Measurements of the natural radioactivity in the Polkowice-Sieroszowice mine

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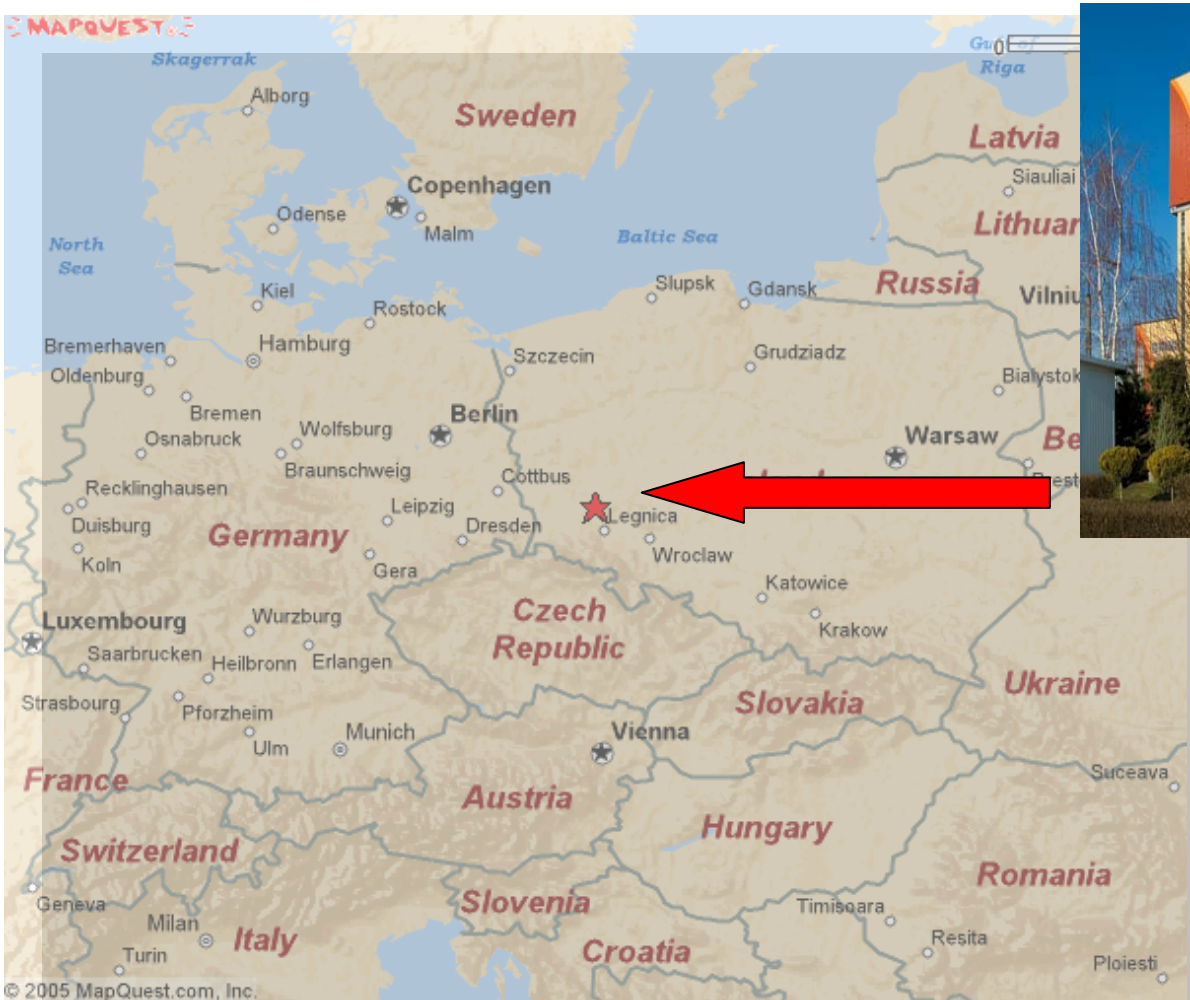
(results obtained in IFJ - Kraków: M.Budzanowski, S.Błażej, K.Kozak, J.Mazur, J.W.Mietelski, M.Puchalska, A.Szelc, E.Tomankiewicz, A.Zalewska

and in IF US - Katowice: J.Dorda, D.Malczewski, JK)

