Experience gained from the former ore processing and the remediation of the site.

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MECSEK-ÖKO Zrt,
Pécs, Hungary

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PRESENTATION OUTLINE

1 Summary of the remediation works
2 Lessons and experience gained from the former mill process
3 Lessons and experience learned from the remediation

MECSEK-ÖKO KÖRNYEZETVÉDELMI RT.

DECREASING OF THE RADIOLOGICAL IMPACT

1 To decrease the radiological impacts to the exceptable level, and long-term stabilization of the radiologically contaminated wastes

This goal is fully achieved

- Shafts are backfilled,waste rock piles are landscaped, and covered
- Mill and other facilities are demolished or cleaned-up, yards, industrial roads are cleaned-up, heap leaching residues have been relocated, sites have been remediated
- Tailings ponds are stabilised, and covered

Altogether the radiological parameters (γ-dose rate, radon exhalation, etc) on the sites ARE IN COMLIENCE WITH all requirements , limits established by the authorities.

GROUNDWATER PROTECTION

2 Restoration and protection of the groundwater and surface water quality from contaminants.

This work is being underway in accordance with the original plans

In this respect:

- Groundwater restoration system and water treatment station have been built: app. 0.5 million m^3/a of contaminated water is being extracted in the vicinity of the tailings ponds and treated. App. 44 kt of solute (TDS) has been removed by this way.
- Water treatment station was built for the uranium-contaminated mine water and seepage from waste rock piles
- In-place uranium treatment columns are in operation in some places
- Experimental permeable reactive barrier has been istalled for in situ groundwater treatment

MECSEK-ÖKO
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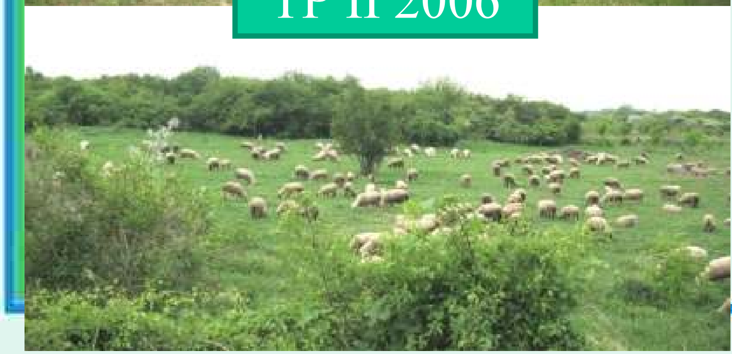
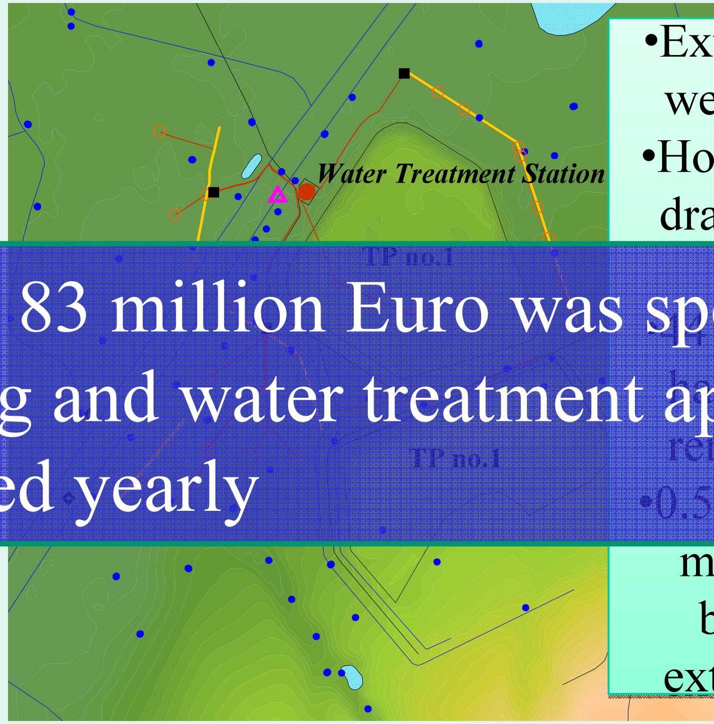
SOME REMEDIATED SITES



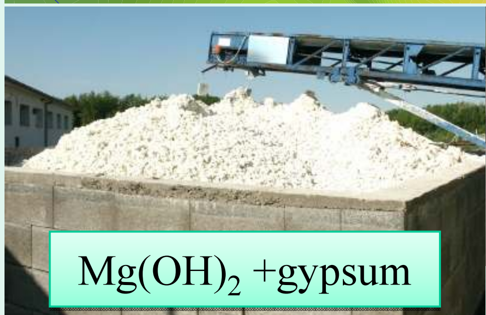
GROUNDWATER RESTORATION AND WATER TREATMENT STATIONS



- Extraction wells: 27
- Horizontal drain: 3.3 km
- TDS has been removed
- 0.5 million m^3/a is being extracted

For the remediation app. 83 million Euro was spent
For long-term monitoring and water treatment app. 2.5 million Euro is needed yearly

