Radiological Evaluation associated to the Mining of Monazite in Central Spain

R.García-Tenorio[a], E. Sanz[b], E. Burkhalter[c], G.Manjón[a], I. Vioque[a] and I. Diaz[a]

[a]Department of Applied Physics II, University of Sevilla, Spain
[b]Geomnia Natural Resources, Madrid, Spain
[c]Quantum Mineria, Madrid, Spain

2016 Rio norm VIII CHALLENGES AND SOLUTIONS

SUMMARY

A detailed radiological evaluation has been performed associated with the mining of the "Mulas" monazite deposit . This evaluation has been based in the following studies:

a) determination of the activity concentrations of several radionuclides from the Uranium and Thorium series in representative samples of the material mined,

b) construction of an external gamma dose-rate map of the mining area,

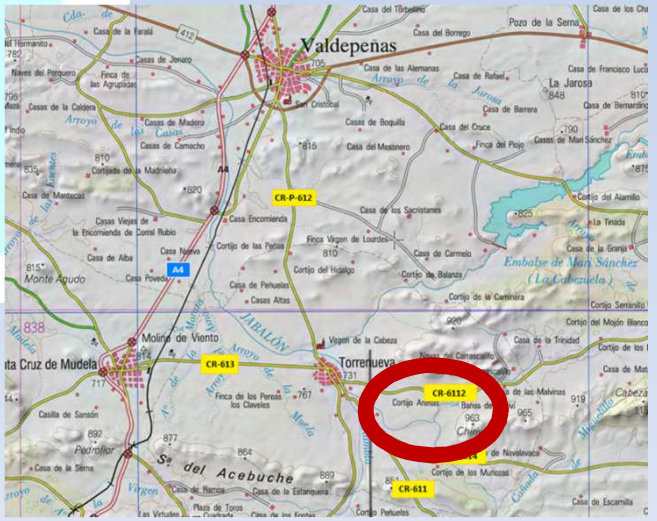
c) study of the distribution of the natural radioactivity in the material extracted as a function of the grain size,

d) radon determinations in the area, and

e) laboratory leaching experiments.

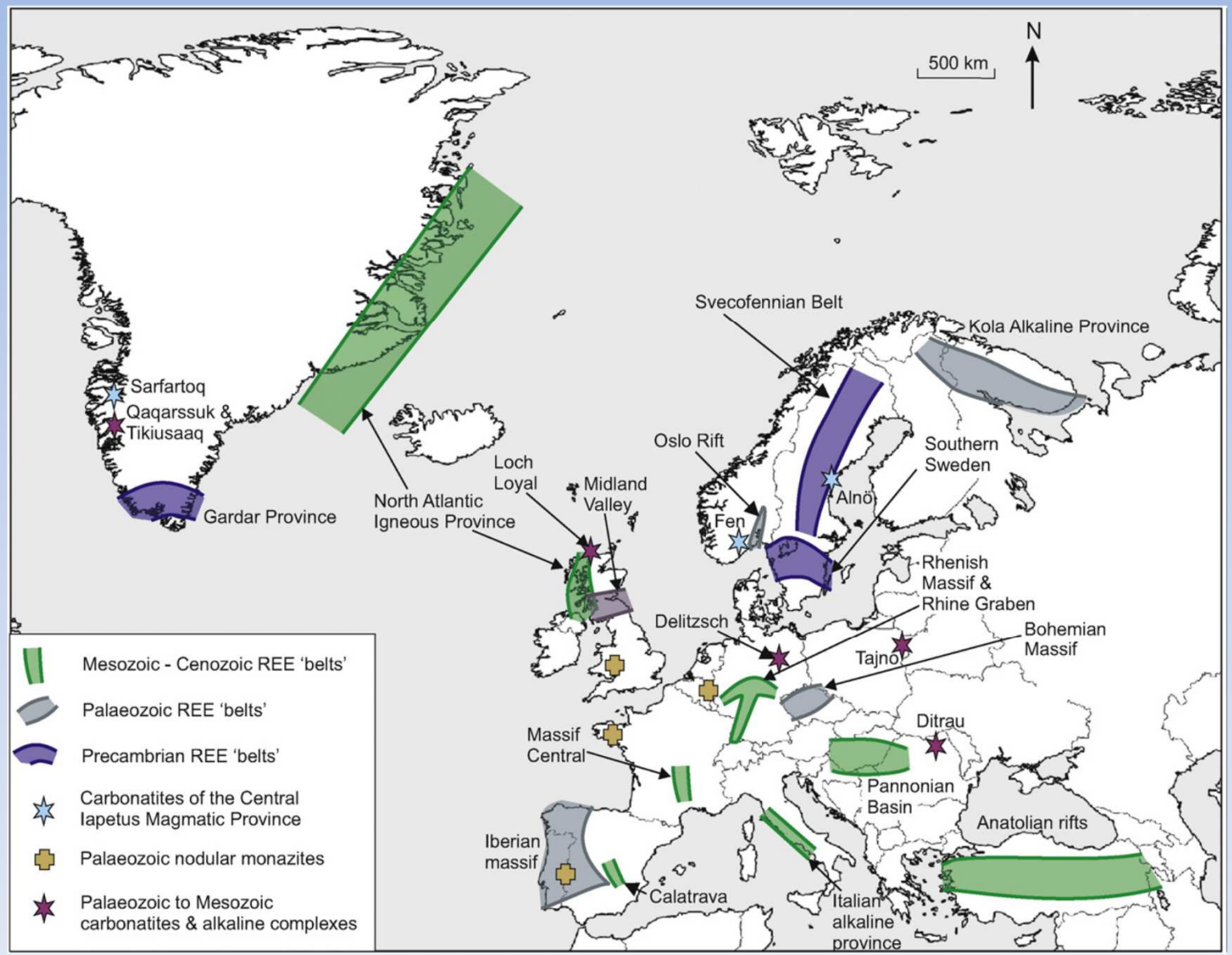
Although the rare earth extraction mining is one of the activities recognized in the positive list of NORM activities, all the results allow concluding that the rare earth mining activity performed in Central Spain can be considered as exempted, being not needed the adoption of radiological countermeasures.

