Possible location for the underground laboratory in Poland

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Munich, 2.06.2006

based on contributions from:

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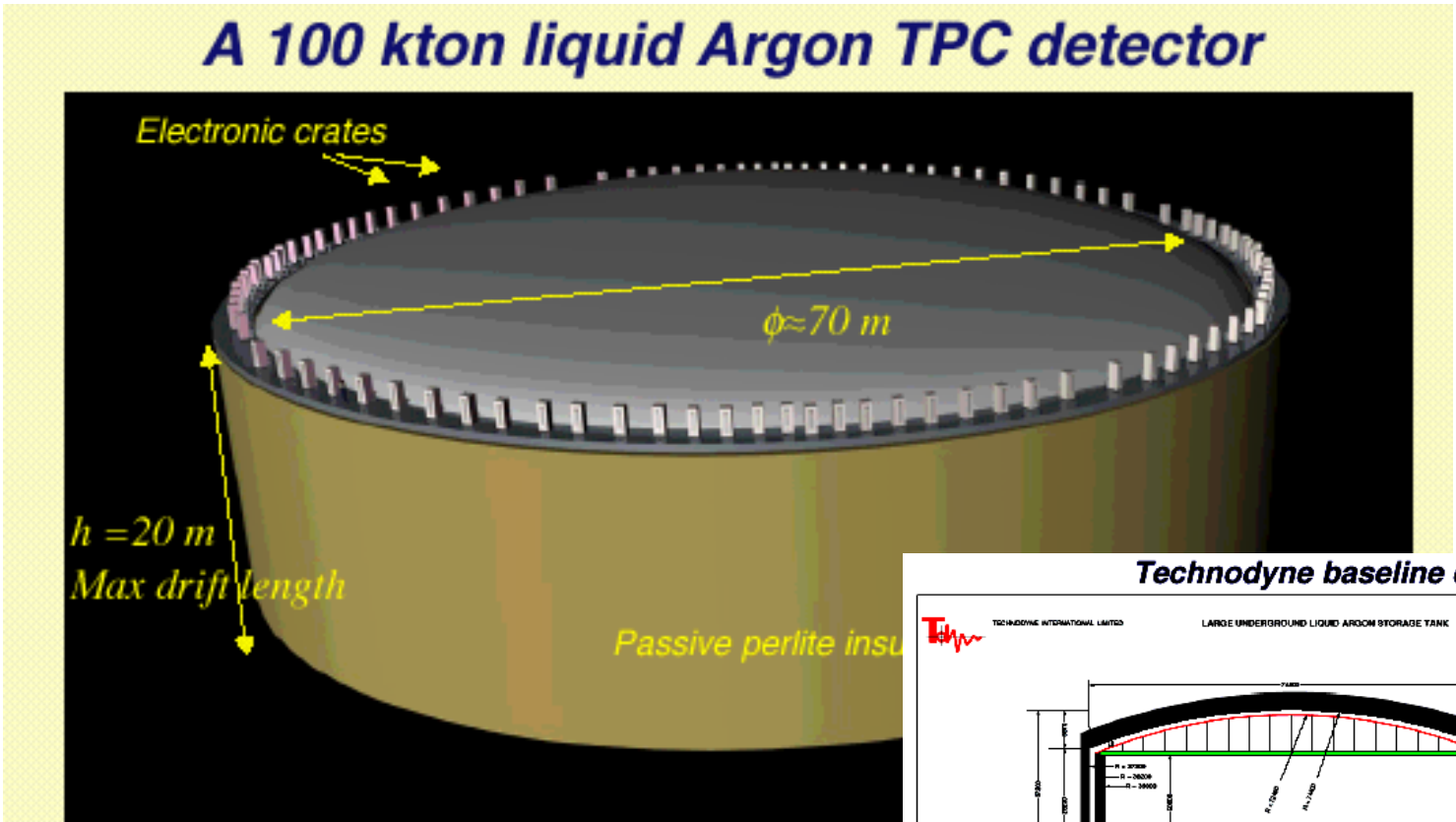
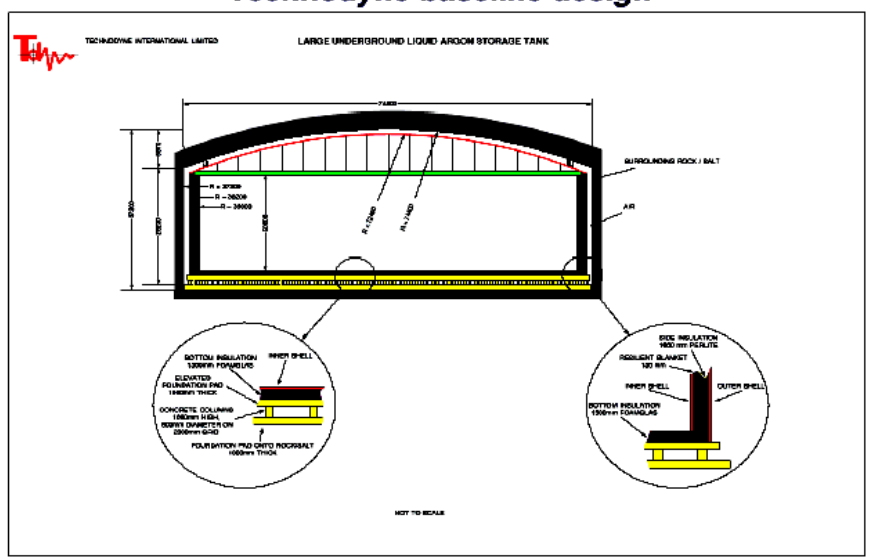
The origin of this study



Technodyne baseline design



A.Rubbia
hep-ph/0402110

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Polkowice - Sieroszowice

Near Wrocław, south-west of Poland

Possible underground sites in Europe ?