Mine water treatment



$Mg(OH)_2$ +gypsum

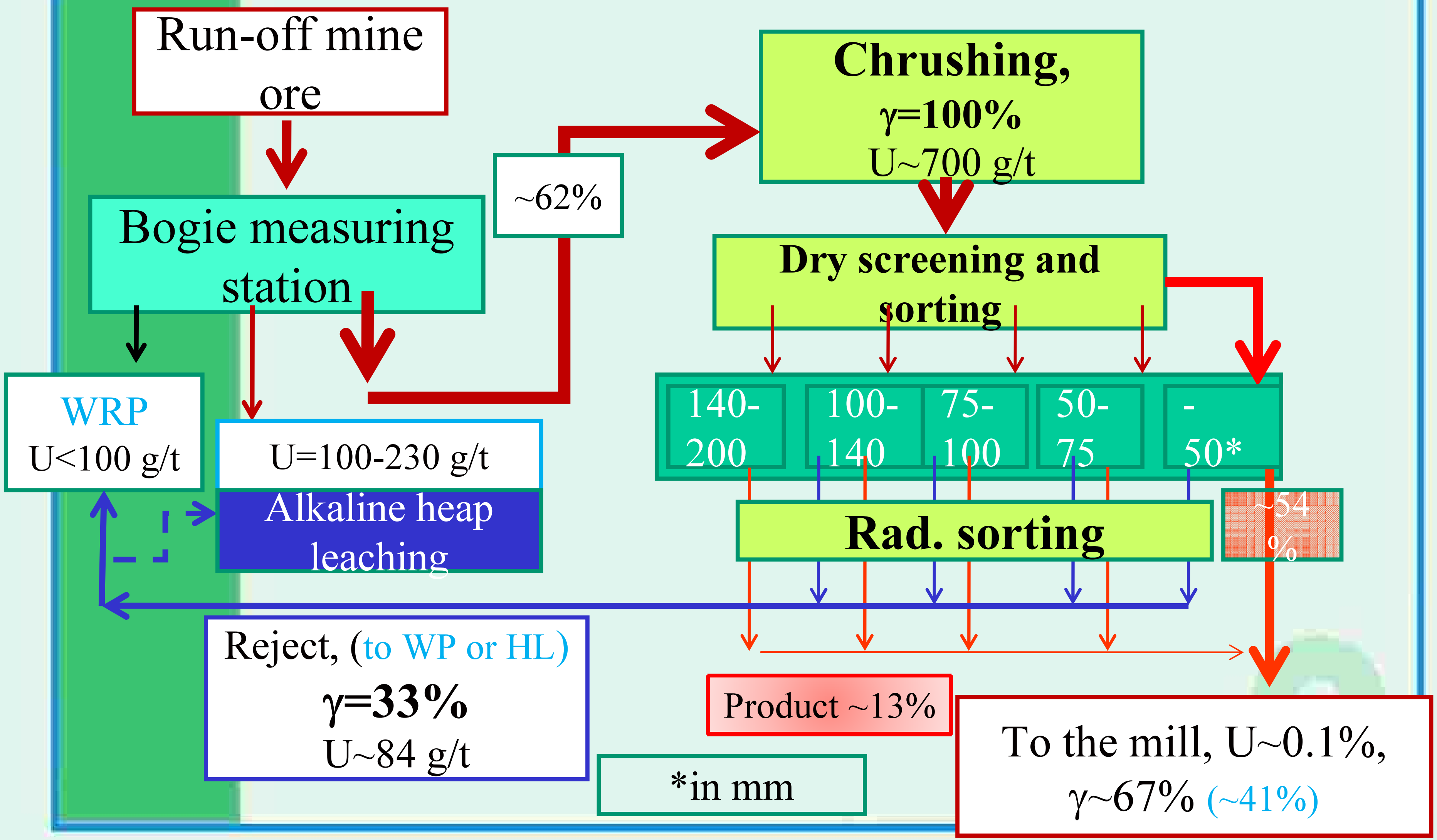
Groundwater restoration

2 Experience from the former milling

Flow sheet:
Conventional acid leaching (18.5 Mt) and alkaline heap leaching (7.2 Mt) for low-grade ore

1 Radiometric sorting
2 Leaching
3 Regeneration of the hydrochloric acid used for the eluation

RADIOMETRIC SORTING OF THE ORE



ACID LEACHING

The leaching process was continuously developed because th

(branerite)

Only small part (~12%) of the ore is leached at low free acid concentration

Main milestones of the development:

One stage leaching

Separate leaching of the sand-fine

with dividing the pulp into four portion by **hydrociclones** and adding the bulk of **acid** into the **first stage**

To the milling

Hydrociklones

Pulp from thickener

150 → 12 g/l

Acid

Free acid	~5 g/l	For: sandy part~ 60-30 g/l Fines~10-15 g/l	150 → 12 g/l
U recovery	~89%	~92%	~94%