THE LOCATION

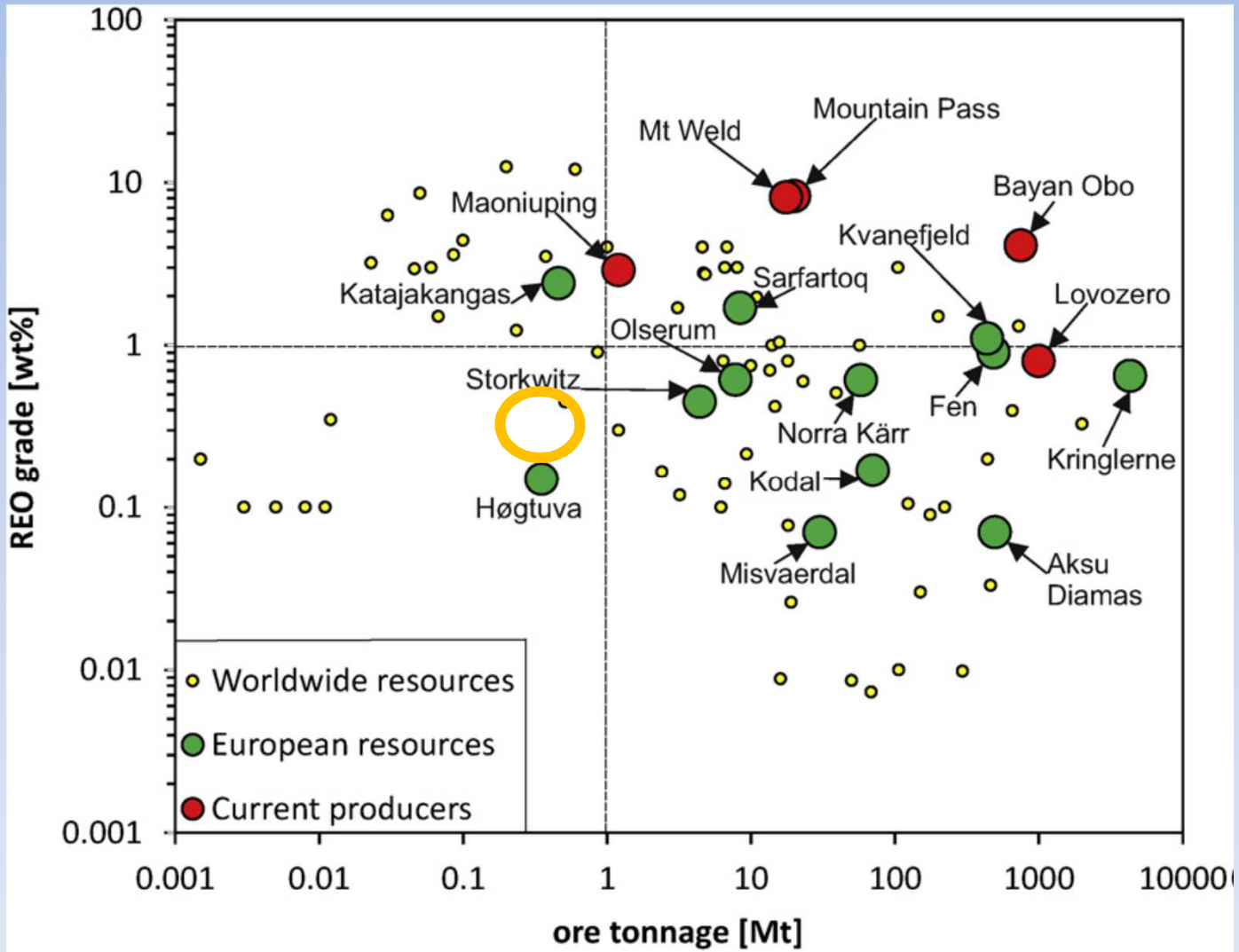


MATAMULAS SITE

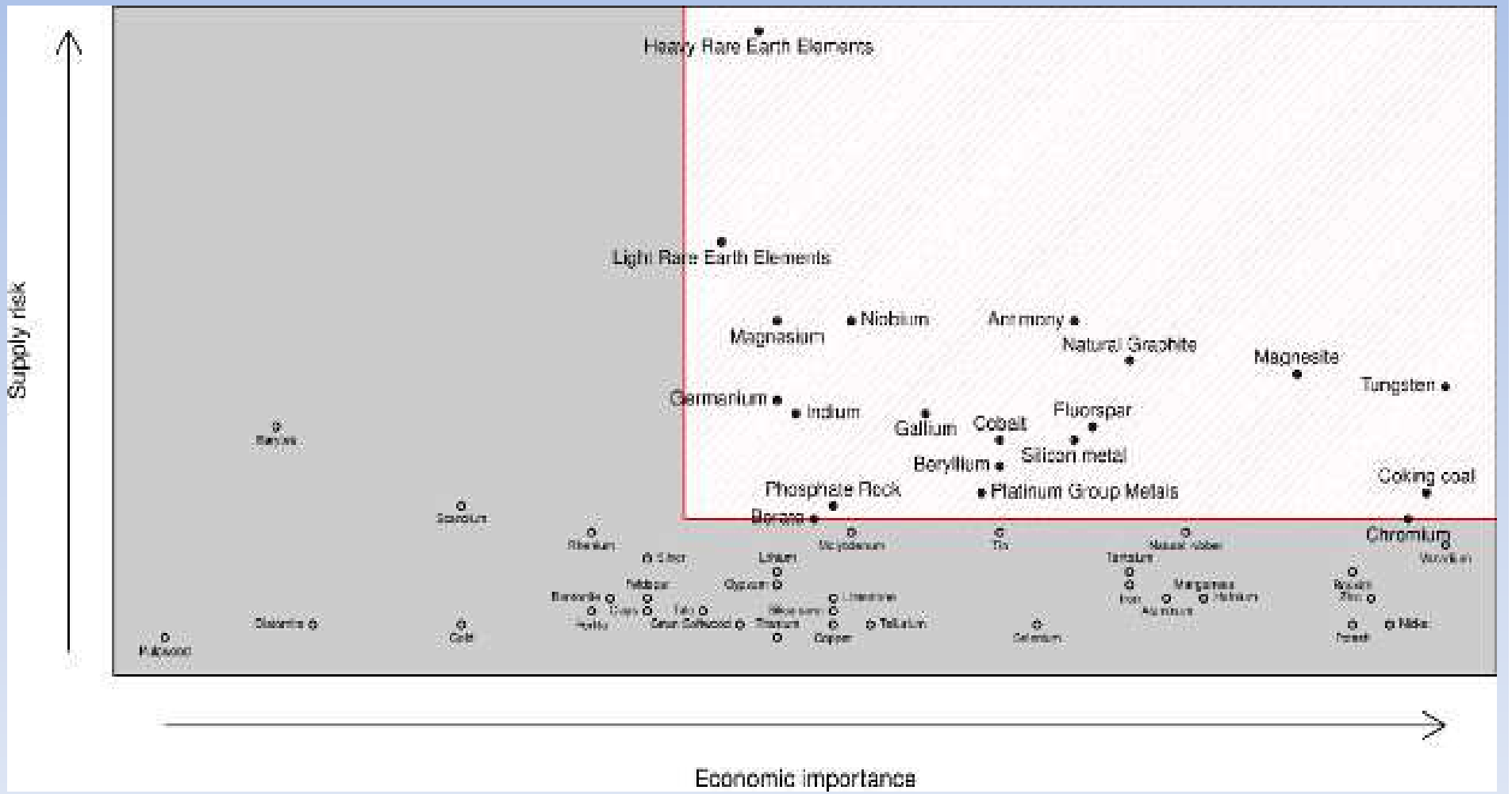
REE ORES in EUROPE



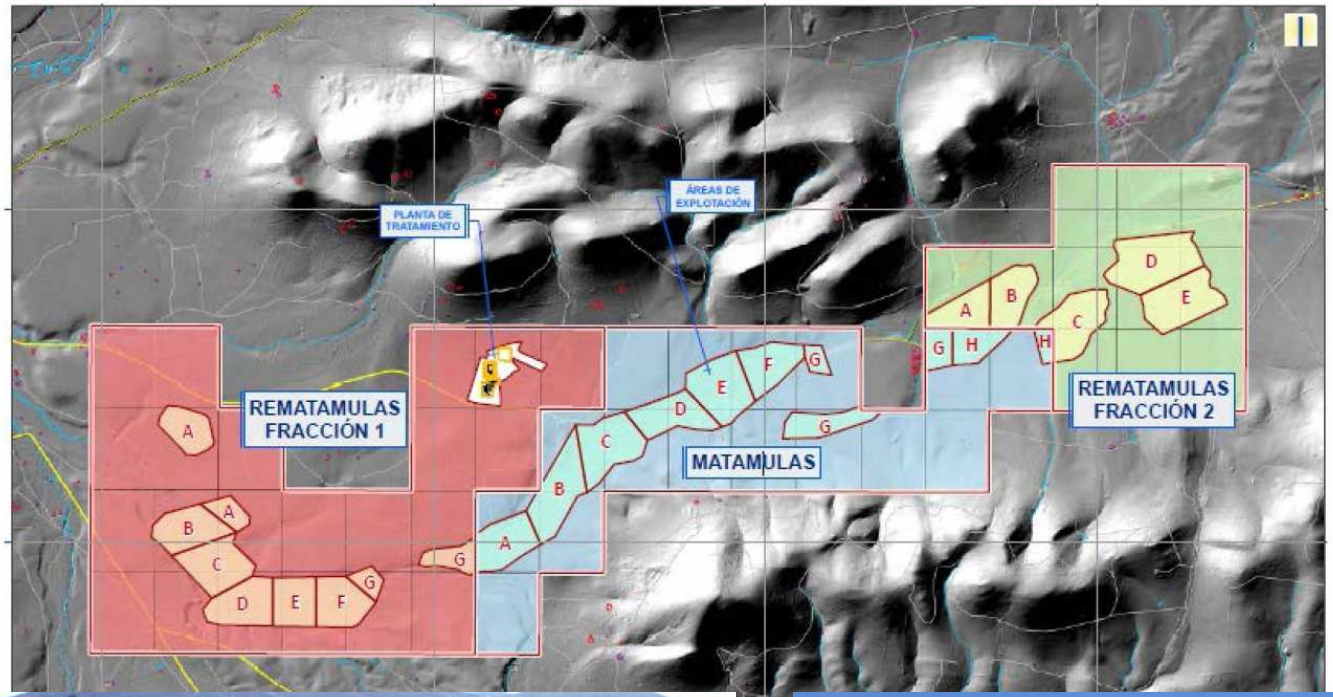
"DIMENSION" OF MATAMULAS ORE



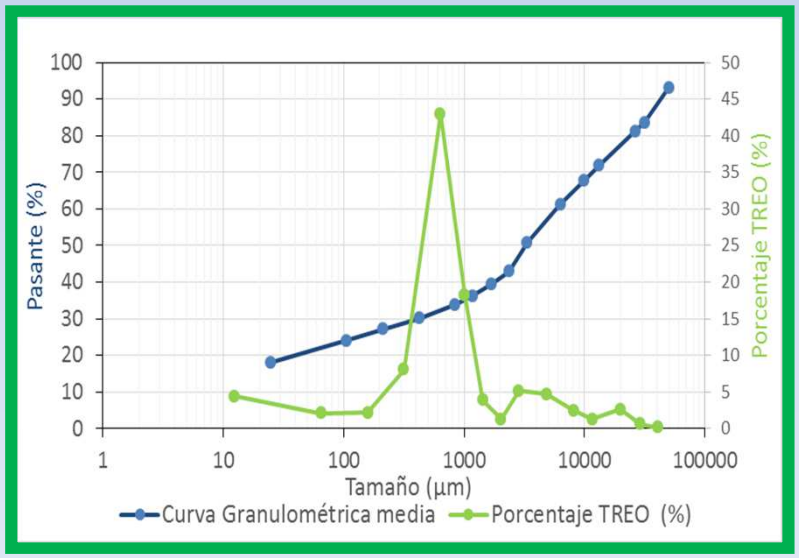
CRITICAL RAW MATERIALS



MINING AREA


PLANTA DE TRATAMIENTO
ÁREAS DE EXPLOTACIÓN
REMATAMULAS FRACCIÓN 1