Polkowice-Sieroszowice

L=950 km

CERN

France

L=630 km

L=730 km

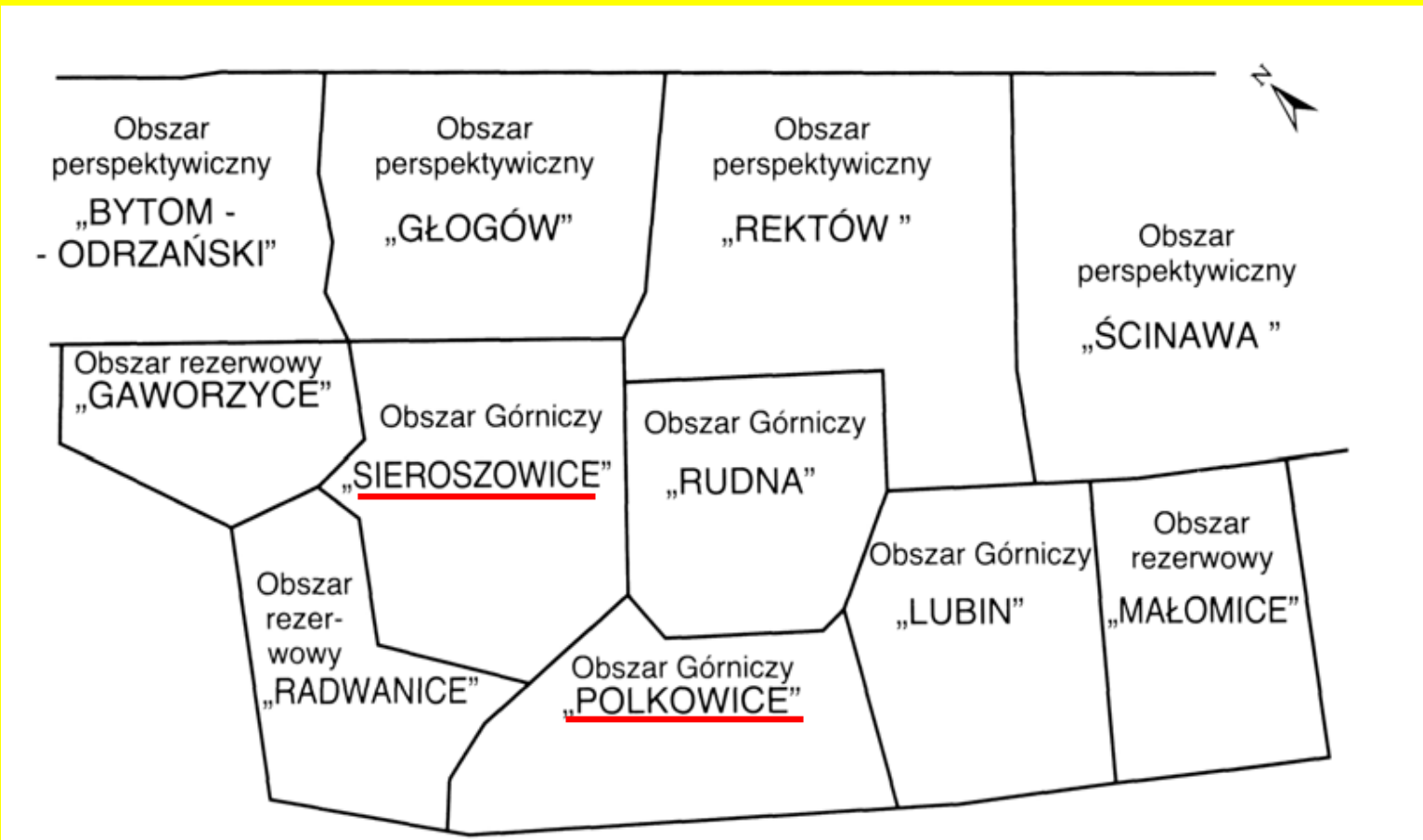
Fréjus

L=130 km

LNGS

Andorra

Region of copper mines



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

Silver – 2nd position

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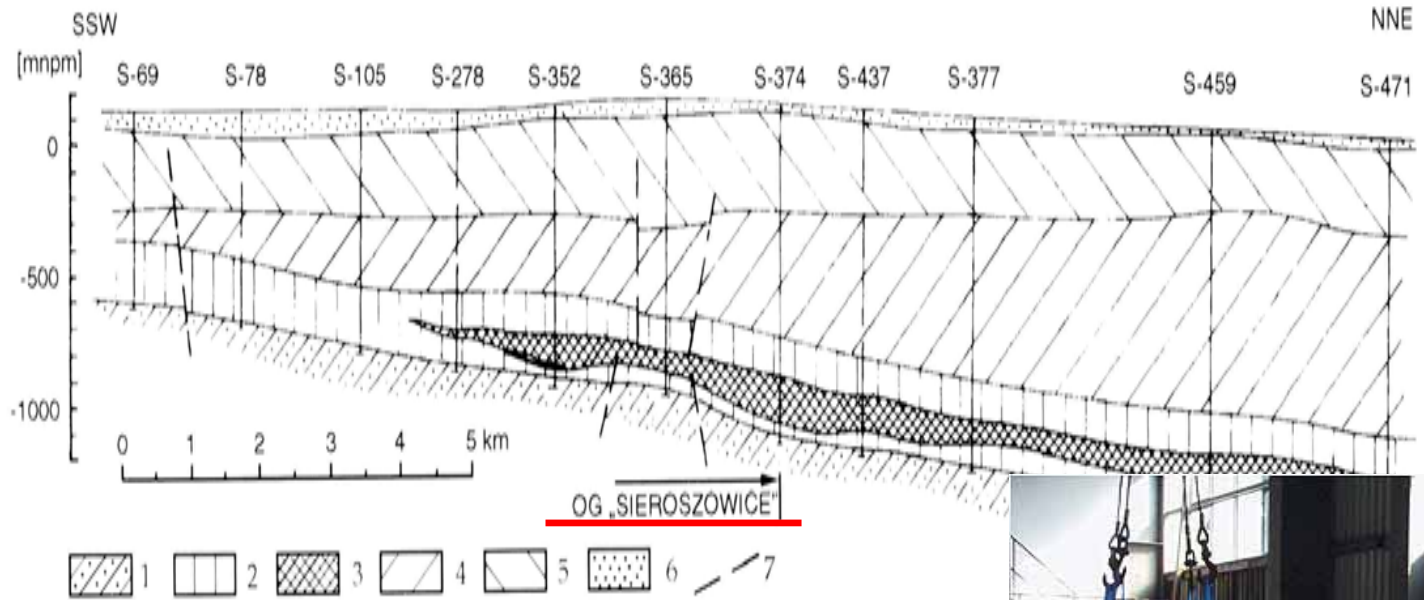
... But also salt mines



