Pre-feasibility study for the Sieroszowice salt mine

Agnieszka Zalewska

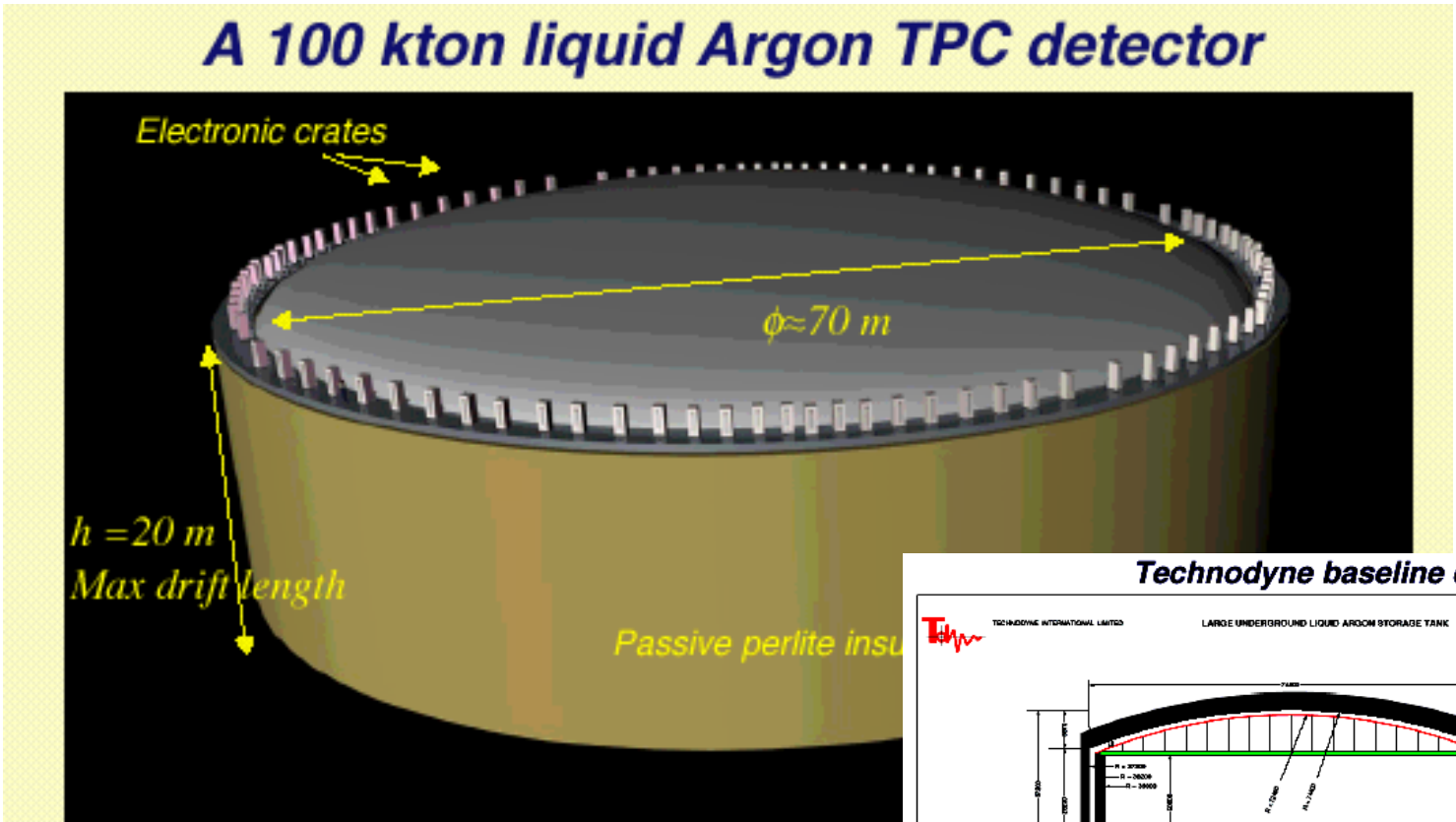
PARIS, 19.12.2006

- Possible location for the underground laboratory in Poland (SUNlab – Sieroszowice Underground laboratory)
- Measurements of natural radioactivity in the European underground labs within the ILIAS project

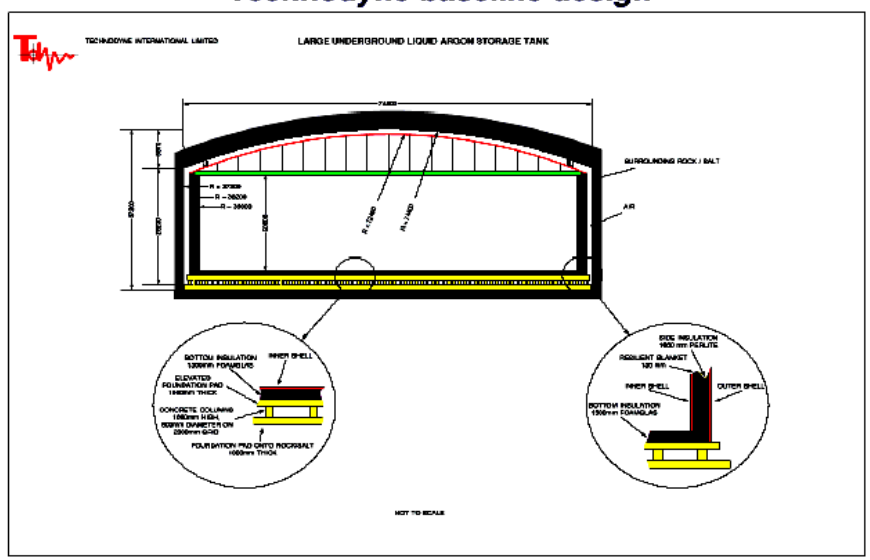
SUNLab

(Sieroszowice Underground Laboratory)