MATAMULAS
REMATAMULAS FRACCIÓN 2

MONAZITE CHARACTERISTICS

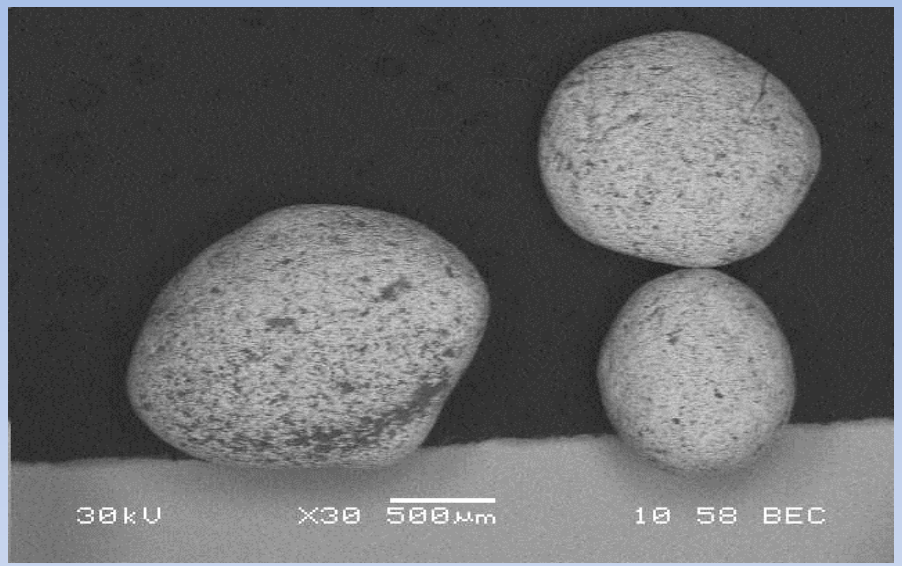


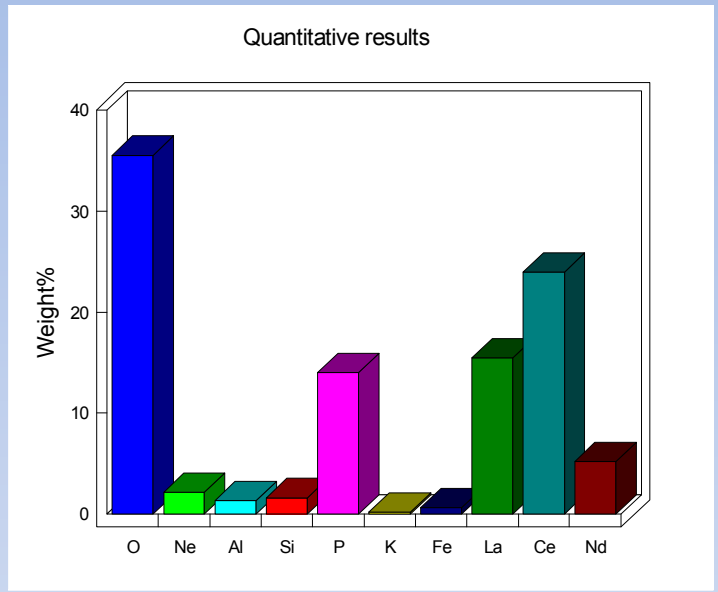
	100% REO
CeO_2	42,93
Nd_2O_3	27,26
La_2O_3	15,95
Pr_8O_{11}	5,77
Sm_2O_3	4,18
Gd_2O_3	1,78
Y_2O_3	0,60
Dy_2O_3	0,40
Eu_2O_3	0,40
Ho_2O_3	0,38
Tb_4O_7	0,21
Yb_2O_3	0,06
Tm_2O_3	0,05
Er_2O_3	0,03
Lu_2O_3	0,00