Przekrój geologiczny poprzeczny

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

Sieroszowice mine - big salt cavern

Volume
(100x15x20) m^3

depth ~950 m from a surface

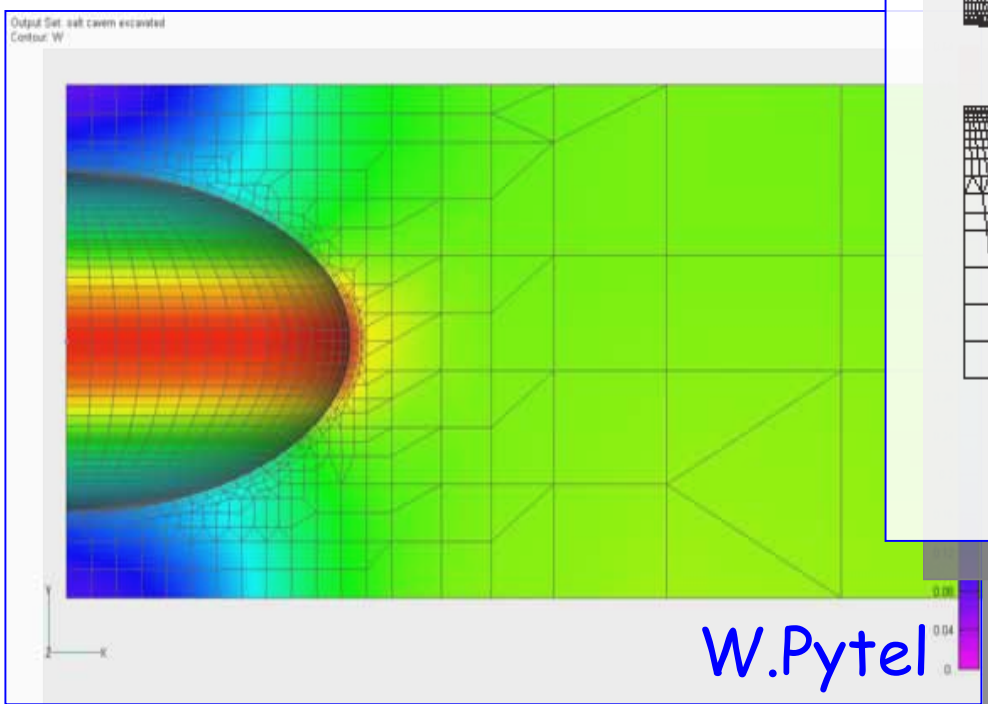
salt layer ~70 m thick