REGENERATION OF THE HYDROCHLORIC ACID FOR ELUATION

$2R\text{-}Cl + H_2SO_4 = R_2\text{-}SO_4 + 2HCl$

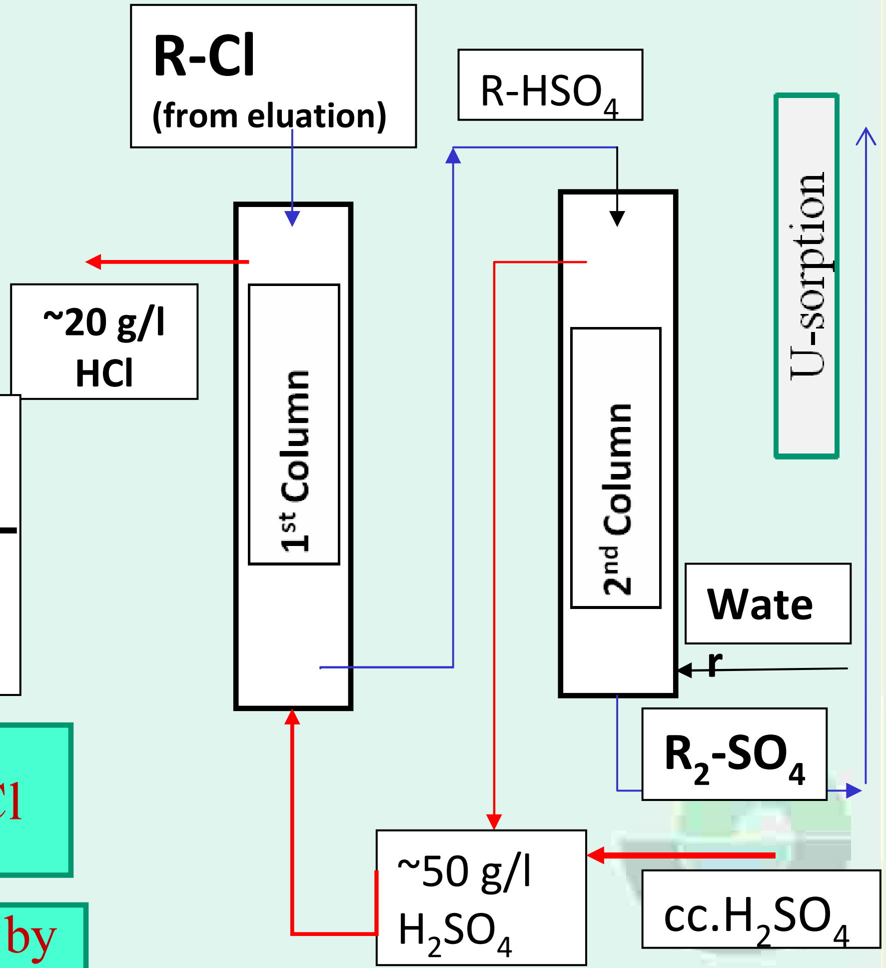
Regeneration of the HCl

$R\text{-}Cl + HSO_4^- = R\text{-}HSO_4 + HCl$

Washing

$R\text{-}HSO_4 \rightleftarrows R_2\text{-}SO_4 + H_2SO_4$