The origin of this study

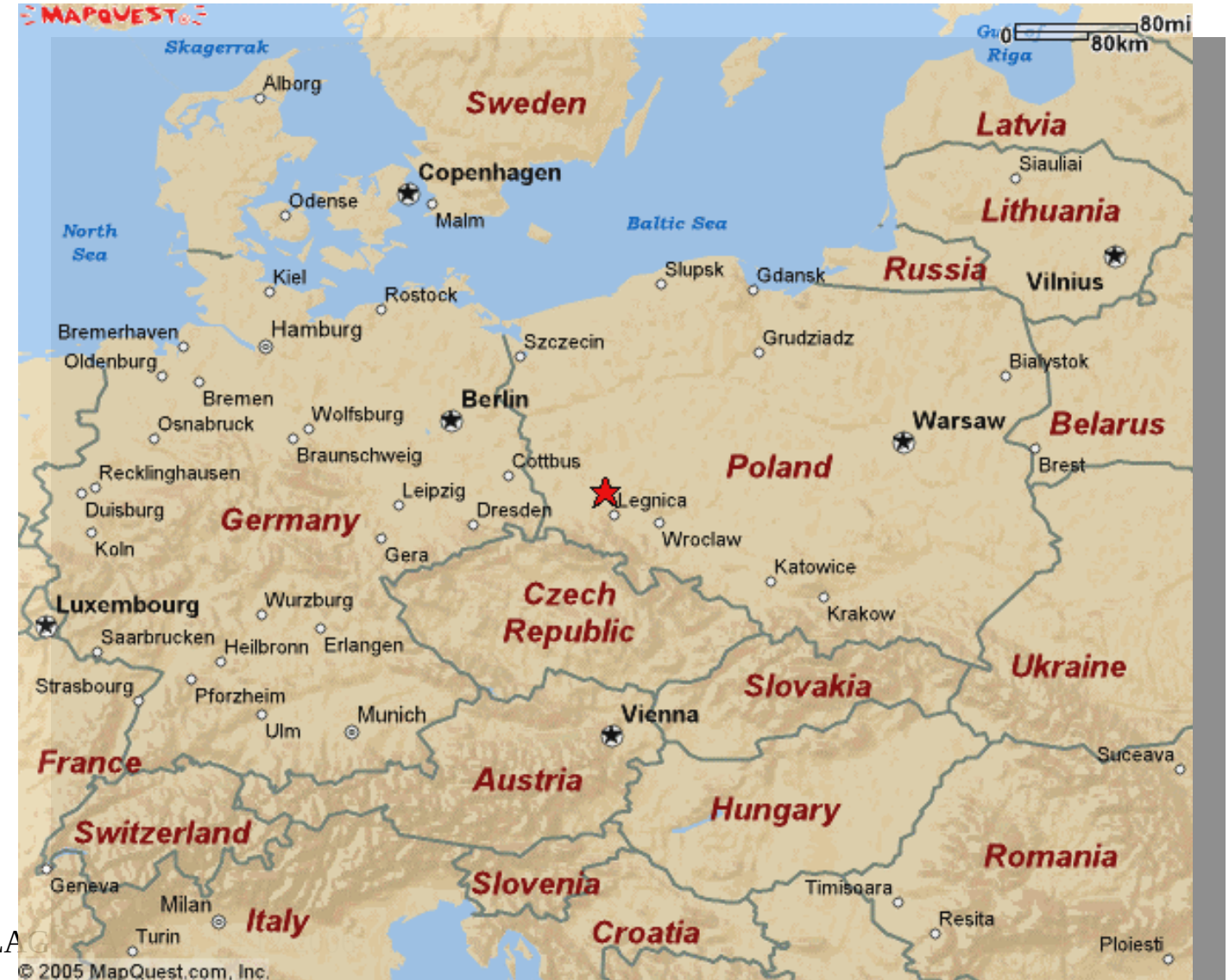


Technodyne baseline design

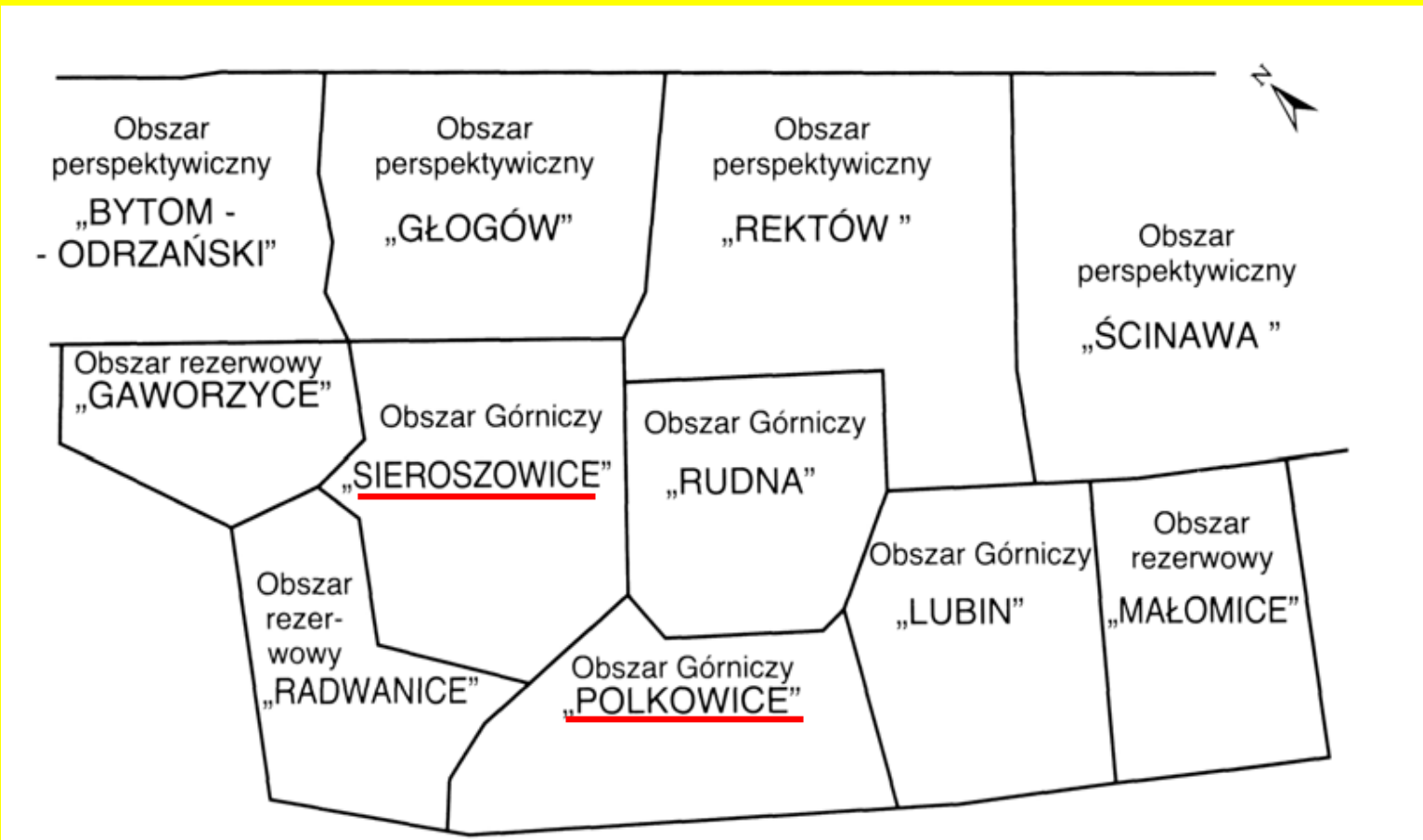


A.Rubbia
hep-ph/0402110

Near Wrocław, south-west of Poland



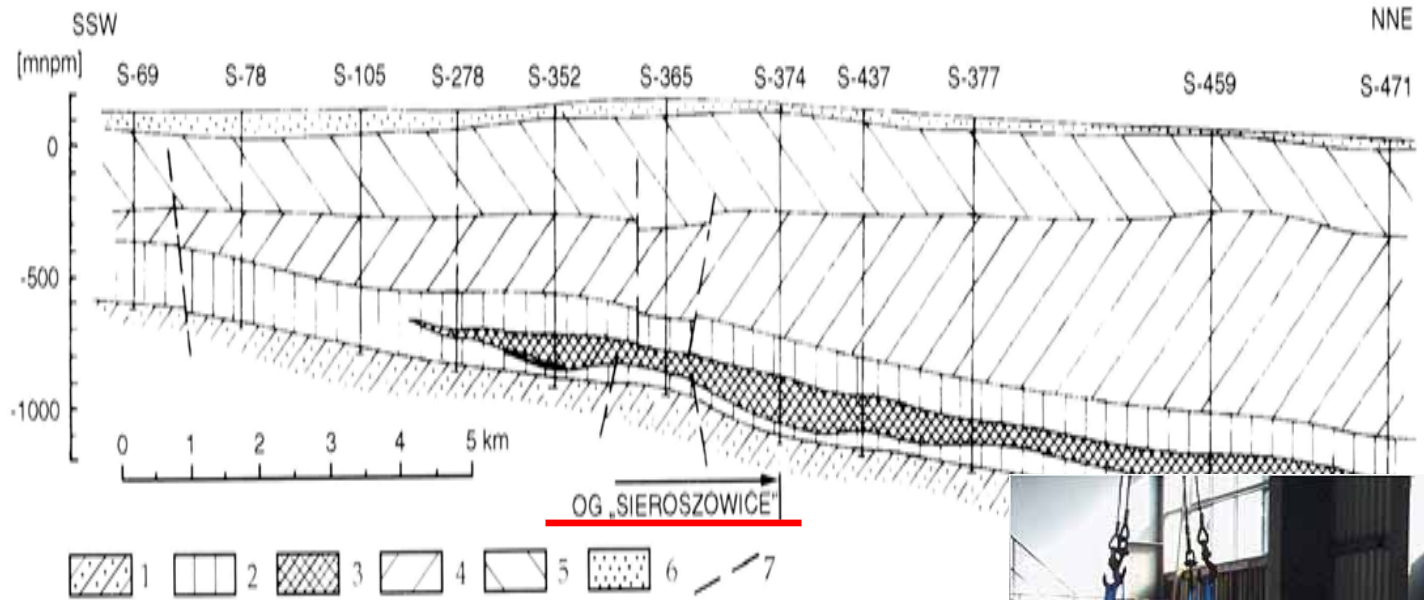
Region of copper mines



Copper – 6th position
in the world's exploitation
ranking

Silver – 2nd position

... But also salt mines