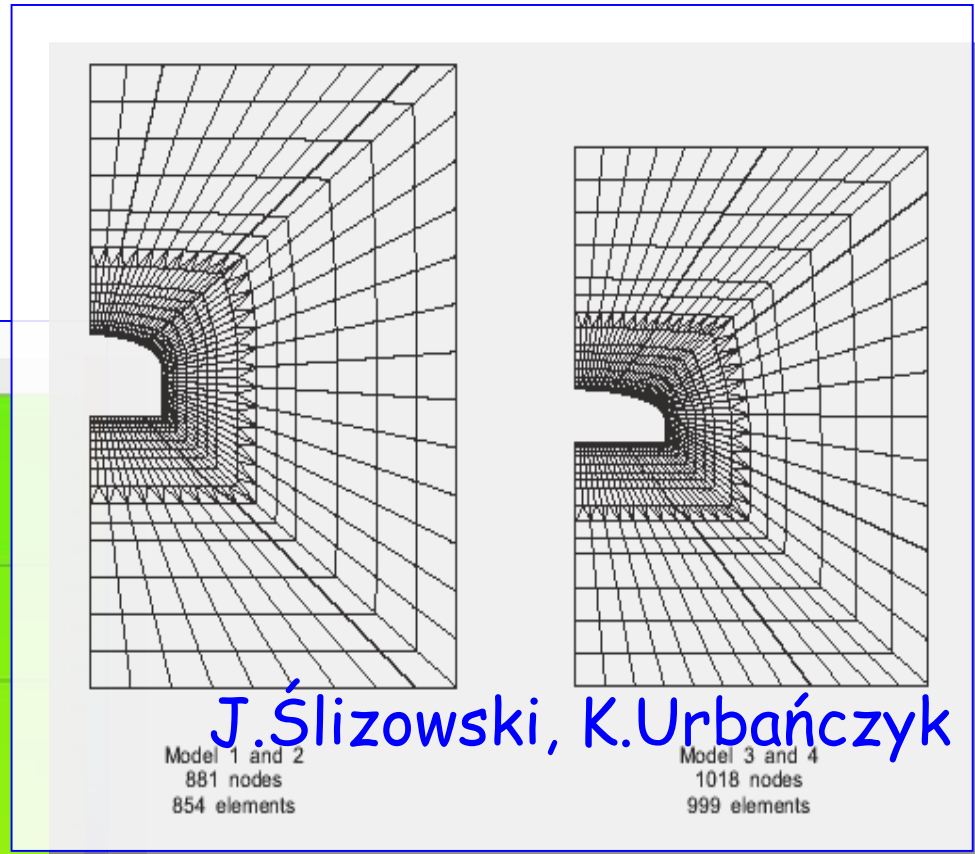
temperature ~35^0C

Geomechanics

Can one dig a football yard at 950 m?

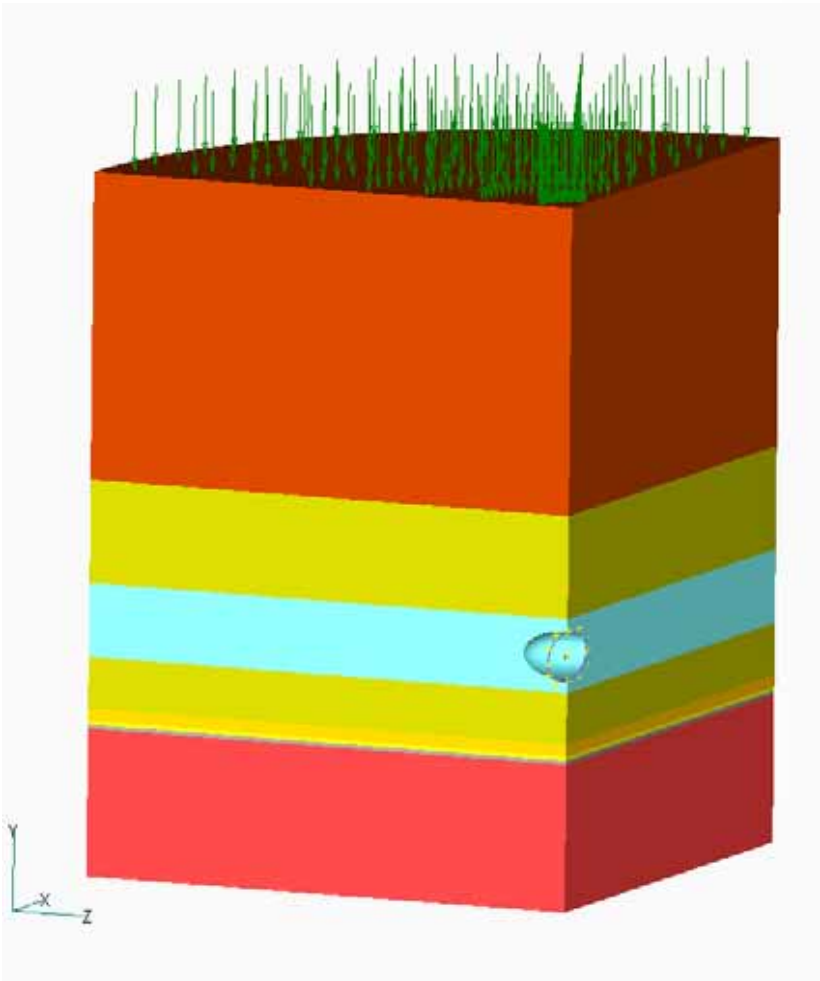
Requirement: a cavern with a diameter 70-100m and stable for 30 years