Outlook

- **ZG Polkowice-Sieroszowice – where?**
- **Measurements of the natural radioactivity in the ZG Polkowice-Sieroszowice**
- **Conclusion and plans**

SUNLAB (Sieroszowice Underground Laboratory) – in ZG Polkowice-Sieroszowice

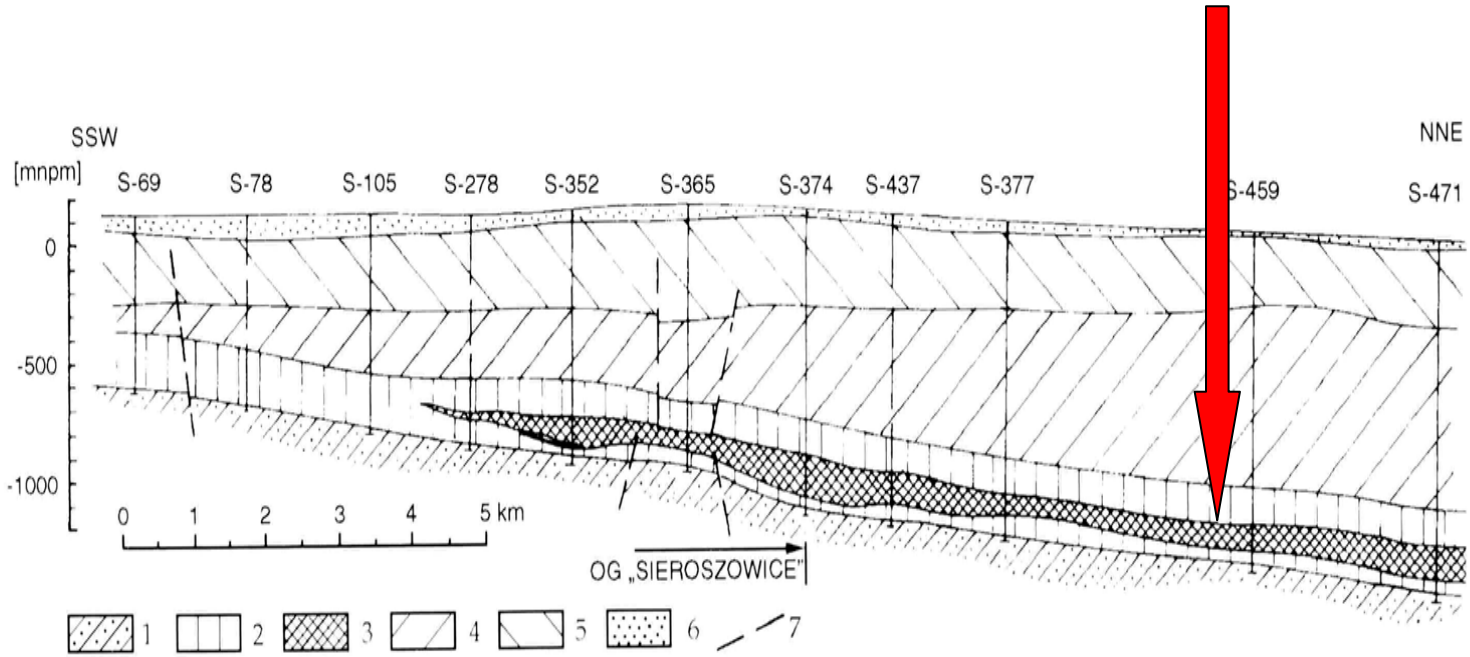


- **South-west of Poland,**
- **90 km north-west from Wrocław,**
- **Belongs to the KGHM Polska Miedź S.A. holding**