Przekrój geologiczny poprzeczny

1. Czerwony spągowiec; 2. formacja cechsztyńska; 3. pokład soli kamiennej; 4. trzeciorzęd; 6. czwartorzęd; 7. przypuszczalne dyslokacje uskokowe

Polkowice-Sieroszowice mine - salt cavern

Volume
(100x15x20) m^3

depth 900-950 m
from the surface
(~2200 m.w.e.)

salt layer ~70 m
thick

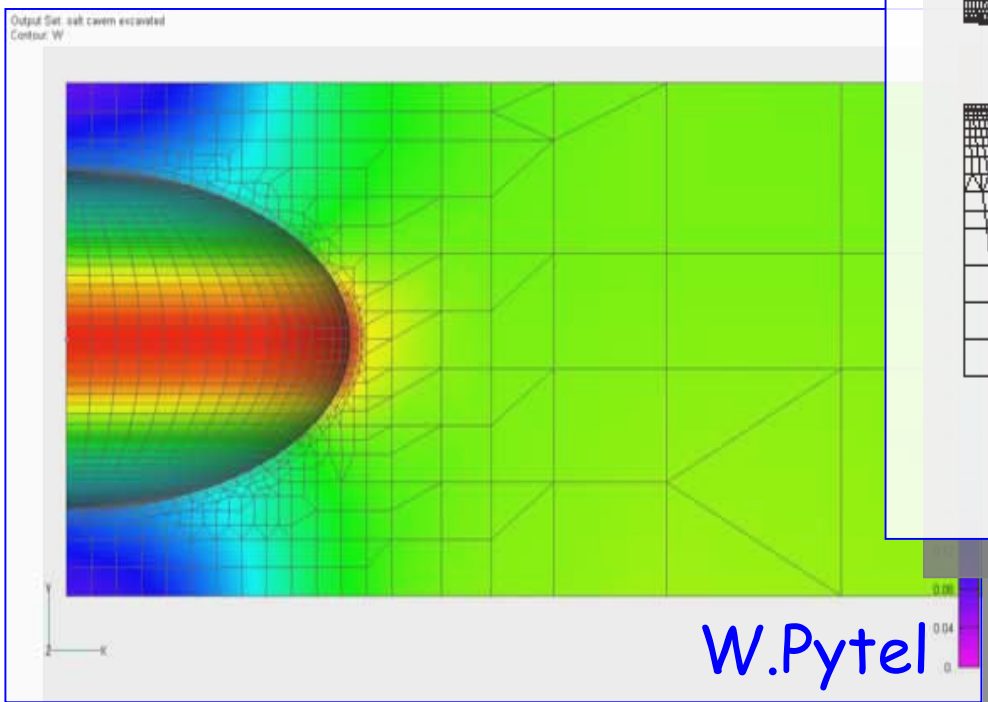
temperature ~35^0C

Two questions:

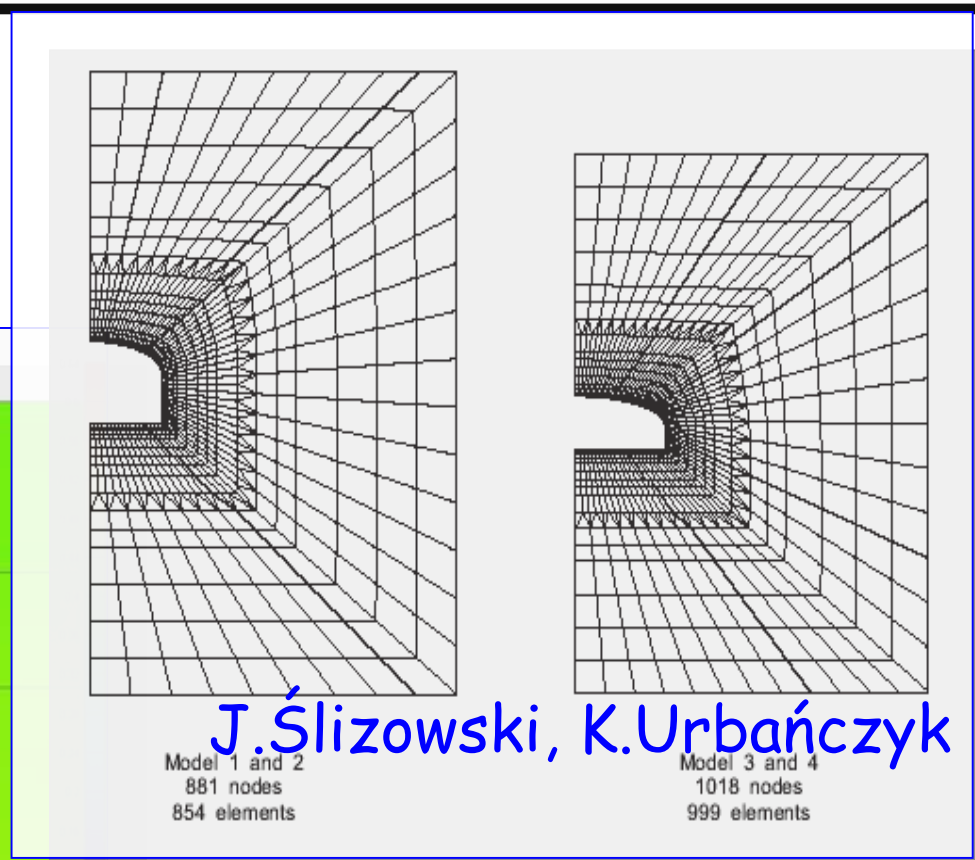
1. Can one dig a huge stable cavern in salt at the depth of ~900 m?
2. Can one make use of the existing cavern?

