

## Radiological evaluation associated to the mining and concentration of monazite in Central Spain

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A detailed radiological evaluation (occupational, public and environmental) has been performed associated with the mining and physical concentration of monazite, enriched in different rare earths, in a zone to be exploited commercially which is located 200 km to the south of Madrid (Spain). This evaluation is performed because the rare earth extraction mining and concentration steps are activities recognized in the positive list of NORM activities to be analysed for possible adoption of radiological controls.

The evaluation has been divided in two main parts: mining and physical concentration. And the evaluation of the mining activity 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 raw 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 in function of the grain size,
- d) radon determinations in the area, and
- e) laboratory leaching experiments.

All the results obtained allow concluding that the rare earth mining activity performed in Central Spain can be considered as exempted, being not needed the adoption of radiological measures associated to this activity. The monazite, although presents high activity concentrations of  $^{232}\text{Th}$  and  $^{238}\text{U}$  (6000 and 2000 Bq/kg, respectively) is found diluted in proportions less than 1% in the raw material mined. In addition the monazite is present as nodules with sizes in the range 0.5 – 1.5 mm (see Figure 1), playing for that reason the inhalation a minor role in the dosimetric evaluations.

The second part of the study was devoted to the radiological evaluation associated to the activities to be performed in a planned plant where the extraction and isolation of the monacite nodules from the raw mineral material mined will be performed. The isolation activities to be applied in the plant are all of them based in the application of physical processes that can alter the activity concentrations of Th and U along the process, but do not provoke the selective mobilization of some of

the daughters. The secular equilibrium in the Th and U series is not disrupted.

The plant evaluation performed, based in the application of simulations with well-established dosimetric models allowed us to conclude that this activity will be also exempted, being not necessary the adoption of any countermeasure from the radiological point of view.

The conclusions obtained in this work are different from the generalized statements found in reports devoted to the description of different NORM industries which indicates that the activities associated to the extraction of rare earths are paradigmatic examples of activities needing regulation from the radiological point of view.

Two are the key points that need to be considered to understand the conclusions obtained in our study

- a) The  $^{232}\text{Th}$  and  $^{238}\text{U}$  activity concentrations in the monazite extracted and isolated in central Spain are comparatively quite low in comparison with the values found in monacites extracted worldwide.
- b) The evaluation performed in this work, is restricted to the mining and physical concentration of the monazite. The posterior beneficiation, chemical treatment and concentration of the rare-earths from the monacite in beneficiation plants, activities that for the moment are not planned to be done in Spain, need an independent analysis. In the extraction and isolation of the different rare-earths from the monazite the secular equilibrium in the U and Th is disrupted, selective enrichments can be produced, and highly radioactive residues should be managed.

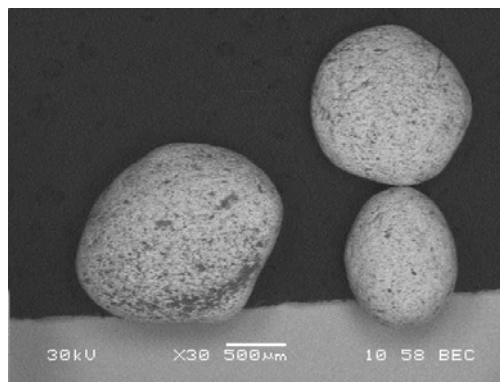


Figure 1.- Electron Microscope Image of monazite nodules enriched in Th and U