KGHM Polska Miedź S.A. holding

- **Cooper - 6th position in the world's exploitation ranking,**
- **Silver – 2nd position,**
- **…but also salt production in the Polkowice-Sieroszowice mine**

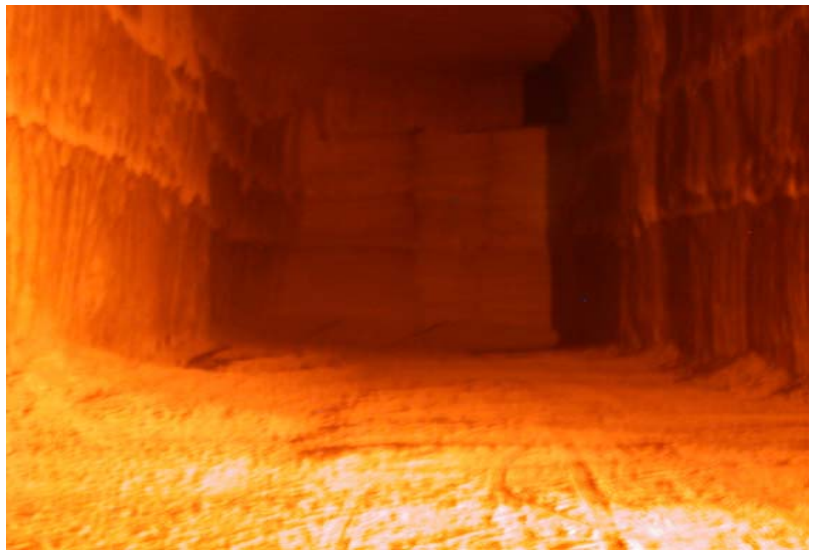
ZG Polkowice-Sieroszowice: salt layer



Przekrój geologiczny poprzeczny

1. Czerwony spągowiec; 2. formacja cechsztyńska; 3. pokład soli kamiennej najstarszej (Na 1); 4. trias; 5. trzeciorzęd; 6. czwartorzęd; 7. przypuszczlane dyslokacje uskokowe

ZG Polkowice-Sieroszowice: salt caverns



- **4 salt caverns: depth ~ 930m (~2500m w.e.),**
- **in a salt layer of thickness of ~ 70m, surrounded by anhydrite,**
- **dimensions: 15m×20m×100m,**
- **temperature: ~ 35^{0}C,**
- **measurements in the salt cavern Ps1**

Measurements of the natural radioactivity in the SUNLAB

- ***In-situ*** **measurements in the salt cavern:**
  - use of HPGe detector (EG&G ORTEC),

- **Radon concentration measurements in the salt cavern:**
  - use of AlphaGUARD detector,

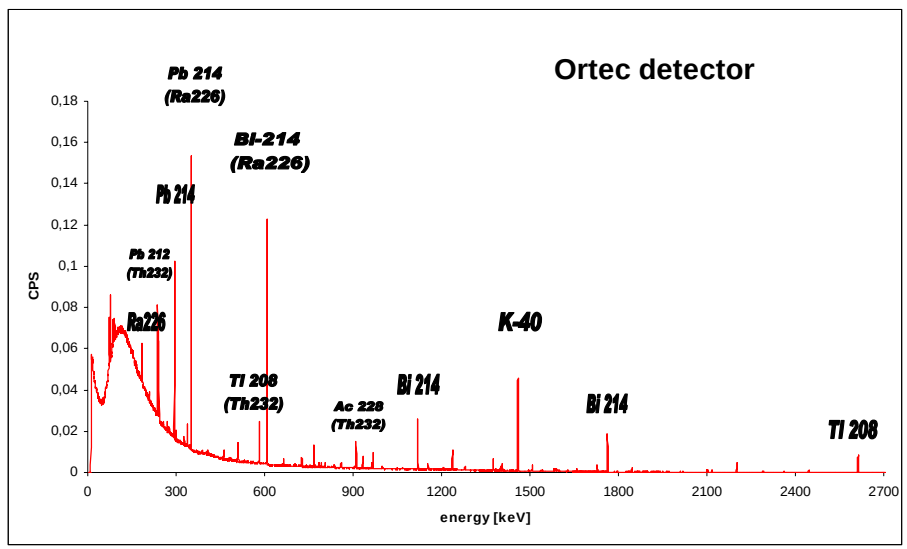
- **Rock samples (salt and anhydrite) measurements:**
  - use of alpha spectroscopy,