Answer to question 1: geomechanical simulations

Requirement: cavern with a diameter 70-100m and stable for 30 years



W.Pytel

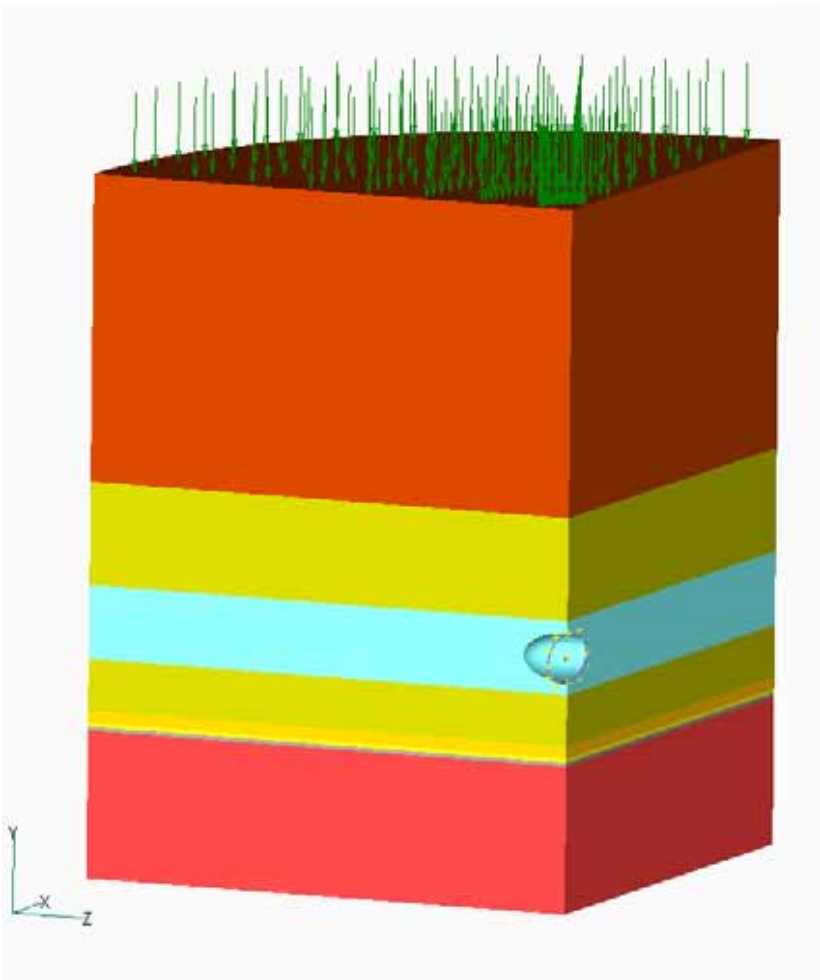


J.Ślizowski, K.Urbańczyk

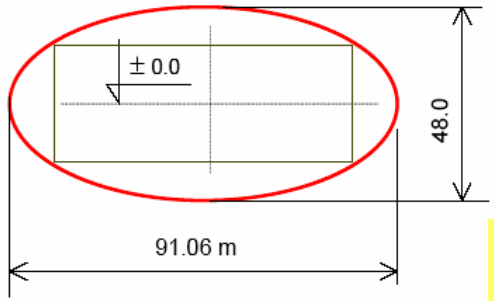
Two independent analyses

W.Pytel

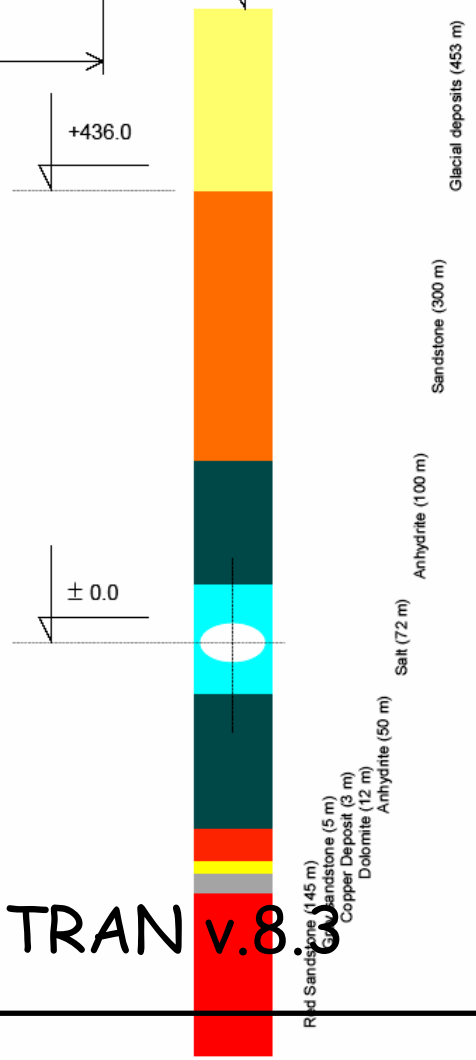
Technical University and CUPRUM, Wrocław



1. Ellipsoidal shape of salt cavern (half-axes are as follows: a = 45.53 m, b = 24.0 m)



2. Applied geological log:



3D finite element analysis with the NE/NASTRAN v.8.3

LAGUNA-Paris, 19.12.2006

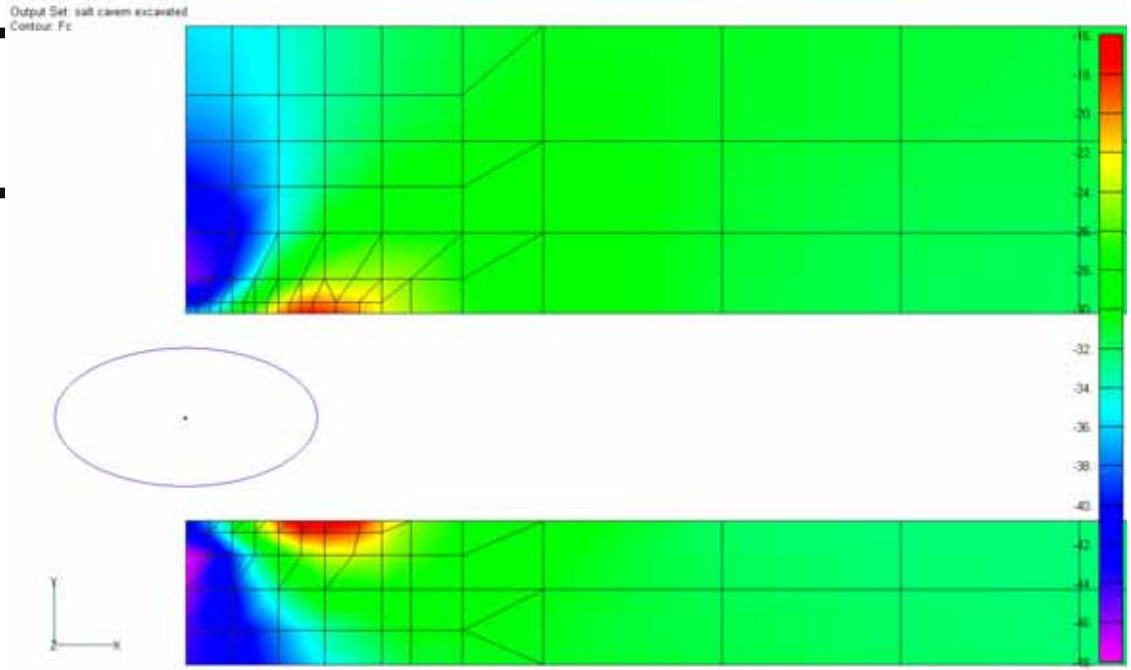
[1] Reduction factor F = 0.25 was applied (in-situ value)

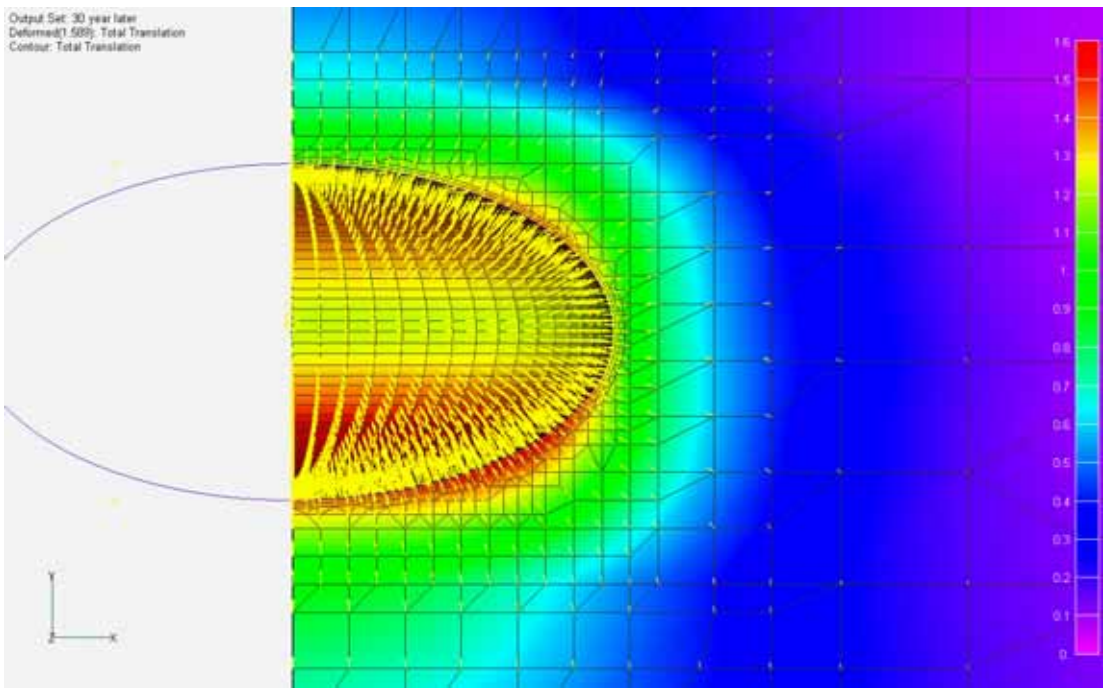
W.Pytel

Main conclusions:

Stable big chamber possible in salt

Anhydrite stable after excavation





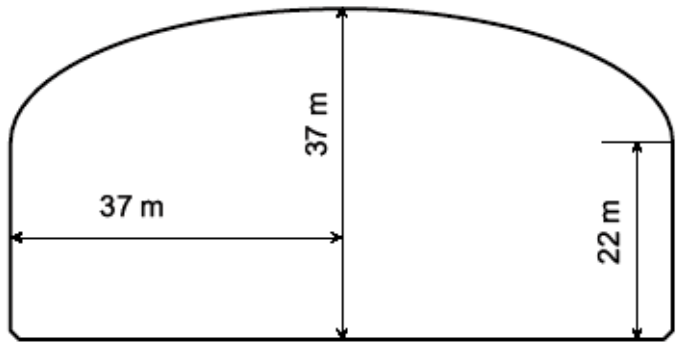
Walls movement after 30 years - by 1.5 m, instant movement after excavation 0.145 m

J.Ślizowski, K.Urbańczyk

Mineral and Energy Economy Research Institute PAN, Kraków

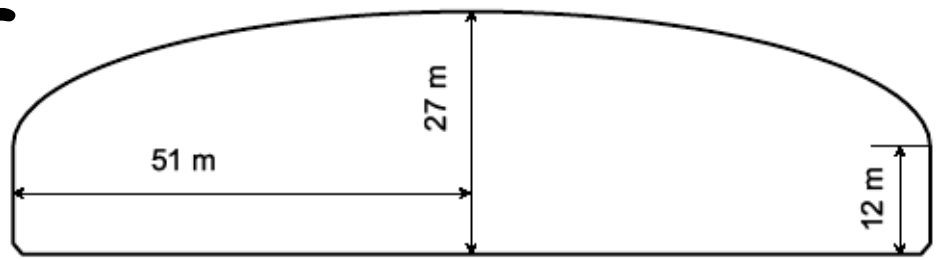
- Two cavern geometries
- Two assumptions about the salt viscous creep
- → 4 models considered
- Depths: 400, 500, 600, ..., 1000 m

1



Model 1 and 2

2

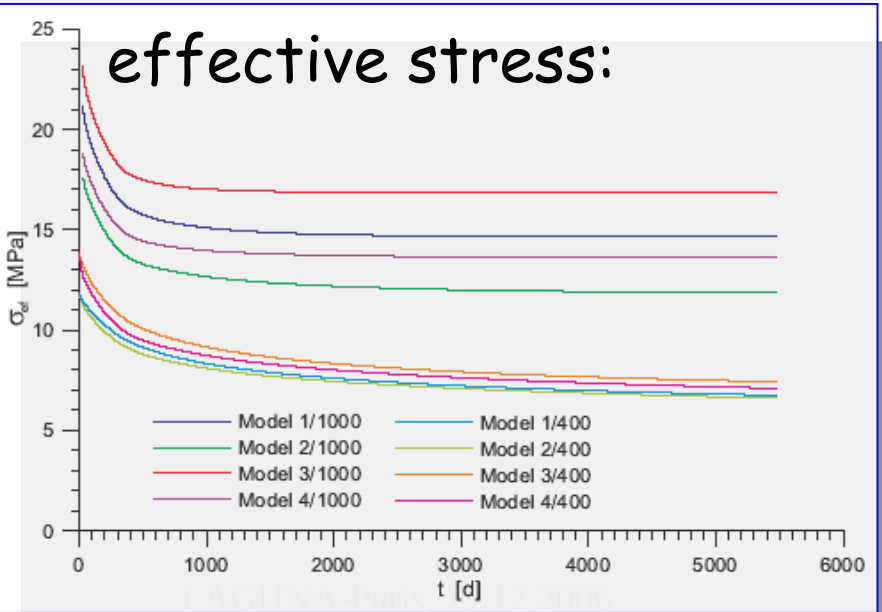


Model 3 and 4

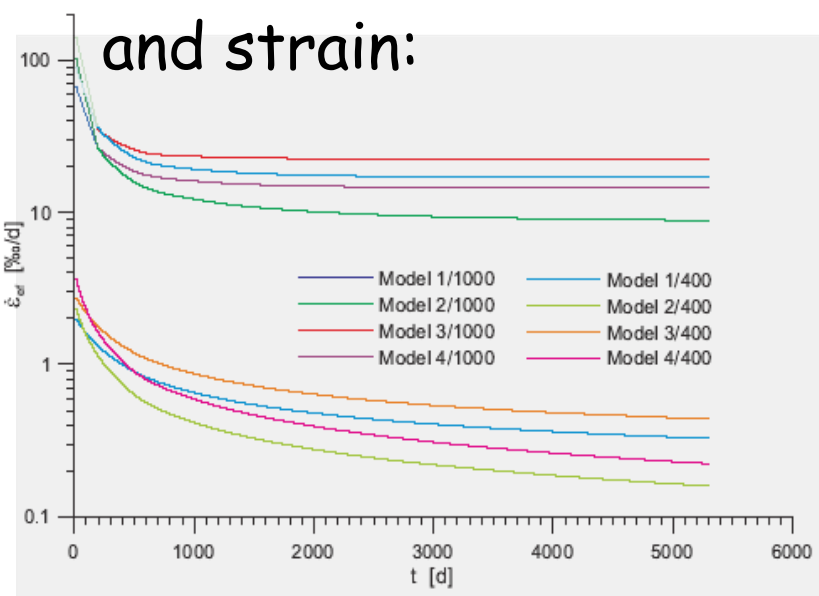
Results of the simulations

- Dependence on the cavern geometry is rather weak
- Depth is crucial
- Cavern of geometry 1 could be safely placed at a depth of 650 m, cavern of geometry 2 at 700 m