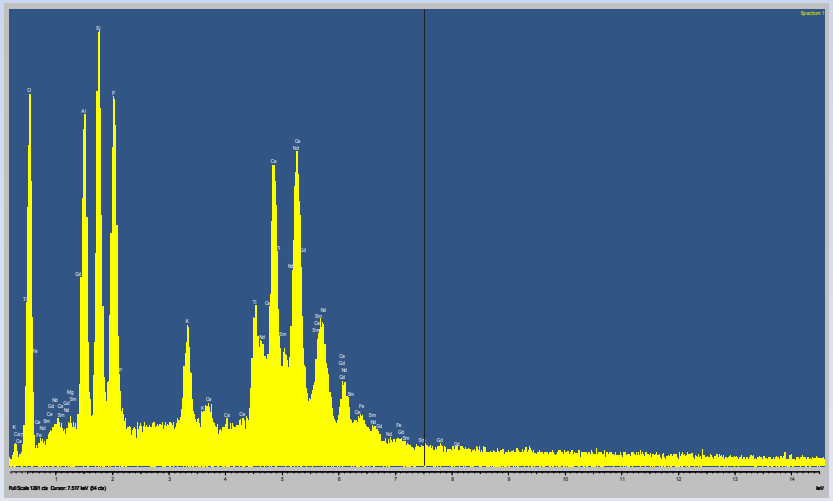
Hardness : 5 – 5.5 Mohs scale

Real Density : 4.65 g/cm^3

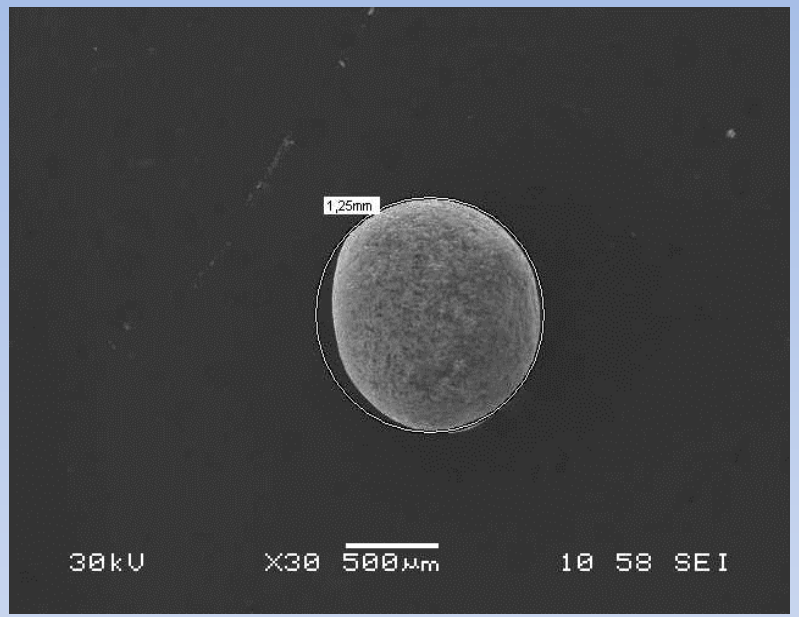
MONAZITE CHARACTERISTICS

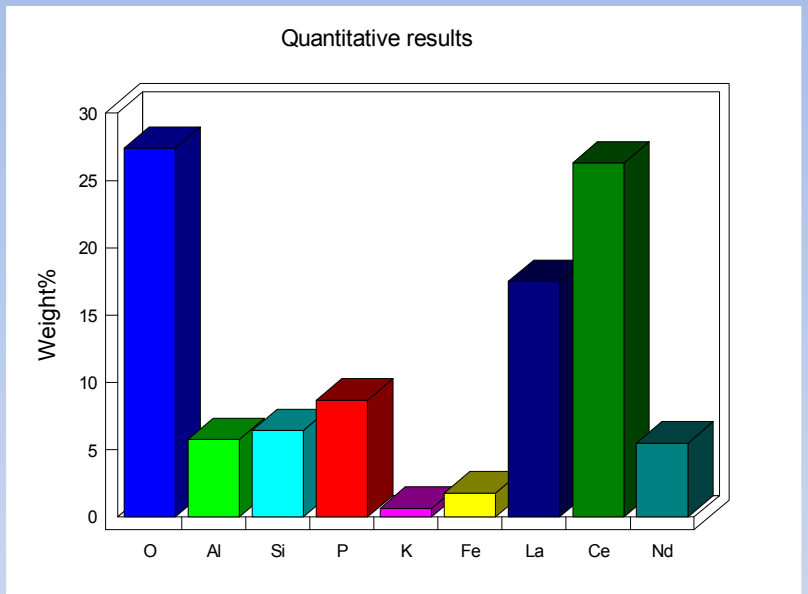


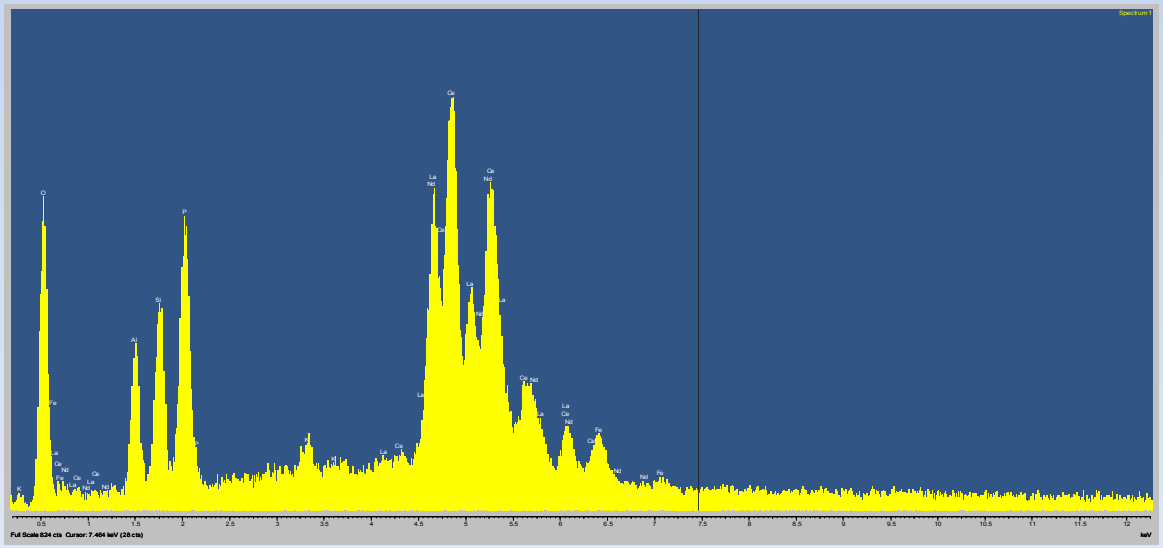




MONAZITE CHARACTERISTICS







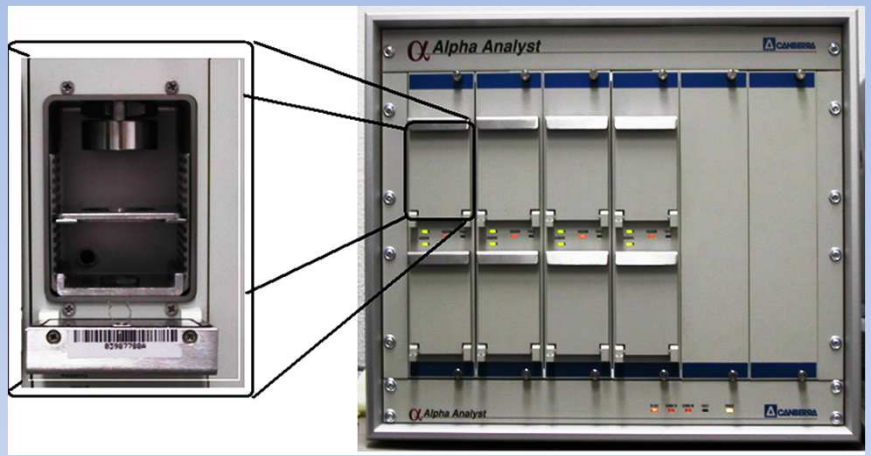
SAMPLING

GRADDED APPROACH

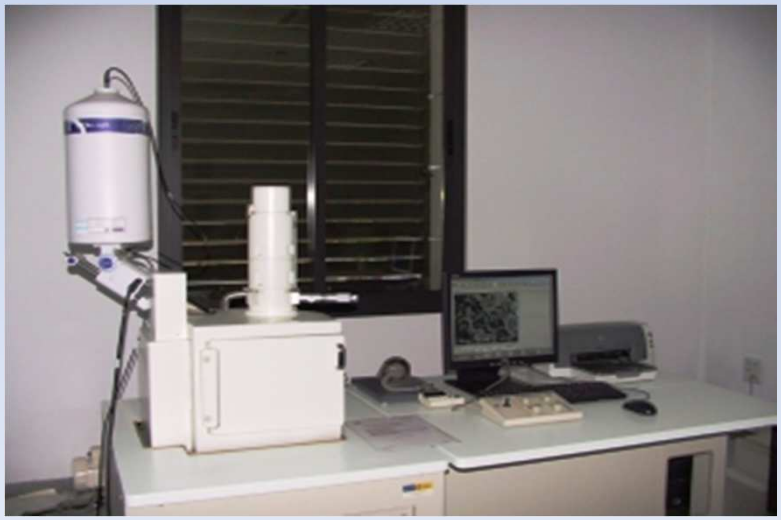
EXPERIMENTAL TECHNIQUES

GAMMA SPECTROMETRY

ALPHA SPECTROMETRY



SEM - EDX



GAMMA DOSE RATE

RADIOMETRIC DETERMINATIONS (I)