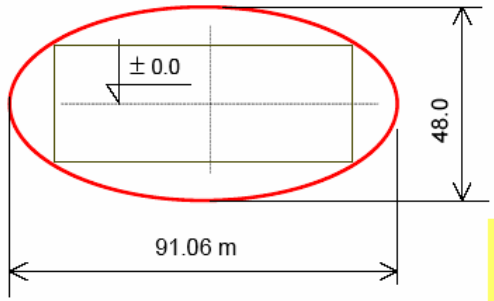


Two parallel geomechanical analyses

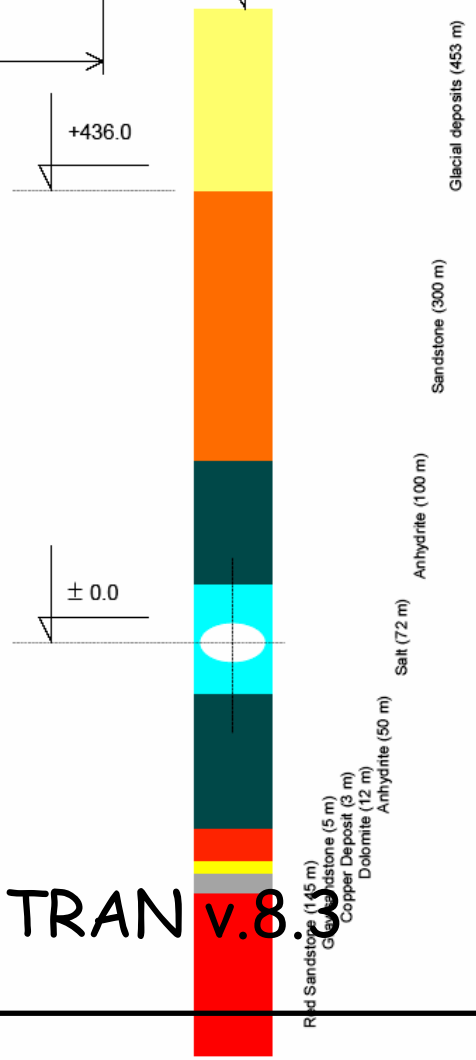
W.Pytel (Cuprum)



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

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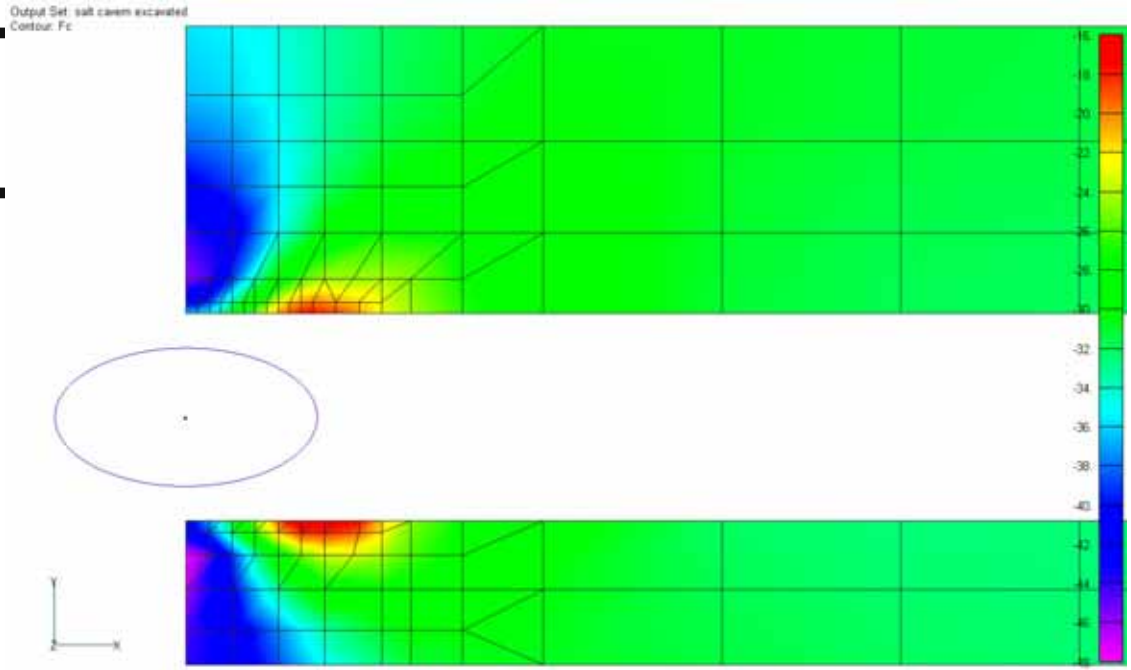
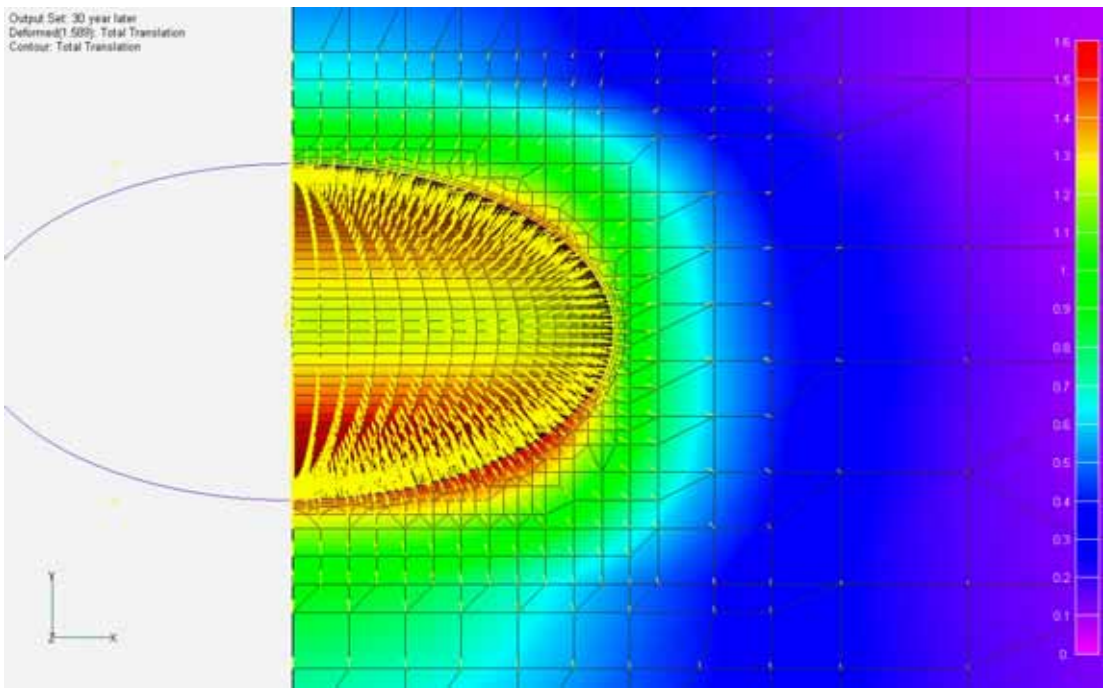
[1] Reduction factor F = 0.25 was applied (in-situ value)

