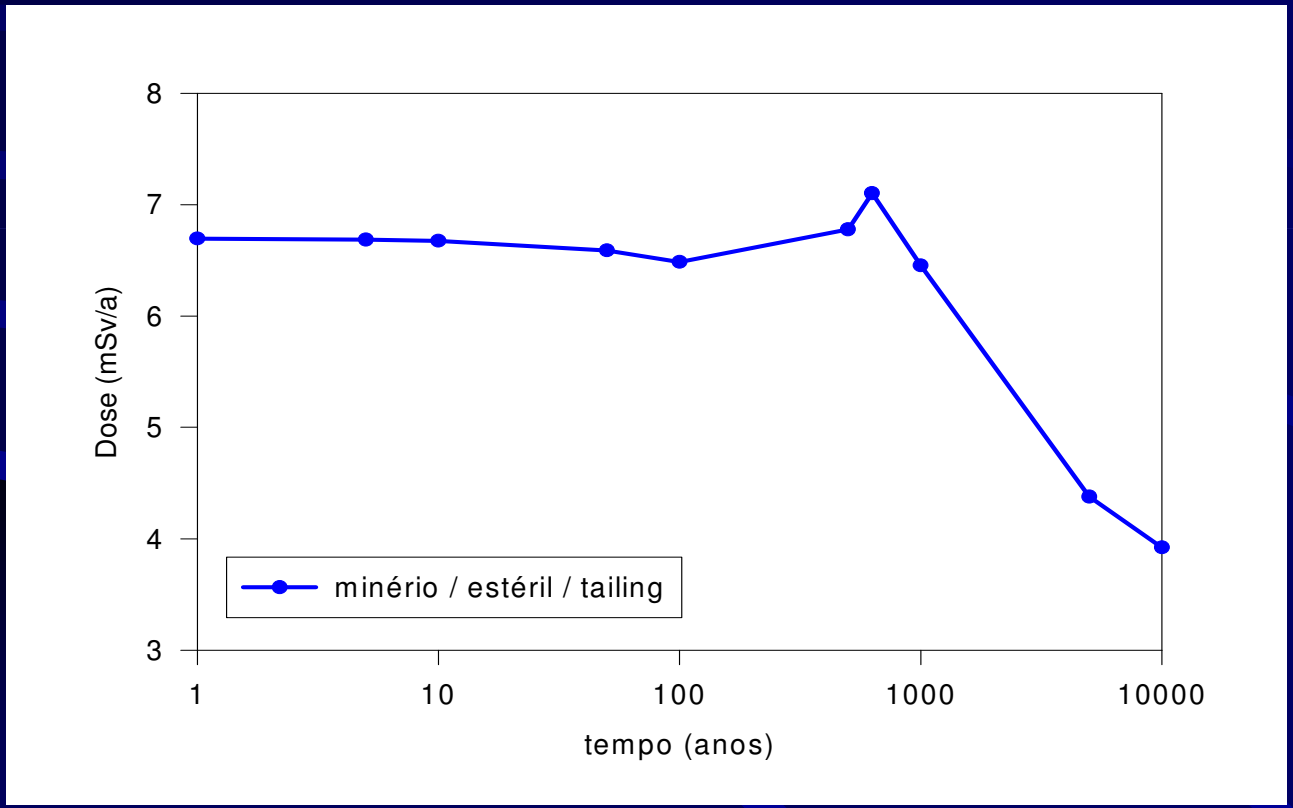
Dose estimation in function of time due to the use of solid waste of the phosphate industry I