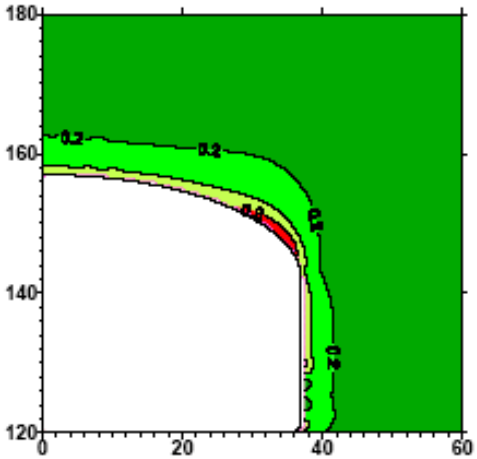
effective stress:



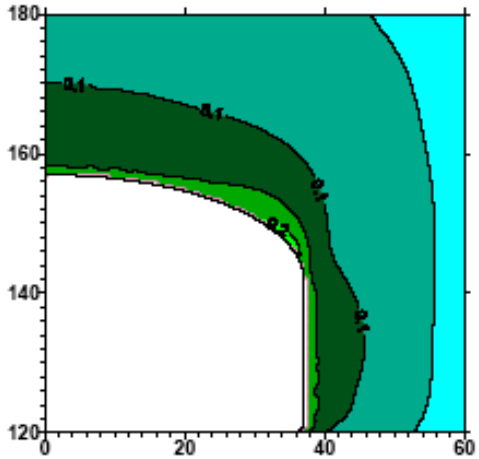
and strain:



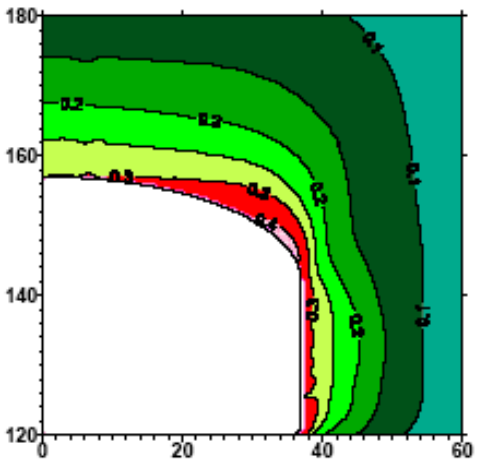
Effort coefficient distribution (after 30 years)
Rozkład współczynników wytężenia (po 30 latach)
model 2/700



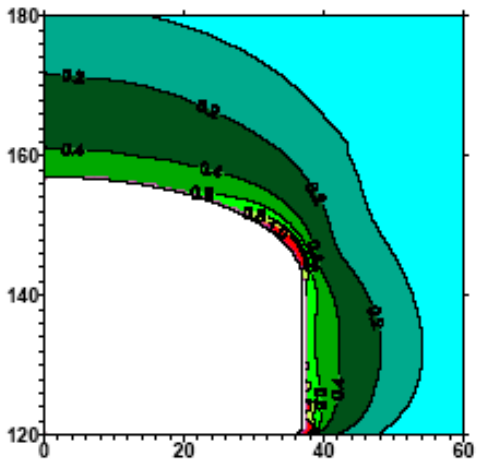
Map 51
Criterion 1



Map 52
Criterion 2



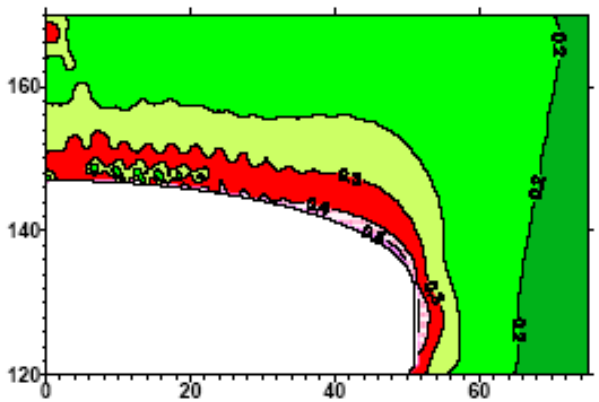
Map 53
Criterion 3



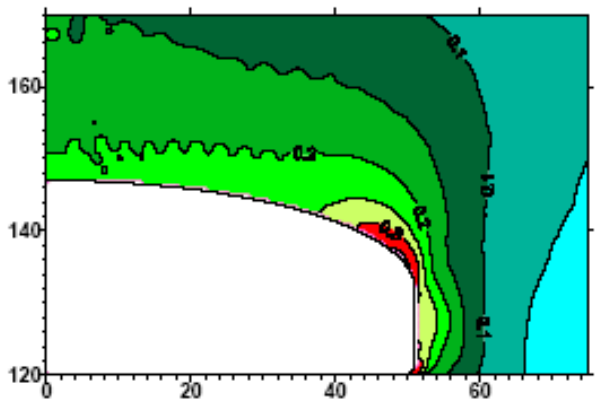
Map 54
Criterion 4

LAGU

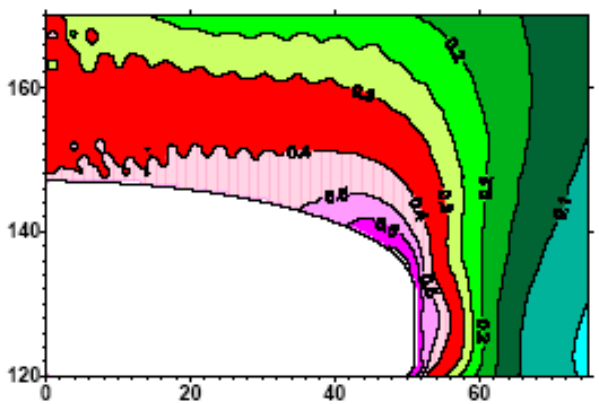
Effort coefficient distribution (after 30 years)
Rozkład współczynników wytężenia (po 30 latach)
model 3/1000