- **Dose measurements in the salt cavern:**
  - use of Tl detectors.

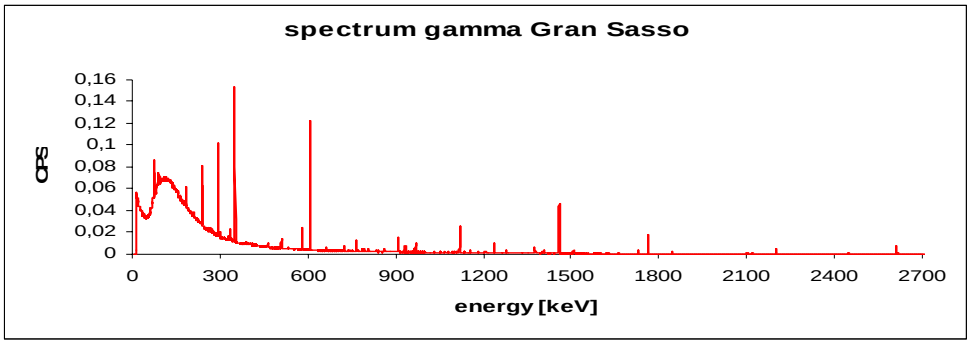
Salt cavern Ps1: *in situ* measurements

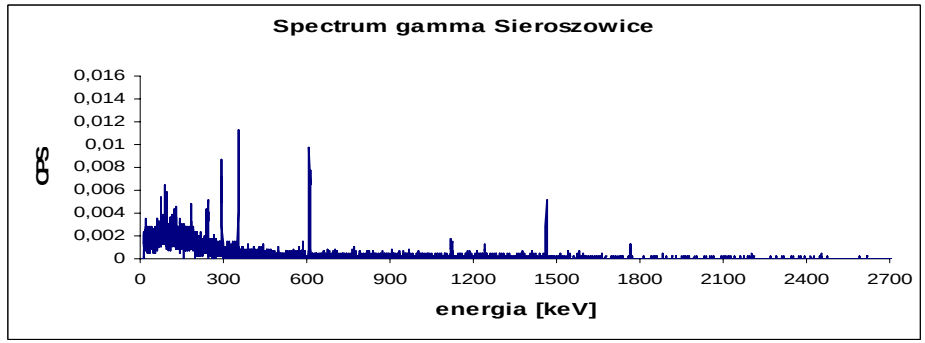
(IF US Katowice: September 2004, J.Dorda, D.Malczewski, JK)

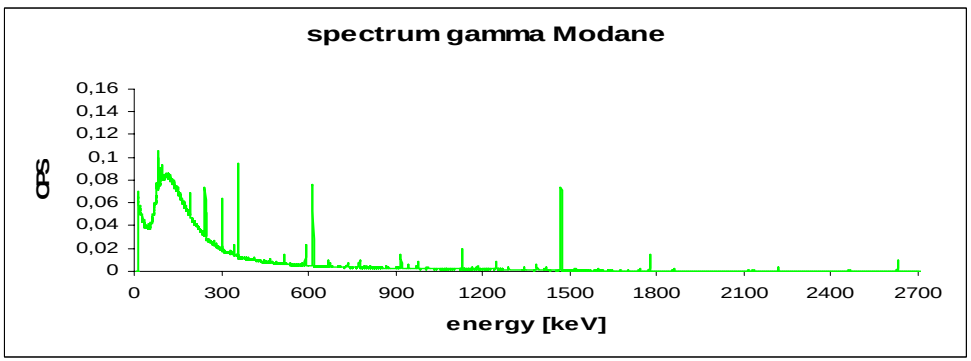
- **HPGe detector (EG&G ORTEC):**
  - 30% relative efficiency,
  - crystal length 59mm and diameter 58.6mm,
  - resolution: 0.67keV at 122keV and 1.73keV at 1.33MeV
- **M-1 B32 (ORTEC) software for the determination of radioisotope activity**
- **M-1 geometry: detector mounted 1m above the surface, gamma emitters recorded from the area in a radius of 10m to a depth of about 30cm (depending on ground and photon energy)**