W.Pytel

Main conclusion: chamber should be stable

Anhydrite stability after excavation



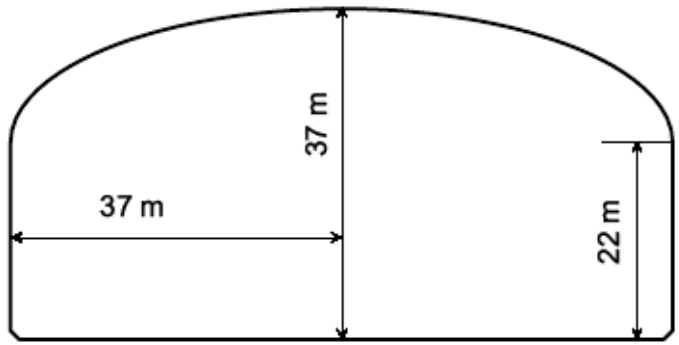


Walls movement after 30 years - by 1.5 m, instant movement after excavation 0.145 m

J.Ślizowski, K.Urbańczyk

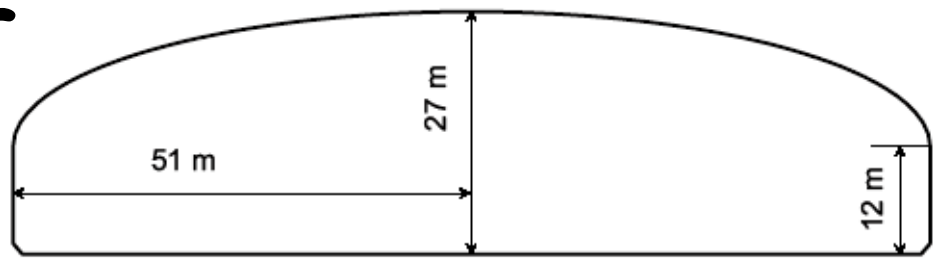
- Two cavern geometries
- Two assumptions about the salt viscous creep
- → 4 models considered
- Depths: 400, 500, 600, ..., 1000 m