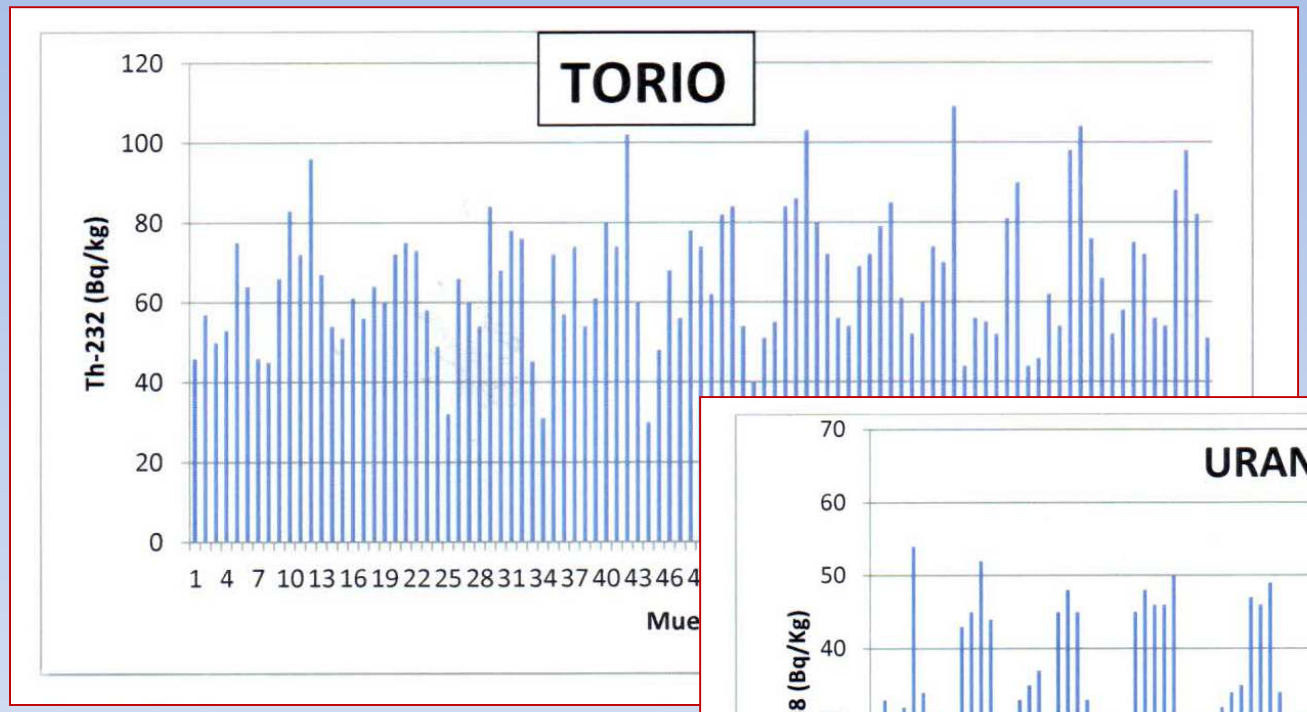
Activity Concentrations (Bq/kg)

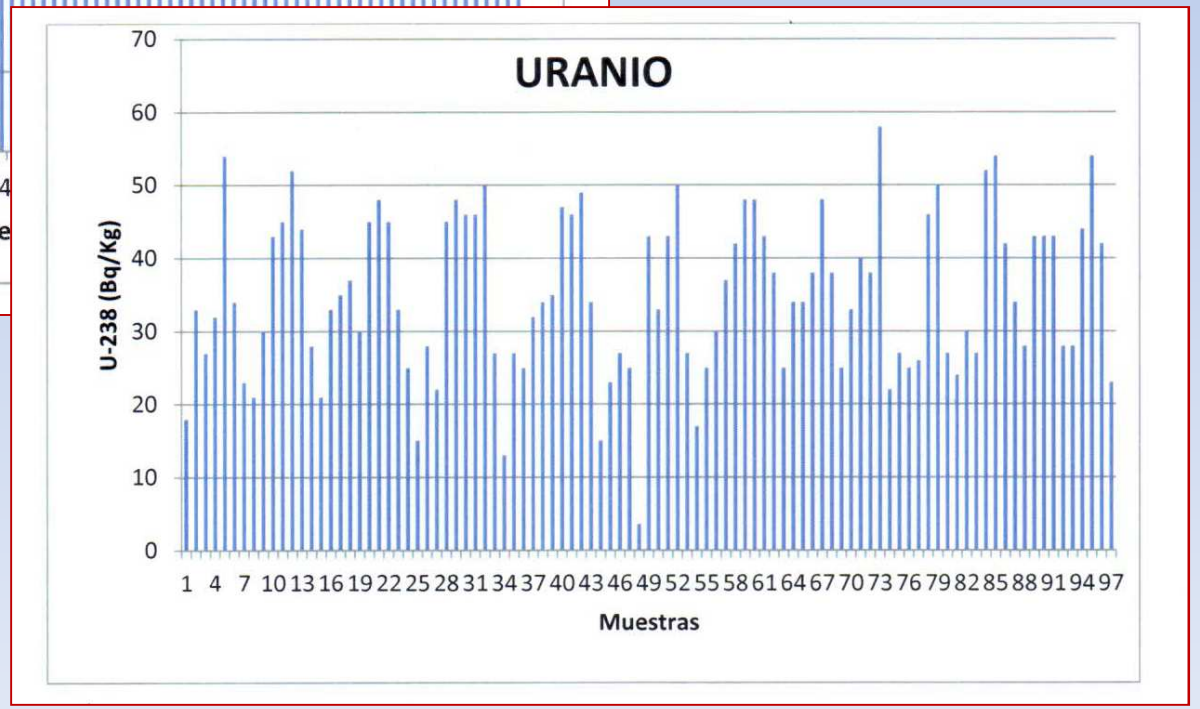
	Muestra 1	Muestra 2	Muestra 3	Muestra 4	Muestra 5	Muestra 6
^{232}Th	94 ± 12	82 ± 10	91 ± 4	77 ± 5	105 ± 6	66 ± 4
^{230}Th	60 ± 3	55 ± 3	47 ± 4	43 ± 2	50 ± 3	46 ± 3
^{238}U	52 ± 12	51 ± 12	46 ± 10	51 ± 10	57 ± 12	42 ± 10
^{234}U	47 ± 3	45 ± 3	49 ± 3	44 ± 4	54 ± 3	49 ± 2
^{40}K	740 ± 41	594 ± 37	851 ± 39	824 ± 43	688 ± 32	845 ± 40
^{137}Cs	2.3 ± 0.3	< 1.0	< 1.0	3.1 ± 0.4	3.0 ± 1.0	< 1.0

Quite uniform the radionuclide distribution
-Comparable with the obtained ones in big extensions over the country

The “grey” monazite is enriched in natural radionuclides?

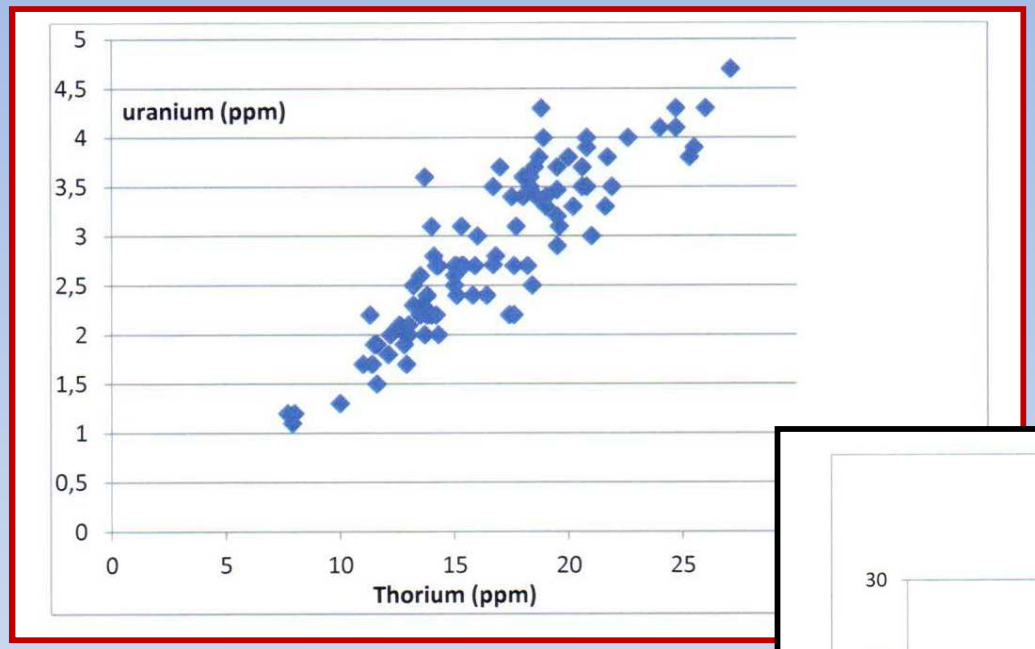
RADIONUCLIDE DETERMINATIONS (II)