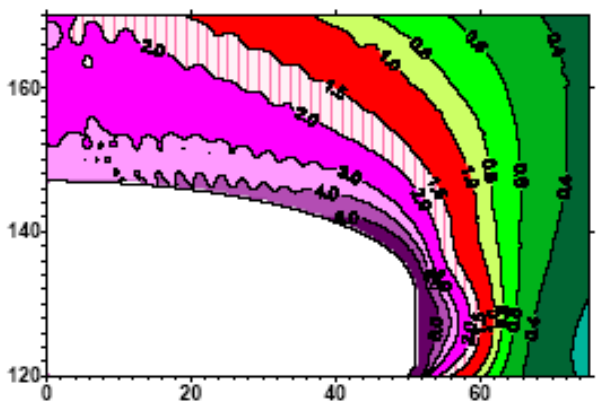
Map 71
Criterion 1



Map 72
Criterion 2



Map 73
Criterion 3



Map 74
Criterion 4

LA

Very important

Wall movements for one of the existing chambers have been monitored since 1997 by the mine staff

Answer to question 2:

Natural radioactivity measurements in the existing cavern

J. Kisiel, J. Dorda, A. Konefał

University of Silesia, Katowice

M.Budzanowski, S.Grabowska, K.Kozak, J.Mazur, J.W. Mietelski, M.Puchalska, A.Szelc, E.Tomankiewicz, A. Zalewska,

IFJ PAN Kraków

α and γ spectrometric measurements from March 2006

Salt:

U-238: 0.0165+-0.0030 Bq/kg

U-234: 0.0225+-0.0030 Bq/kg

Th-232: 0.008+-0.001 Bq/kg

K-40: 4.0 +-0.9 Bq/kg

Anhidrite:

U-238: 0.82+-0.10 Bq/kg

U-234: 0.76+-0.09 Bq/kg

Th-232: 0.52+-0.15 Bq/kg

Th-230: 1.26+-0.24 Bq/kg

Dose measurements with TL detectors

Integration time: 8 months from the 23rd of March till the 22nd of November 2005

1.8 nGy/h, similar for all 11 sets of detectors
(for comparison – in Cracow at 1m under the surface it is 65 nGy/h)

M.Budzanowski
M.Puchalska
(INP Kraków)

Radon measurements

Mostly due to a pumping of the external air through a ventillation system → aging of this air could be needed → better measurements will be performed in 2007

Results from point 1 (K.Kozak, B.Mazur, INP Kraków)

		Resolution	Mean:	(Min – Max)
Radon–222	[Bq/m^3]	**1**	**19 ± 5**	**(10 ÷ 38)**
Temp.	**[°C]**	**0.1**	**33.6**	(33.3 ÷ 34.0)
Air Pressure	**[mbar]**	**0.1**	**1038**	(1037 ÷ 1039)
Humidity	**[%]**	**0.1**	**23**	(22 ÷ 26)

Conclusions for the Sieroszowice site

1. Digging a big cavern in salt of the Polkowice-Sieroszowice mine may be feasible but more detailed studies should be performed

In particular:

→ What is the maximal cavern which could be safely excavated at the depth of ~900 m?

2. Natural radioactivity is very low

But:

→ The background due to h.e. muons at 2200 m.w.e. should be understood

The detailed simulations of the neutron and the muon induced backgrounds have started in order to better understand the potential of the Sieroszowice site

Measurements of natural radioactivity in European underground labs within the ILIAS project

J. Kisiel, J. Dorda,

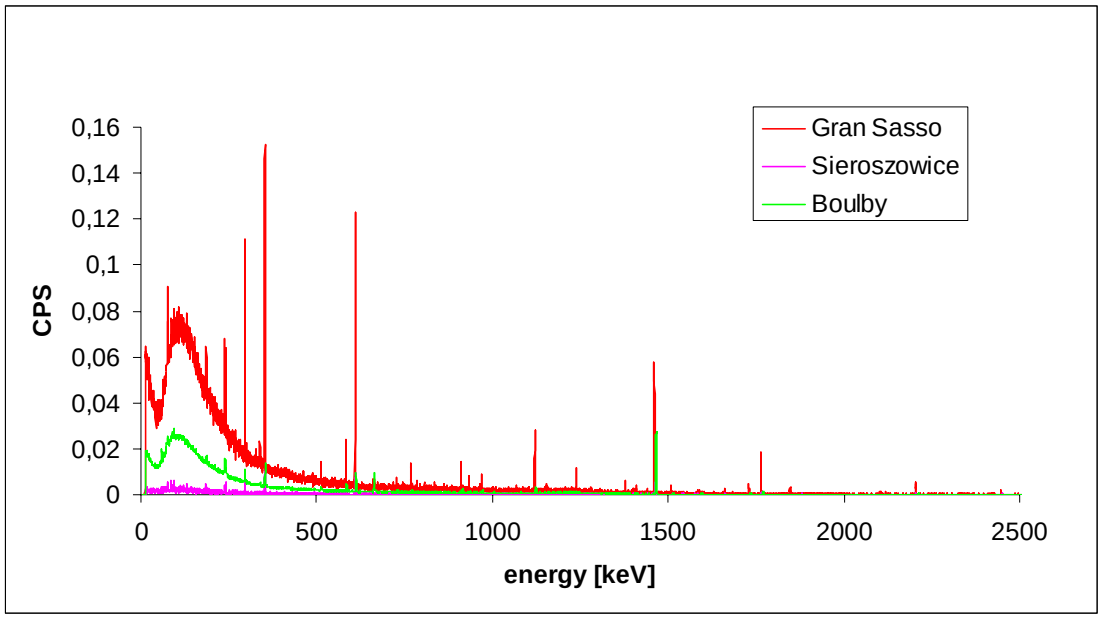
University of Silesia, Katowice

What has been done?

- Gran Sasso Lab. (December 2004):
  in-situ measurements, radon emission from the surface, water samples measurements,
- Boulby Lab. (August 2005):
  in-situ measurements, radon emission from the surface, rock samples measurements,
- Sieroszowice/Poland, salt chamber (2005):
  in-situ measurements, radon emission from the surface, rock samples measurements.

Additional measurements were performed in Boulby and in Frejus in summer 2006 (results not yet included)

Net Count Rate [cps] – in situ mesurements



In situ measurements: GS, Boulby, Sieroszowice
Integral background counting rates

Energy [keV]	Gran Sasso	Boulby	Sieroszowice
50-2700	57.68 (0.05)	17.00 (0.01)	2.30 (0.02)

Conclusion:

Very low natural radioactivity is a characterictic feature of the Sieroszowice site