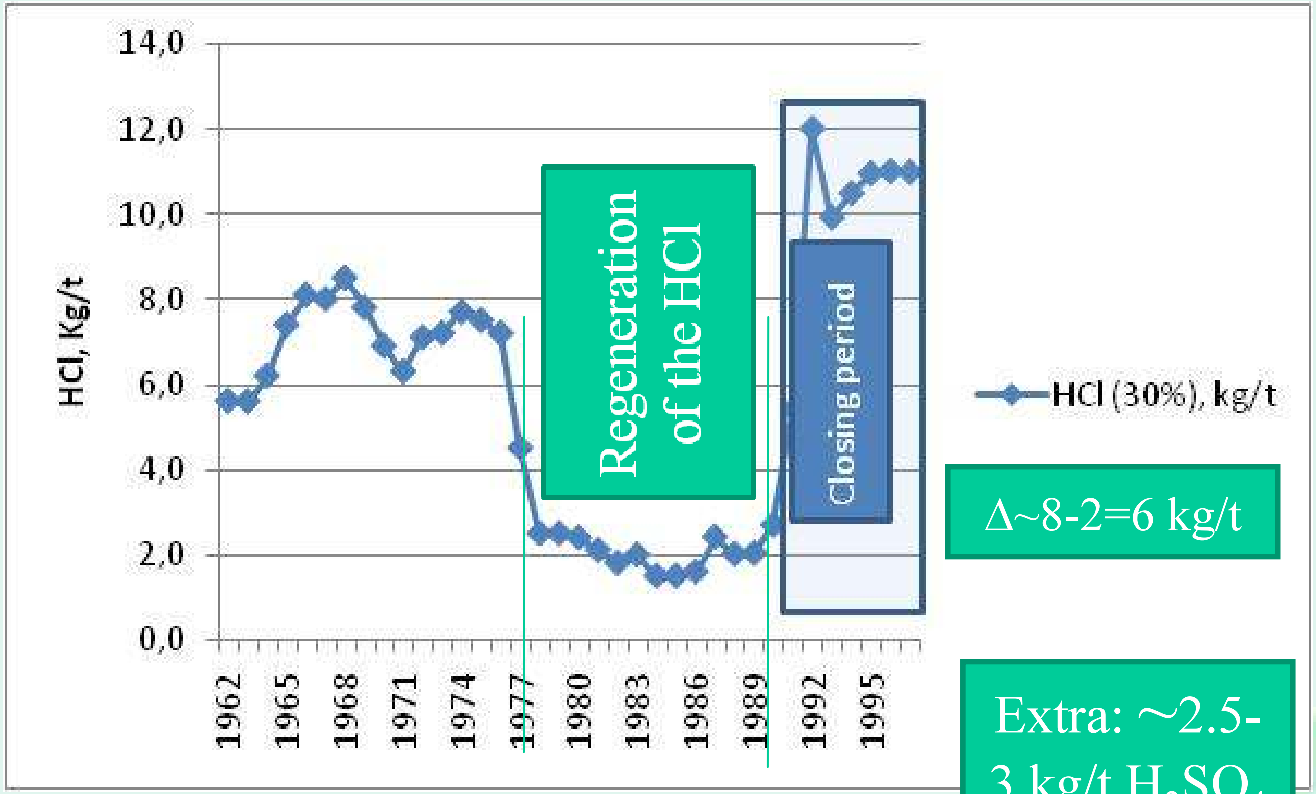
1st Column
2nd Column



Spec. consumption: 1.4 kgH_2SO_4/kg HCl

Decreasing of the chloride consumption by ~2 kg/t

DECREASING OF THE CONSUMPTION OF THE HCl FOR ELUATION



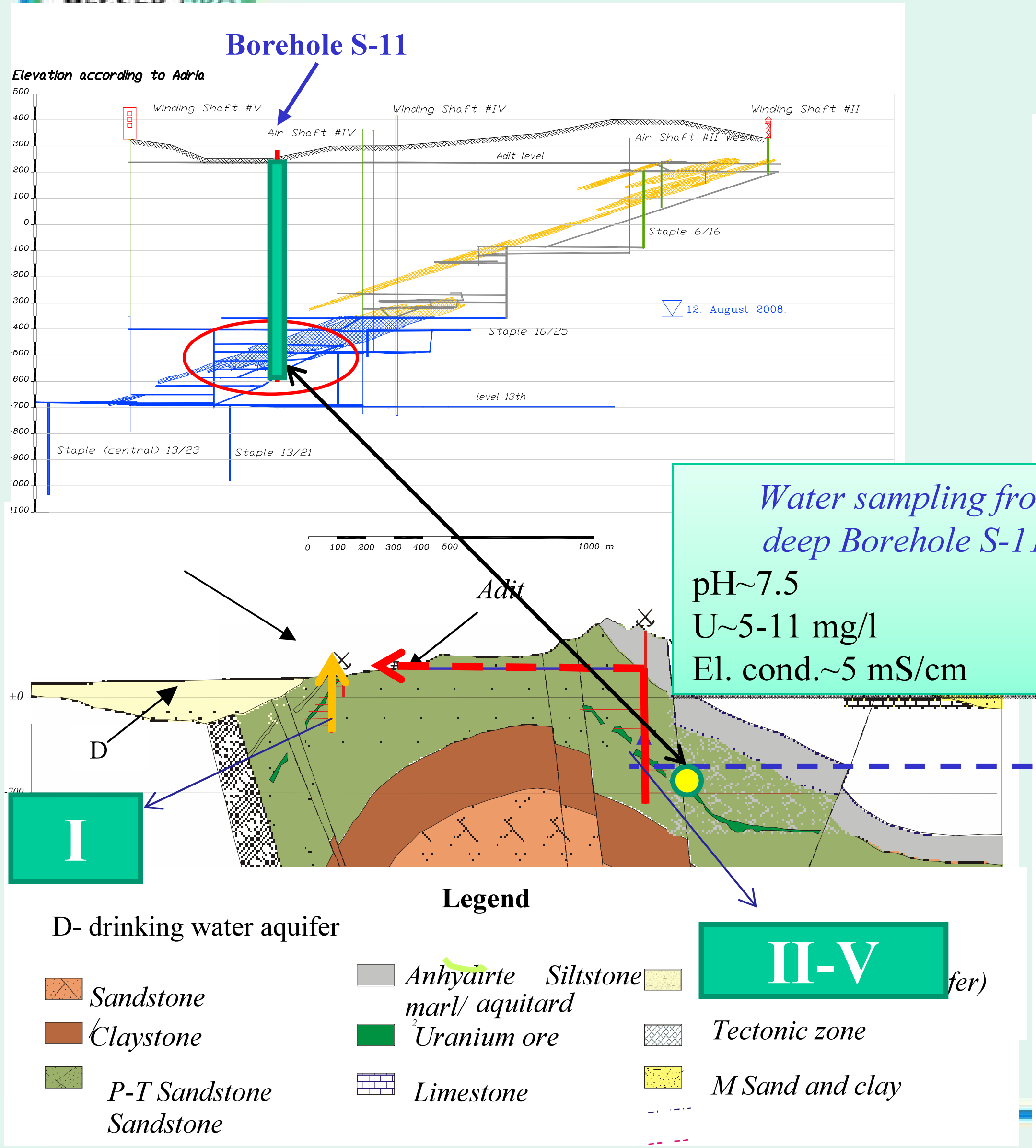
Δ~8-2=6 kg/t

Extra: ~2.5-3 kg/t H_2SO_4