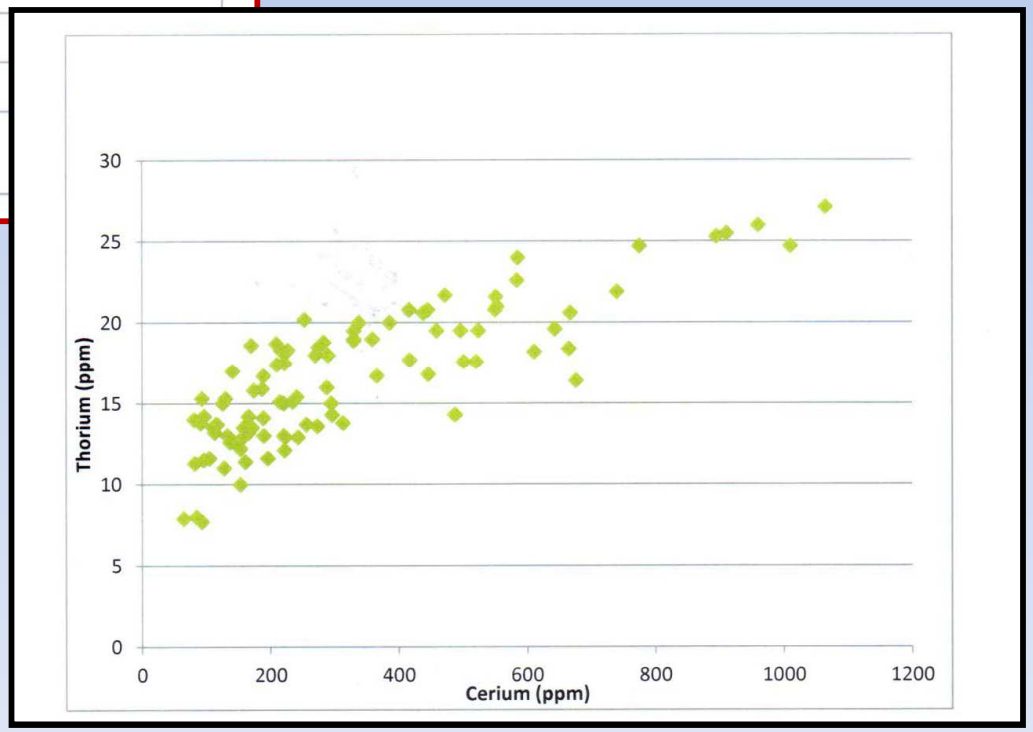




^{232}Th 30 - 100 Bq/kg
^{238}U 10 - 50 Bq/kg

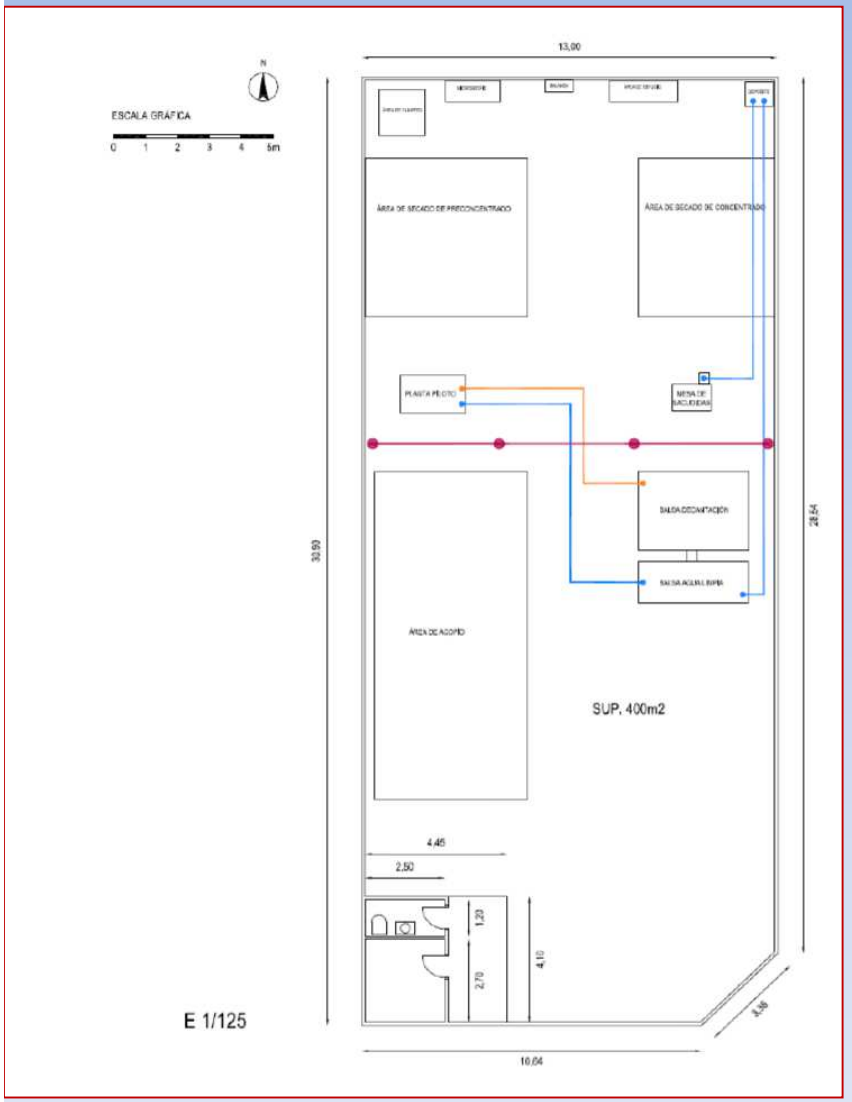
RADIONUCLIDE DETERMINATIONS (III)