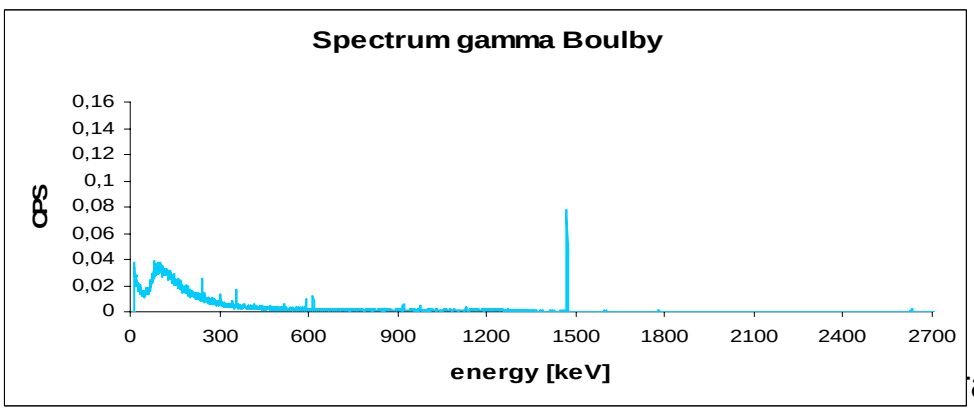


Natural radioactivity (*in-situ* measurements within ILIAS project): Boulby, Gran Sasso, Modane i Sieroszowice (1)