1



Model 1 and 2

2

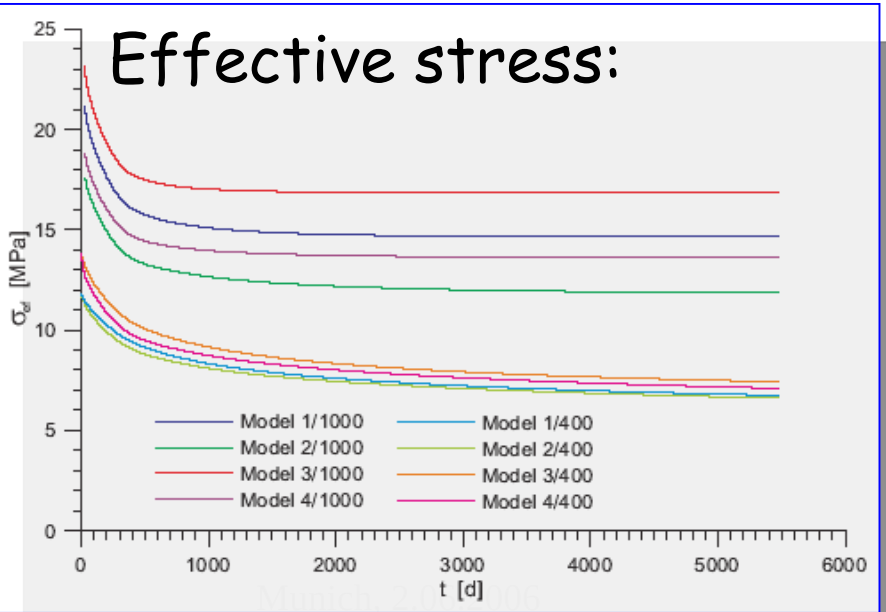


Model 3 and 4

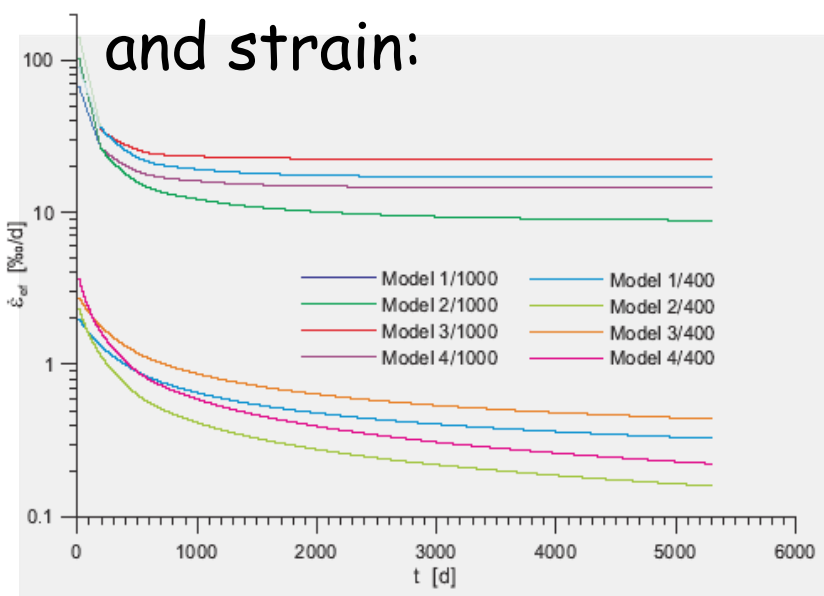
Results of the simulations

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

Effective stress:



and strain:



Results of the simulations

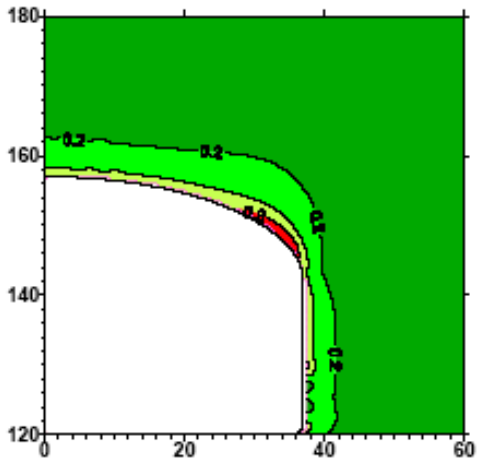
Table 5 Depth at which the maximum efforts at the roof and walls of a chamber reach critical values.

Głębokości, na których maksymalne wytężenia w stropie i na ociosie osiągają wartości krytyczne.

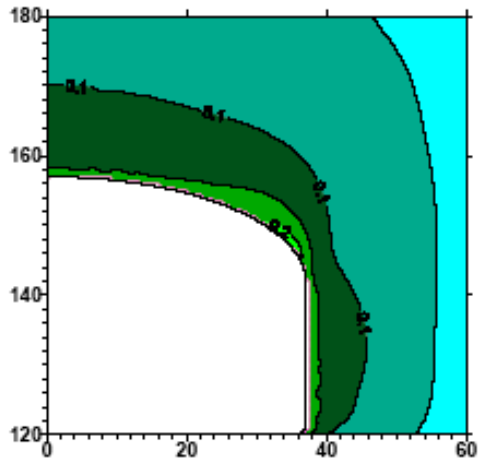
Criterion	Critical value of c^{eff}	Depth			
		Model 1	Model 2	Model 3	Model 4
1	0.3	491.3	555.4	418.3	465.8
	0.4	777.5	931.1	652.7	751.1
2	0.3	836.1	>1000	706.4	875.6
3	0.4	498.0	564.5	428.3	485.0
4a	1	549.7	616.9	510.0	574.6
4b	1	731.0	838.9	665.2	761.4

Interesting question: what is the max. volume of the safe cavern at 950 m?

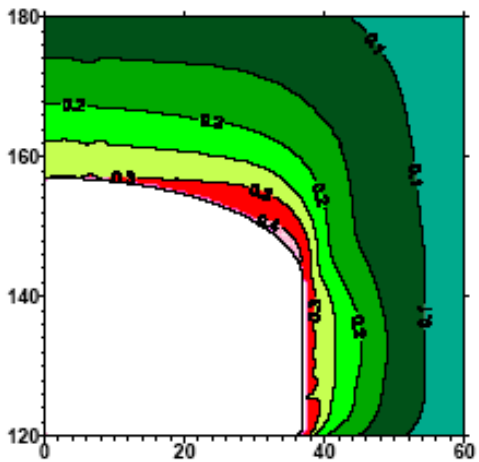
Effort coefficient distribution (after 30 years)
Rozkład współczynników wytężenia (po 30 latach)
model 2/700