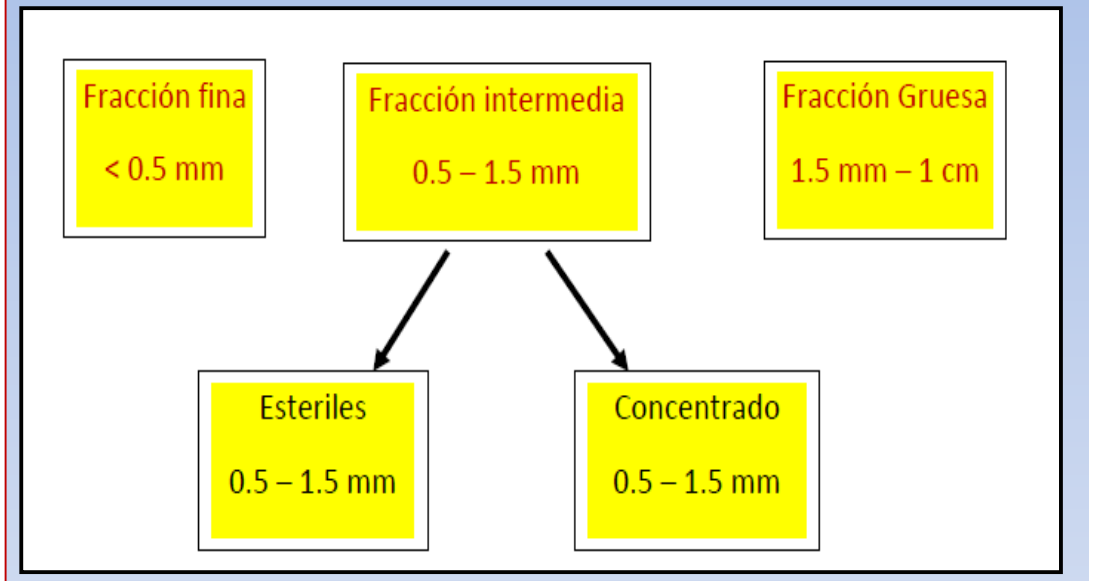




EXTERNAL GAMMA DOSE RATE MAP

Monazite separation and concentration

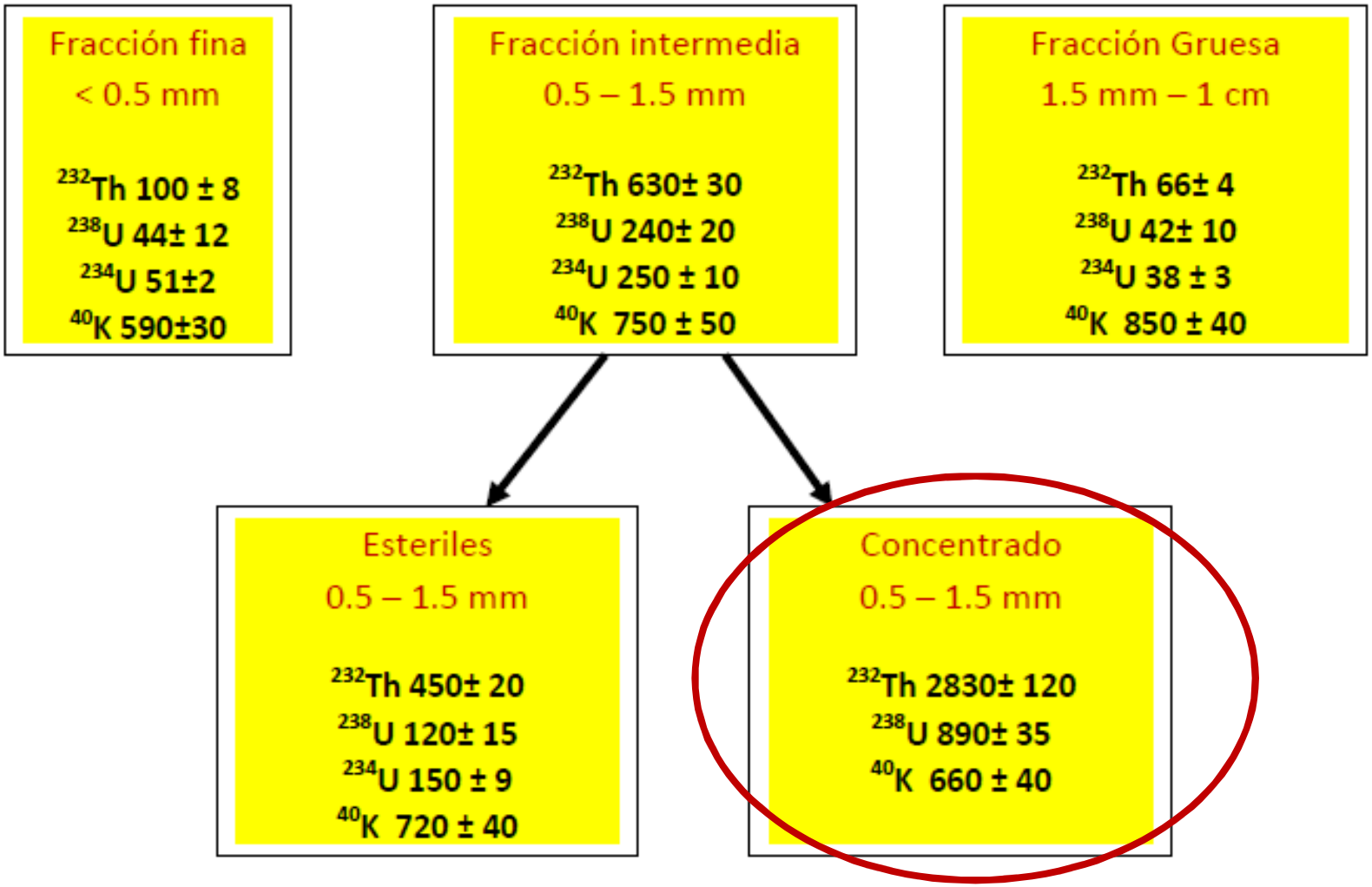




Only physical processes applied

Intermediate fration less than 5% in weigth

Radionuclide Granulometric Distribution

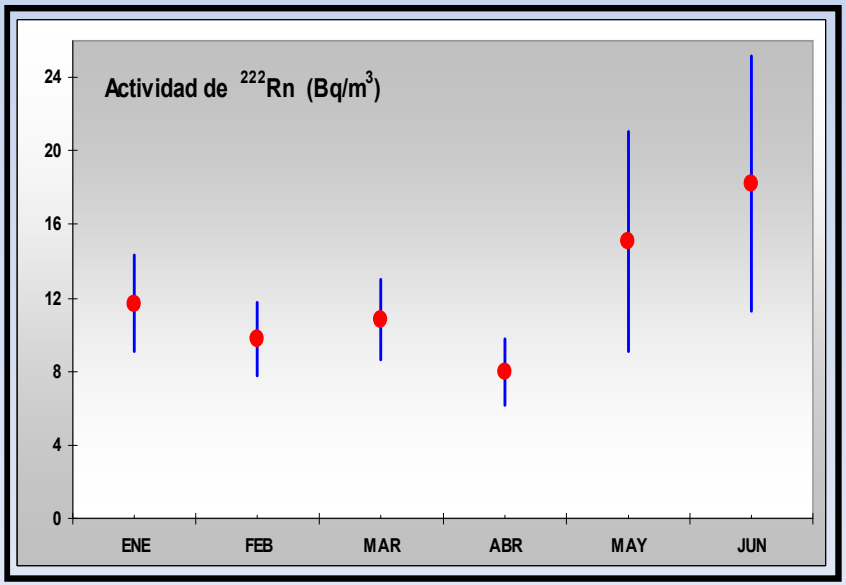


Radiological Implications

Negligible radiological impact in the mining process due to external radiation

Negligible radiological impact in the mining and concentration process due to inhalation. The fine material susceptible to be resuspended/inhaled in the mining and concentration processes "depleted" in natural radionuclides.

Radiological impact due to ^{222}Rn should be discarded, because the mining and concentration processes are carried out at open-air.



Occupational doses susceptible to be received by the workers in charge of the different concentration processes and of the handling and storage of the concentrates in the plants evaluated as 0.15 – 0.20 mSv/a due to the external radiation. This estimation was performed adopting very conservative assumptions.

Environmental Radiological Implications

Radiometric determinations in

-5 underground waters collected from wells located in the mining area

-vegetables (lettuces. Spinachs, chards, tomatoes)

-fruits, olives, cereals …….