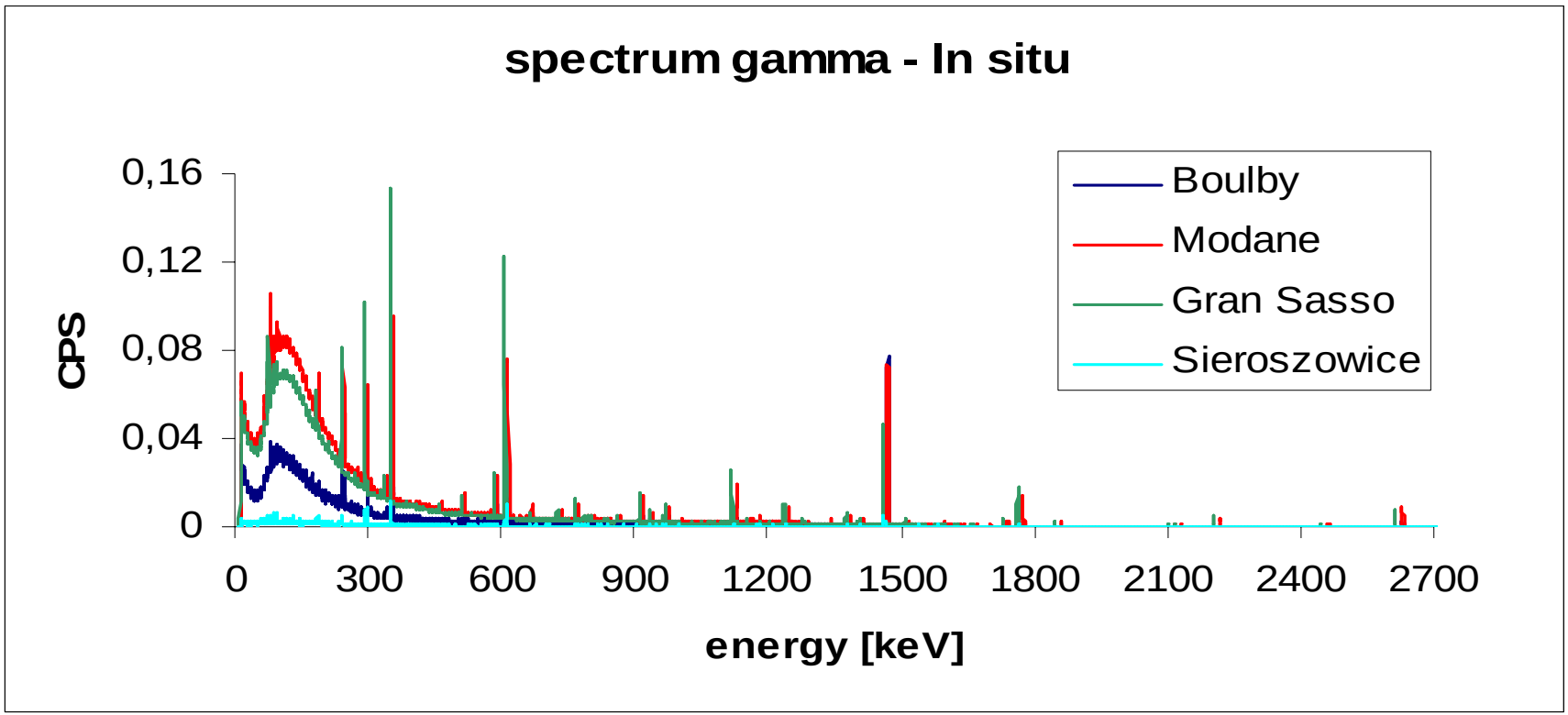






Integral background counting rates 50 – 2700 keV [CPS/keV*kg]	
Sieroszowice	**2.30 (0.02)**
Gran Sasso	**57.68 (0.02)**
Modane	**66.06 (0.03)**
Boulby	**23.83 (0.05)**

Natural radioactivity (*in-situ* measurements within ILIAS project): Boulby, Gran Sasso, Modane i Sieroszowice (2)



Measurements of ^{222}Rn concentration in the salt cavern Ps1 (IFJ Kraków: K.Kozak, J.Mazur)

- **Measurements in the „open air, 25 cm above the surface, in 5 locations in cavern PS1, cycle duration: 10 min. (4 measurements) i 1 min. (1 measurement).**

- **Radon detectors AlphaGUARD PQ 2000 and AlphaGUARD PQ 2000 PRO have been used.**

- **Results: radon concentration varies from 15(4) Bq/m^3 (low ventilation) to 45(5) Bq/m^3 (high ventilation)**