3 Experience from the remediation

3.1 Mine water treatment
3.2 Heap leaching
3.3 Groundwater contamination and restoration on TPs area
3.4 TPs remediation
3.5 Passive/semi-passive methods of water treatment

MINE WATER TREATMENT

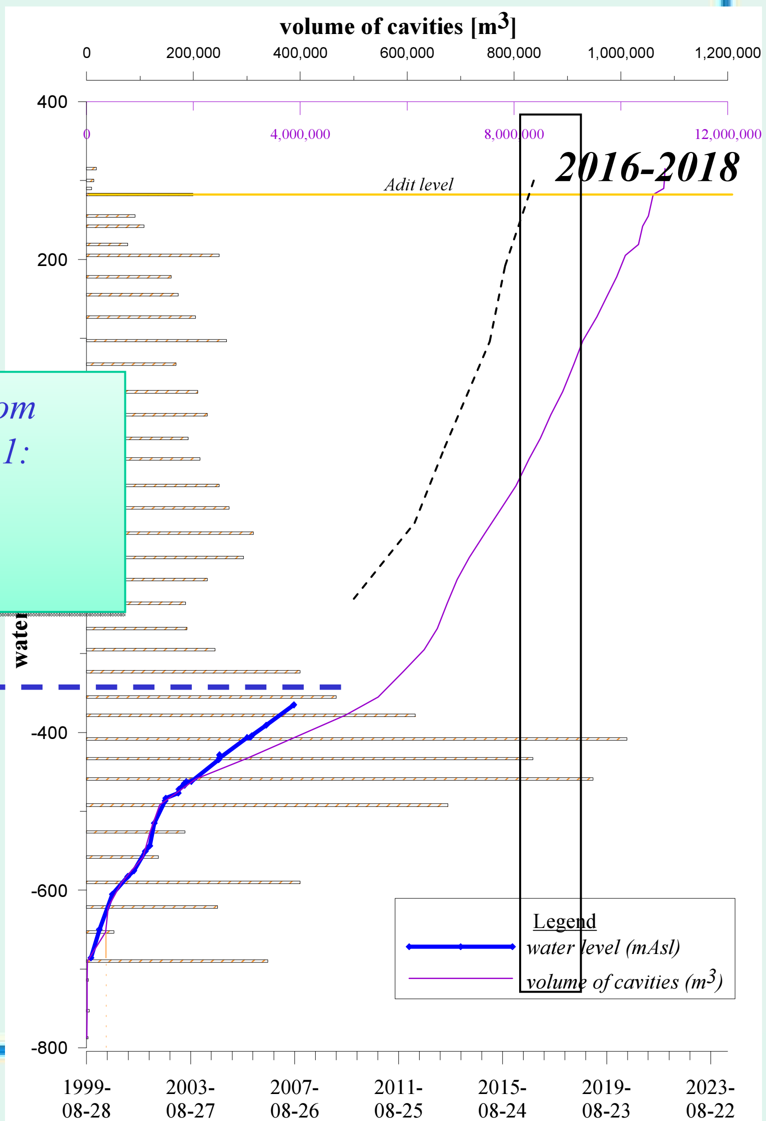


Water sampling from deep Borehole S-11:

pH~7.5

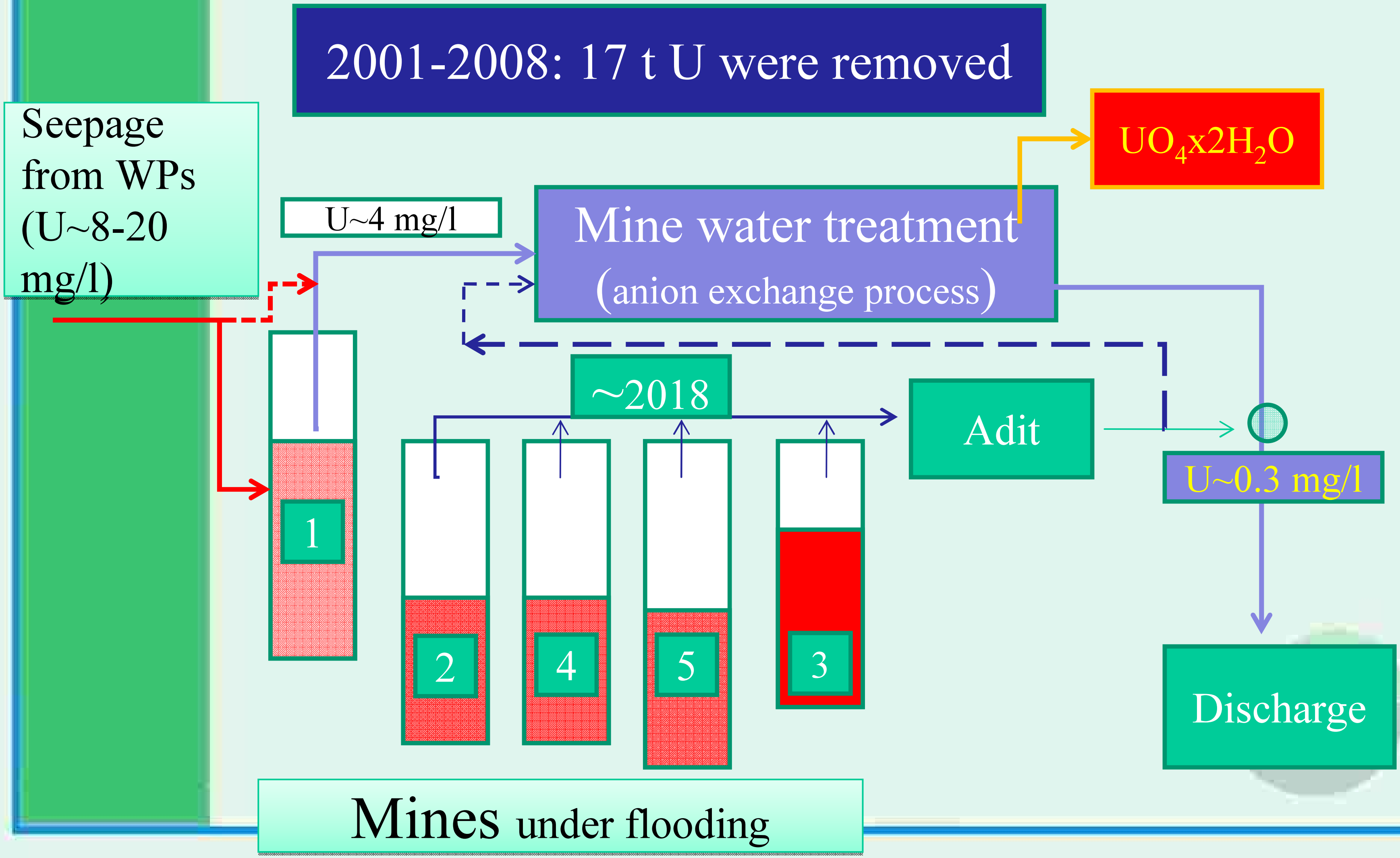
U~5-11 mg/l

El. cond.~5 mS/cm



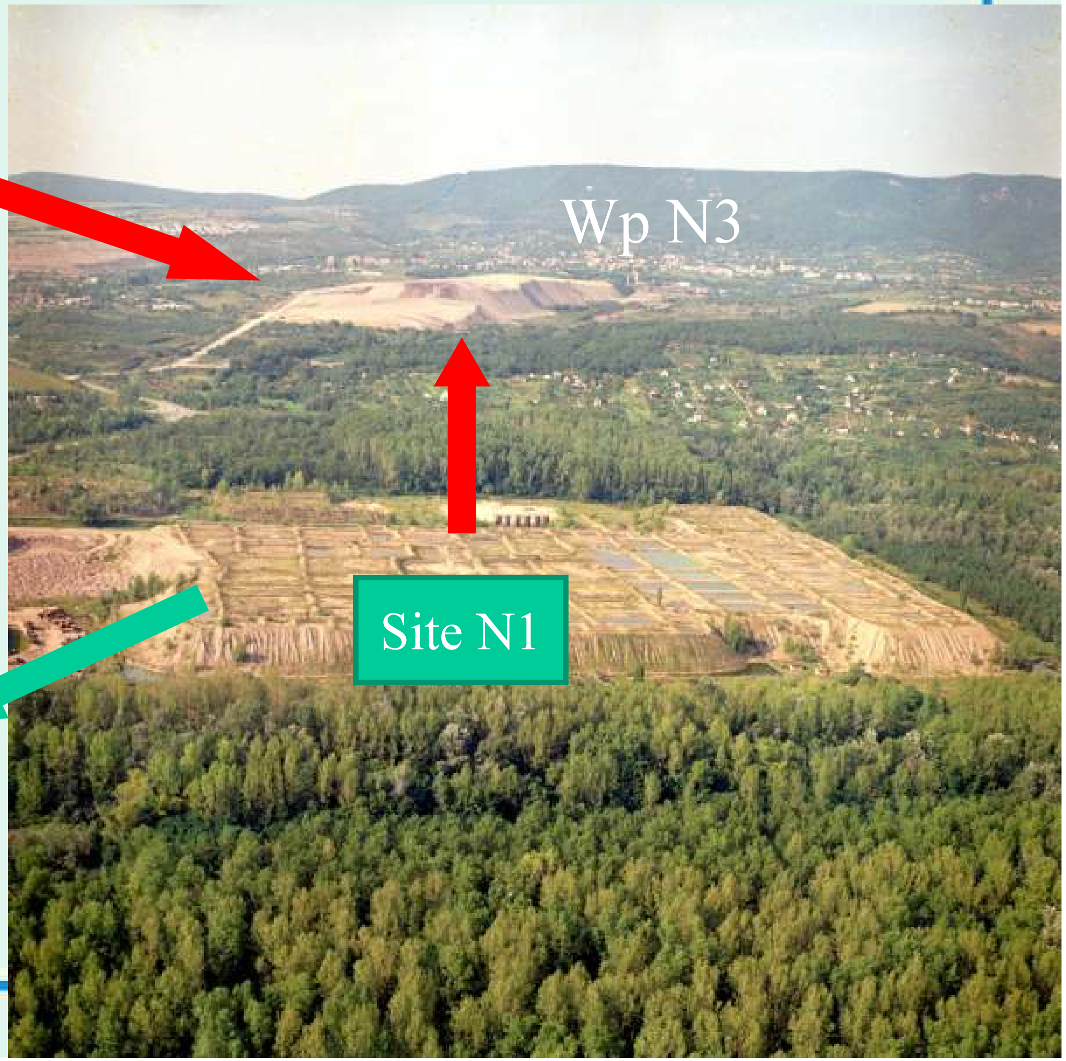
MINE WATER TREATMENT (cont.)