DO NOT SHOW ENHANCEMENTS IN NATURAL RADIONUCLIDES IN THE MINING AREA

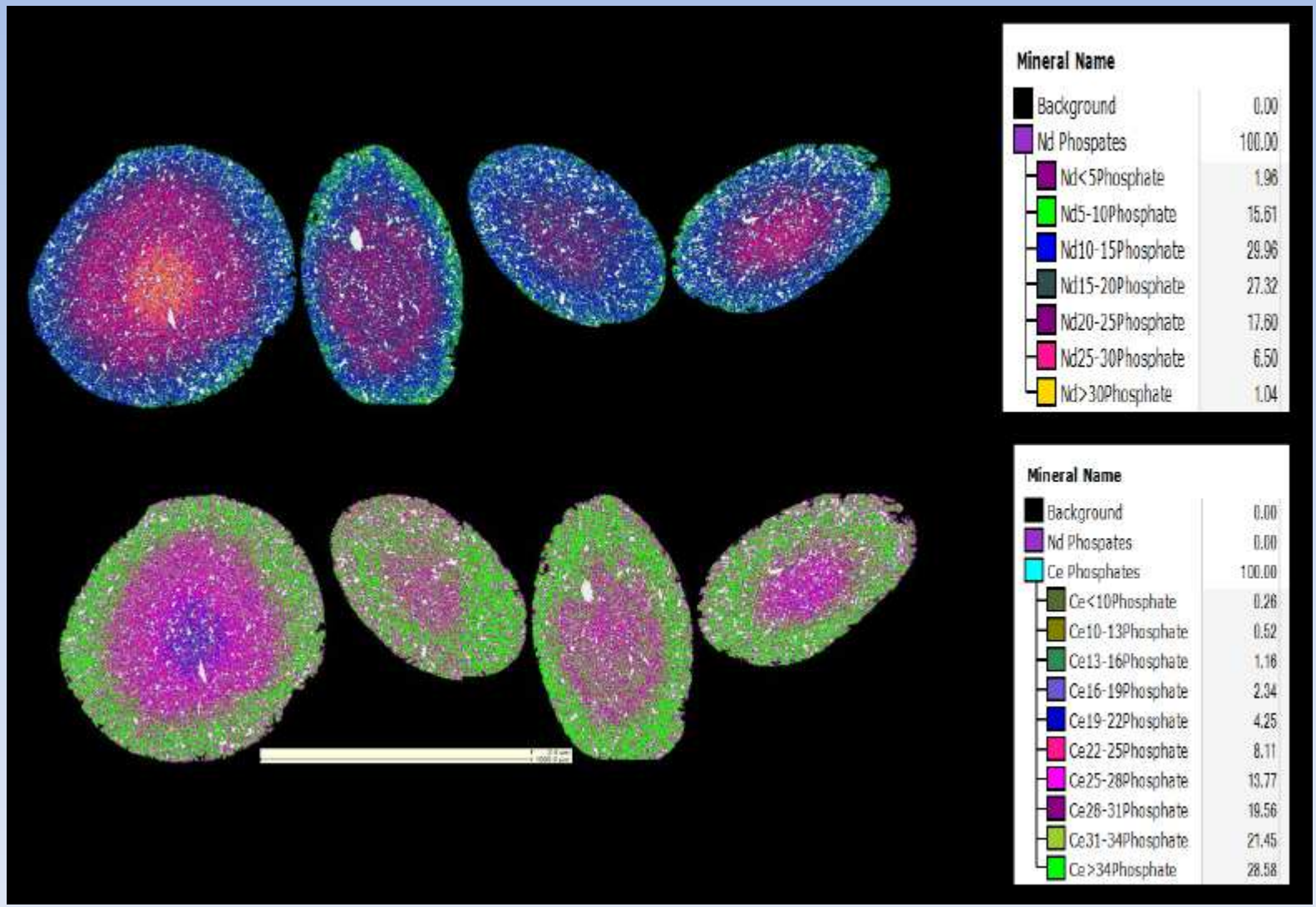
Leaching experiments submitting monazite fractions during 24 hours to the action of

-rainwater - ground water -0-16 M HCl

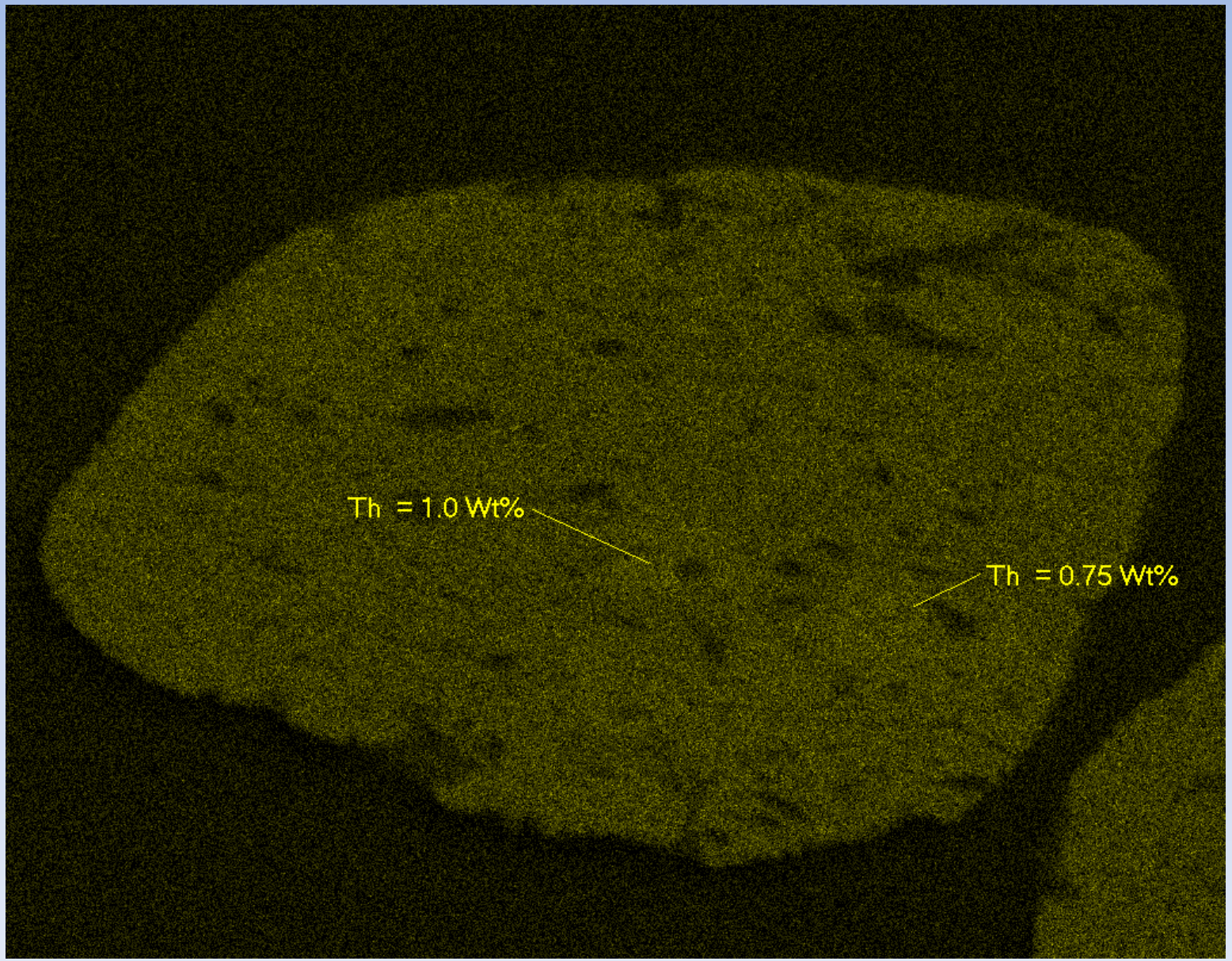
show not detectable activities in the leachates (by alpha and gamma spectrometry)

MONAZITE QUITE REFRACTORY MATERIAL

Nd is enriched in the central parts of the particles, whereas the Ce content increases in the opposite direction.

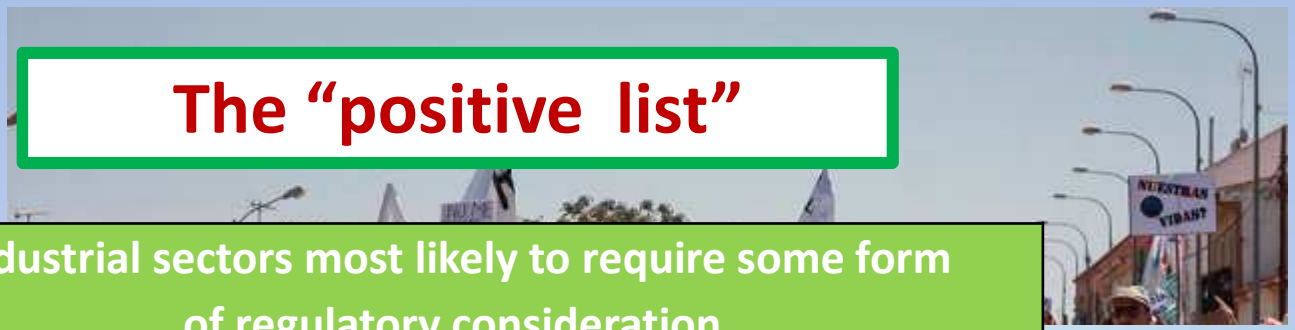


Th internal distribution



PUBLIC RISK PERCEPTION

The "positive list"



Industrial sectors most likely to require some form of regulatory consideration
Uranium mining and processing
Rare earths extraction
Thorium extraction and use
Niobium extraction
Non-U mining- including radon
Oil and gas
Production and use of TiO2
Phosphate industry
Zircon and zirconia
Metals production (Sn, Cu, Al, Fe, Zn, Pb)
Burning of coal
Water treatment-including radon


Thanks
Gracias