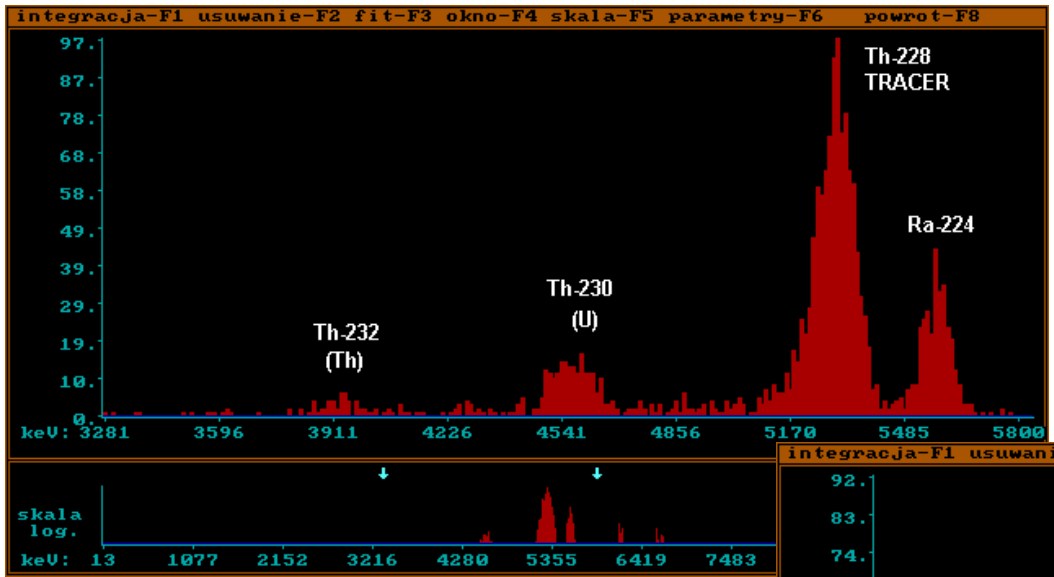
Sieroszowice: rock samples measurements

(IFJ-Kraków: March 2006, J.W.Mietelski, E.Tomankiewicz, S.Błażej)

- **Radiochemistry + alpha spectrometry, 4 samples of salt rock: 43.09 g, 41.64g, 40.55g and 100.3 g (out of bigger sample taken for gamma measurement)**
- **Results from gamma measurement (sample 4) - only ^{40}K above detection limit: 2.1 ± 0.3 Bq/kg (66 ± 9 ppm nat. K in 1 kg of salt rock)**

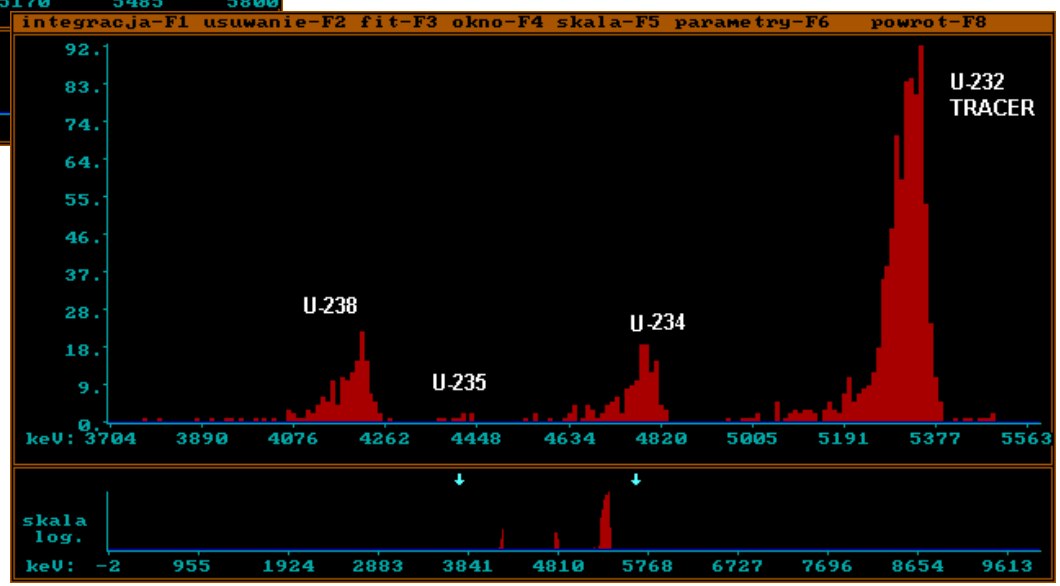
Alpha spectrometer Silena AlphaQuattro (4 tracks), PIPS and SBSi detectors

Alpha spectroscopy: examples of spectra



U fraction

Th fraction



Results for alpha emitters (salt rock) [Bq/kg]:

(corrected for blank: ~0.02 Bq/kg subtracted, 2004)