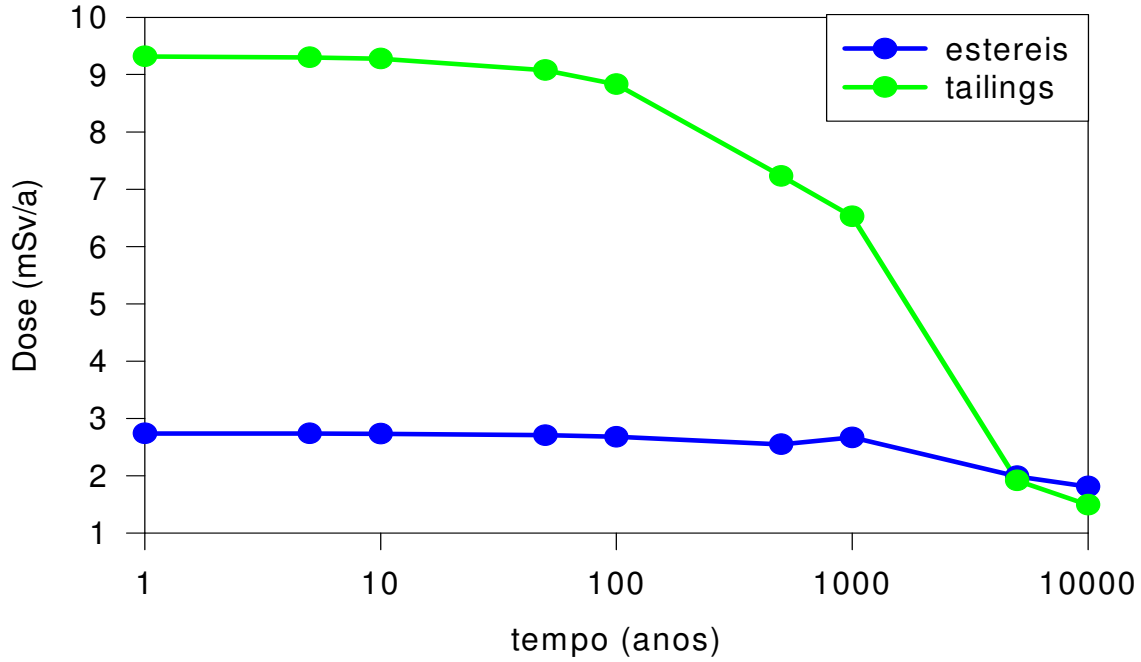
Dose estimation in function of time due to the use of solid waste of the phosphate industry II



Dose estimation in function of time due to the use of solid waste of the coal industry



Dose estimation in function of time due to the use of solid waste of the gold industry



Contribution to the total dose by pathways of the solid waste from the industries

Industry	Radon	γ_{ext}
phosphate	70%	30%
coal	70%	30%
gold	90%	10%

Results and Discussion

Actual scenario - operational phase

industry	**H_E**
niobium	**10 µSv ≤ H_E < 0.3 mSv/year**
phosphate	**-**
coal	**≅ 10 µSv/year**
gold	**10 µSv < H_E ≤ 0.3 mSv/year**

Main Conclusions

- General trend observed in the investigated industries to recycle process water;
- Chemical treatment of the effluent tends to reduce pollutant emissions to the environment
- Chemical processing may remobilize significant amounts of radionuclides;

Main Conclusions (cont)

- Radiological problems are mostly associated to the solid wastes (tailings and slags) that need to be properly managed;
- Natural processes --> Acid Mine Drainage can cause significant radiological impacts;
- Changes in the process may reduce environmental problems and economical recovery (of uranium for example)

Future Studies

- Assess the present extension and situation of dump sites in the mining industries;
- Experimental and modeling studies on radionuclide migration from deposited wastes and assessment of the contamination of groundwater;
- Development of methods to immobilize pollutants in the wastes;

Main Conclusions

- Exposures will depend on a large extent on the type of exposure scenario considered,
- Conservative scenarios will lead to the fact that most of industries will not be exempted from the regulatory control,
- Generic scenarios are not convenient to the address the problem properly.

Future Studies

- Radon exhalation studies above dumpsites and experimental tests to reduce exhalation
- Prioritize studies involving radon exposure of workers in work-places, specially in underground mines (situation completely unknown)
- Development of geochemical modelling of pollutant release and transport from the wastes

Regulatory Framework

- Specific legislation is underway in Brazil.
- The idea is to provide a certification of the industries according to the radiation protection and safety requirements,
- Cooperation and harmonization with other nations is intended

Contacts

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