(all uranium-contaminated waters are treated)

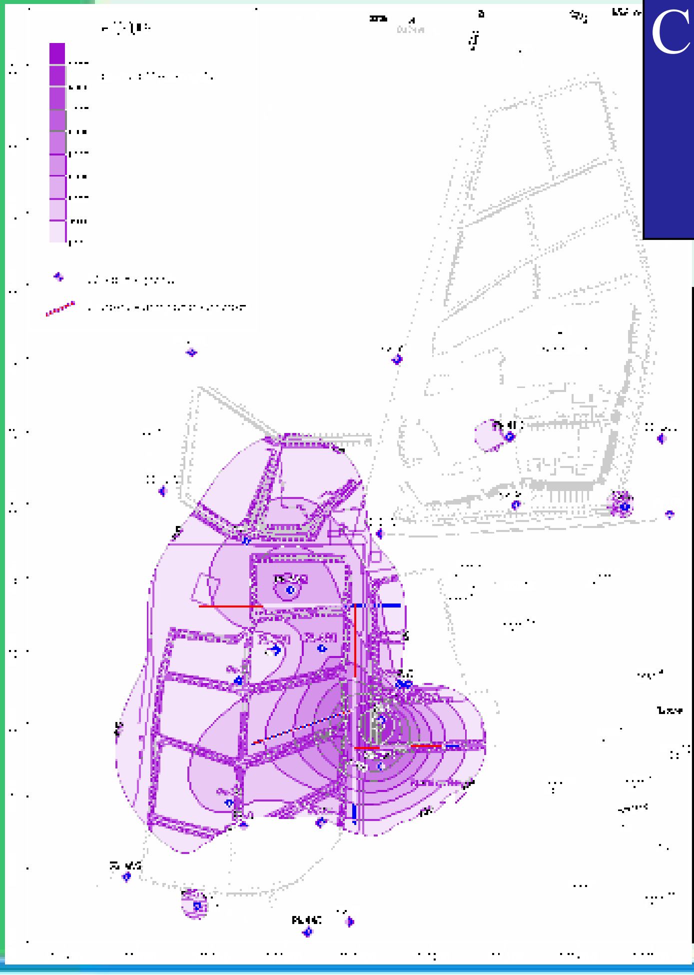


HEAP LEACHING RELOCATION OF RESIDUES TO THE FINAL STORAGE AREA

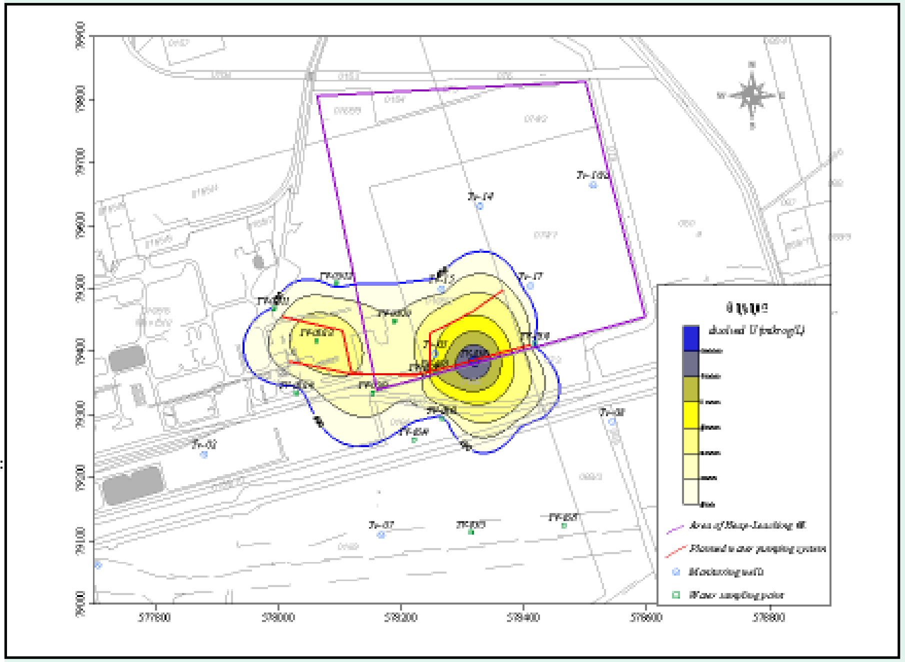
Site II



GW CONTAMINATION ON HL-SITES



Contamination was observed first of all nearby the pumping stations and pipe lines



HEAP LEACHING PRACTICE