	SAMPLE No: 1	2	3	4
U series:				
^{238}U	0.40±0.06	0.34±0.05	0.10±0.02	0.14±0.02
^{234}U	0.38±0.06	0.33±0.05	0.14±0.02	0.14±0.02
^{230}Th	0.29±0.05	0.34±0.06	0.10±0.03	0.19±0.03
Mean:	*0.357*	*0.337*	*0.113*	*0.157*
(~0.03 – 0.01 ppm)				
Th series				
^{232}Th	0.09±0.03	0.08±0.02	0.03±0.02	0.11±0.02
(~0.03 ppm)				

U concentrations in a typical rock are above 30 Bq/kg

Results for alpha emitters (anhydrite):

(IFJ-Kraków: March 2006, J.W.Mietelski, E.Tomankiewicz, S.Błażej)

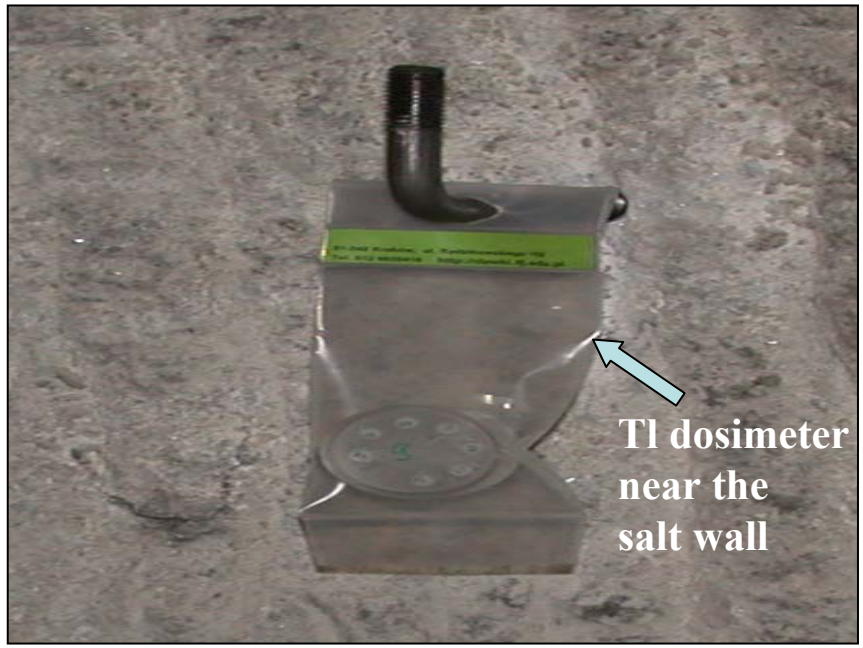
- **Alpha spectrometry method: advanced and careful chemical preparation of rock samples.**

- **Anhydrite samples from galleries close to the cavern Ps1.**

	Salt [Bq/kg]	Anhydrite [Bq/kg]
^{238}U	0.0165(0.0030)	0.82(0.10)
^{234}U	0.0225(0.0030)	0.76(0.09)
^{232}Th	0.008(0.001)	0.52(0.15)
^{40}K	4.0(0.9)	-
^{230}Th	-	1.26(0.24)

Sieroszowice: dose measurements

(IFJ-Kraków: M.Budzanowski, M.Puchalska)



- **TL high sensitive MCP-N (LiF:Mg,Cu,P) detectors; integration time: 8 months from the 23rd of March, till the 22nd of November 2005, 11 sets of detectors.**
- **dose equal to 1.8 nGy/h, similar for all 11 sets of detectors, (for comparison – in Cracow at 1m under a surface it is 65 nGy/h)**

Conclusion:

- **Due to the extremely low level of natural radioactivity the salt cavern in the ZG Polkowice-Sieroszowice is an ideal place to establish an underground physics laboratory.**

… and plans

- **Measurements of the natural radioactivity in the proposed location of the SUNLAB in ZG Polkowice-Sieroszowice, in the vicinity of the existing salt caverns → similar levels of natural radioactivity expected.**