

## Characterisation of materials suitable as NORM reference materials

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Academiejaar:

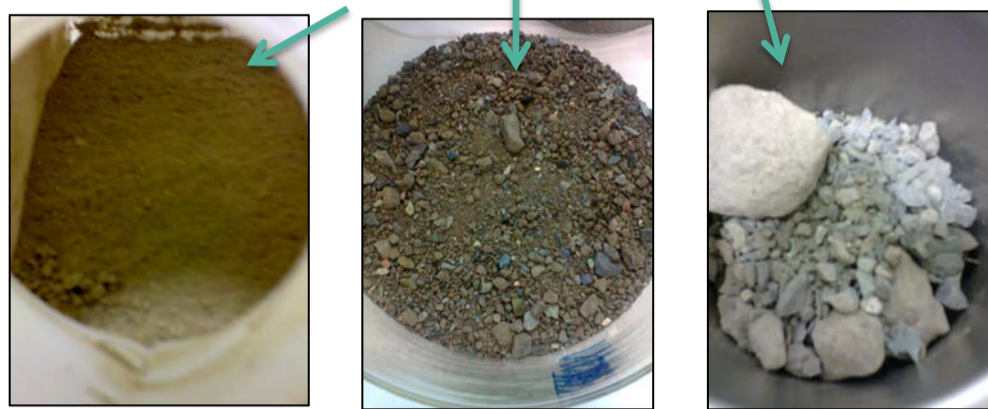
2014-2015

### Background

- Industries that exploit huge volumes of natural resources generates large amounts of Naturally Occurring Radioactive Materials (NORM) in by-products, residues and wastes
- Contamination of the environment and exposure of the public must be avoided
- More and better measurements are needed
- Measurement systems have to be developed and calibrated with calibration standards and (certified) reference materials (CRM/RM) that are adapted to the real composition and geometry of measured materials

### Possible candidates

- 2 kinds of by-products from Ferro-Molybdenum (Hotspot and slag)
- Italian Tuff rock

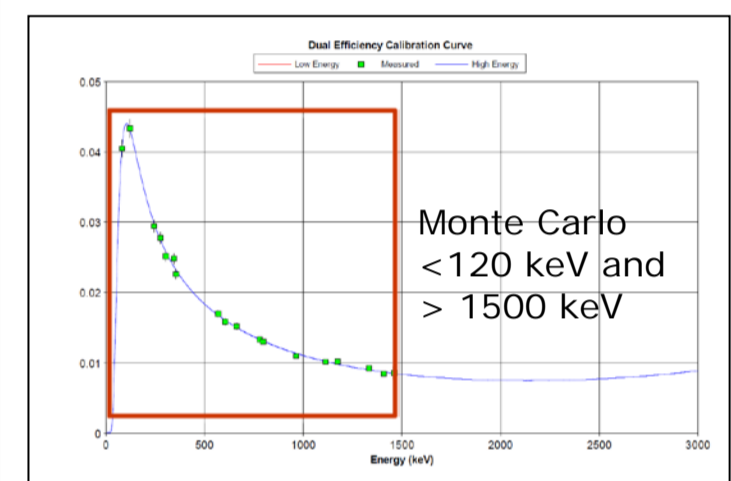


### Aim of the study

- Characterization of radionuclides and activity
- Homogeneity study through different samples of the same material

### Materials and methods

- Gamma-ray spectrometry with a low-background high purity germanium detector (HPGe)
- Liquid solution together with certified radionuclide activities with Monte Carlo simulation was used for detector efficiency determination



### Sample preparation and measurement

1) Grind sample



2) Put in O-ring sealed Teflon container



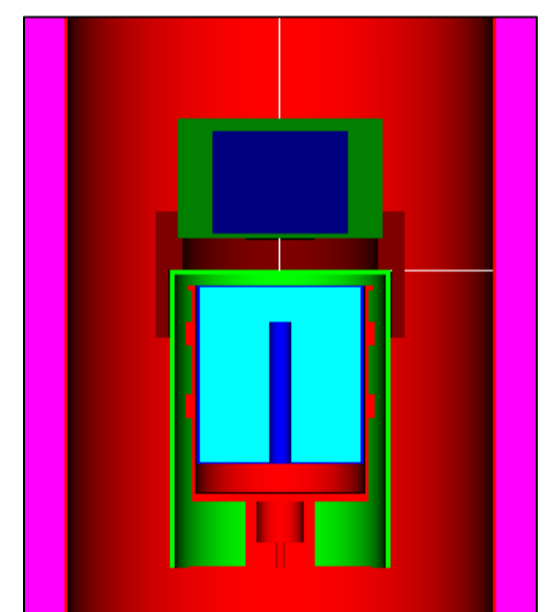
3) Weighing the sample



4) Gamma-ray spectrometry on HPGe detector



5) Efficiency correction with measured standard source and Monte Carlo simulation



### Results

Activity for dry mass in Bq/kg

Radio-nuclide	FeMo Hotspot	Rel-St-dev. (%)	FeMo Slag	Rel-St-dev. (%)	Tuff	Rel-St-dev. (%)
Sub-samples	4	/	4	/	2	/
U-238	480 ± 26	6	2381 ± 208	8	374 ± 38	11
Ra-226	249 ± 4	1	1975 ± 52	8	233 ± 7	3
Pb-210	165 ± 26	18	1543 ± 136	10	246 ± 28	13
Ra-228	2672 ± 77	2	4664 ± 156	6	347 ± 19	4
Th-228	2483 ± 94	7	4853 ± 100	8	355 ± 12	5
U-235	18 ± 1	4	103 ± 6	12	18 ± 2	8
Ac-227	23 ± 4	21	60 ± 4	6	10 ± 2	0
K-40	250 ± 4	2	35 ± 9	60	2085 ± 53	3

### Conclusion

Important parameters for RM

- Suitable radionuclides **OK**
- Activity level suitable for easy use (except Ac-227 (Hotspot and tuff)) **OK**
- Homogeneity **OK**
- Radionuclide low Rel-Stdev **OK**

All 3 materials qualify as potential CRM's CRM development is a long and complex procedure that requires pre-studies like this one

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Remark: Phosphogypsum was also analysed. But due to confidentiality and agreement with the company the results may not be published.