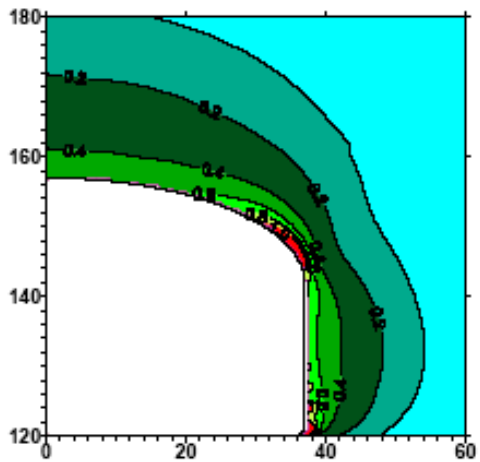
Map 51
Criterion 1



Map 52
Criterion 2

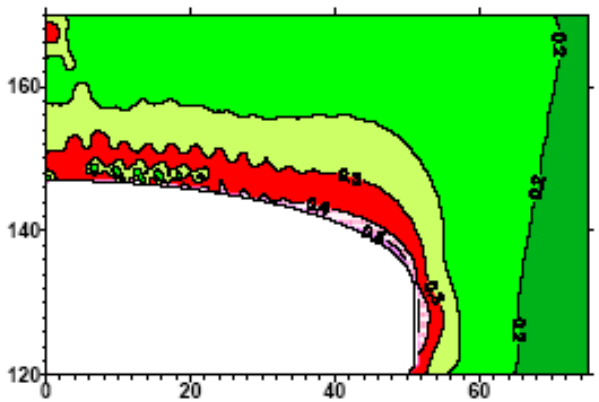


Map 53
Criterion 3

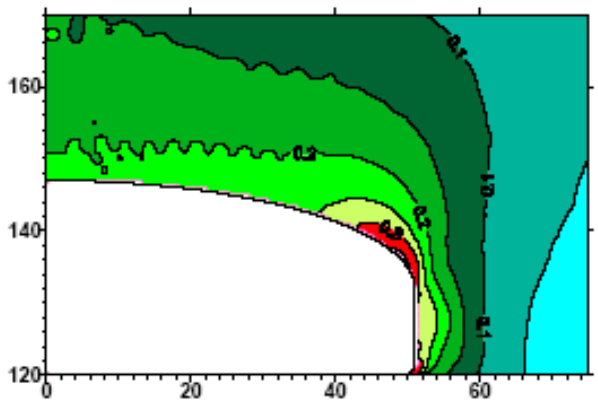


Map 54
Criterion 4

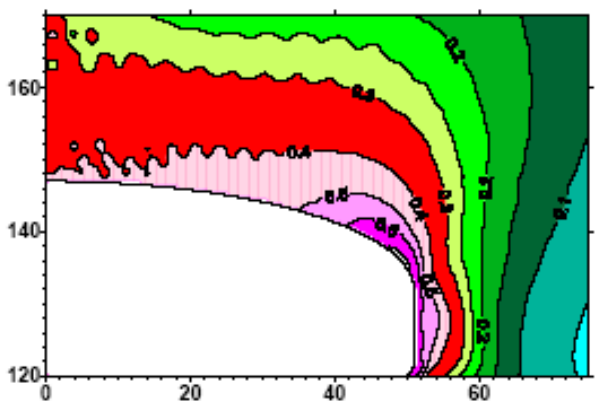
Effort coefficient distribution (after 30 years)
Rozkład współczynników wytężenia (po 30 latach)
model 3/1000



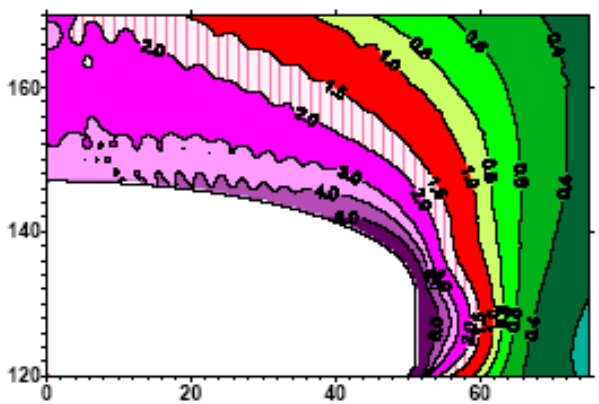
Map 71
Criterion 1



Map 72
Criterion 2



Map 73
Criterion 3



Map 74
Criterion 4

Very important

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

Natural radioactivity

α and γ spectrometry of salt

(J.W.Mietelski, E.Tomankiewicz, S.Grabowska)

Tabela 1. Wyniki stężenia substancji radioaktywnych w badanych próbkach soli z kopalni Sieroszowice.

Radionuklid	1	2	3	4
	[Bq/kg]			
^{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
Średnio sz. U	*0.357*	*0.337*	*0.113*	*0.157*
^{232}Th	0.09±0.03	0.08±0.02	0.03±0.02	0.11±0.02
^{235}U	0.015±0.006	0.015±0.007	<0.005	0.008±0.004
^{40}K	nd	nd	nd	2.1±0.3

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

Munich

Radon measurements

Mostly due to a pumping of the external air through a ventillation system → aging of this air will be needed

Measurements of Radon from the salt will be done in June

Results from point 1

		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

Digging a big cavern in salt of the Polkowice-Sieroszowice mine is feasible but more detailed studies should continue

Natural radioactivity is very low

So:

-- Excellent (too good?) conditions for the big detector

But:

-- Is 2000 m w.e. sufficient for measurements requiring very low background due to h.e. muons?

-- Evaluation of neutrino fluxes from „neighbouring" reactors is also needed

The Sieroszowice mine is certainly worth to check it