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[JEP](#) > Vol.2 No.2, April 2011



## Radiochemical Characterization of Phosphogypsum for Engineering Use

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### ABSTRACT

The new phosphogypsum (PG) waste management policy allowed to reduce the negative environmental impact of this residue by finding better alternatives uses with an extremely limited radiological impact. Building material could be one of these alternatives that could lead to the production of final products with good mechanical properties and very limited radionuclides content. The optimization of the radioactive levels in the building materials when PG is used for its production requires the previous knowledge of the content of naturally occurring radionuclides in the PG waste. This article aims the radioactive characterization of two different PG sources (from Spain (Fertiberia S.A., Huelva) and Tunisia (Sfax), before being incorporated in building materials. For this purpose, the natural selected radionuclides content belonging to uranium and thorium decay series and 40K was determined, by means of two different methods: i) gamma spectrometry with high-purity germanium detectors and ii) laser-induced kinetic phosphorimetry (KPA-11 Chemcheck Instruments Inc., Richland, WA). Also, the semiquantitative chemical composition, the mineralogical study and the morphological aspect of the PG samples were analysed. The results obtained from both techniques show that  $^{226}\text{Ra}$  and  $^{210}\text{Po}$  are the main source of the radioactivity in both studied PG samples. However, PG samples from Tunisia present low natural radionuclide levels (30.7 Bq/kg-1 average value for  $^{238}\text{U}$ , 188 Bq/kg-1 ( $^{226}\text{Ra}$ ), 163 Bq/kg-1 ( $^{210}\text{Pb}$ ), 12.4 Bq/kg-1 ( $^{232}\text{Th}$ )) compared to the level of natural radionuclides in PG samples from Huelva (102 Bq/kg-1 average value for  $^{238}\text{U}$ , 520 Bq/kg-1 ( $^{226}\text{Ra}$ ), 881 Bq/kg-1 ( $^{210}\text{Pb}$ ) and 8 Bq/kg-1 ( $^{232}\text{Th}$ ). Both PG fulfil European Commission Recommendation (ECR) for the maximum activity concentrations of naturally-occurring radionuclides for industrial by product used in building materials in the European Union.

### KEYWORDS

Phosphogypsum, Radionuclides Analysis, Phosphate Industry, Gamma Spectrometry, TENORM

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