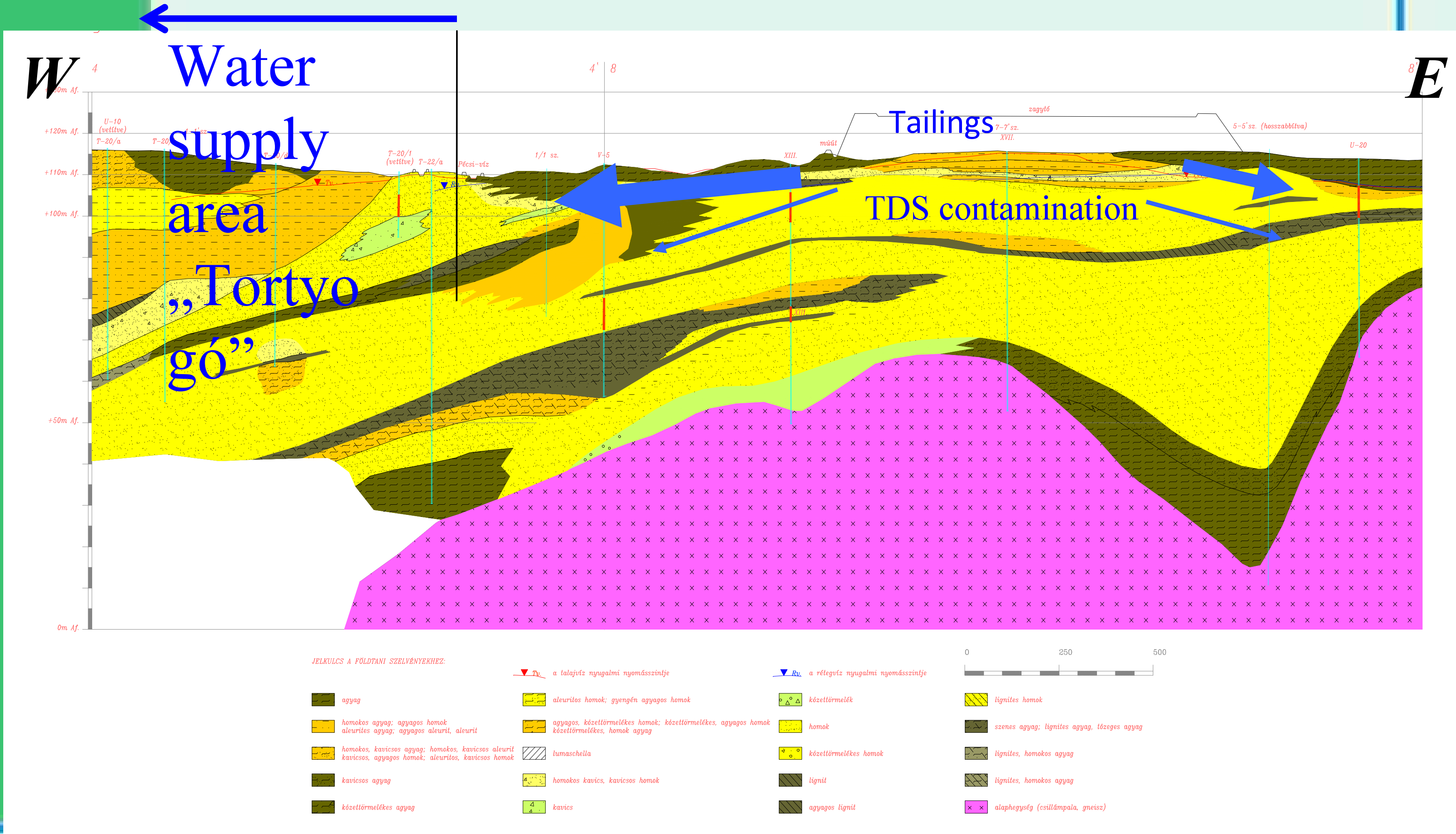
7.2 million t low grade ore was treated (~140 g/t), ~60% recovery (540tU), 5kg/t Na_2CO_3 ,37 ha

How to improve the process?

Continuously expanding pads need rather large area (in our case 6.5 ha/Mt). Therefore **reusable pads** seem to be more reasonable with the disposal of the residues on the final storage area.

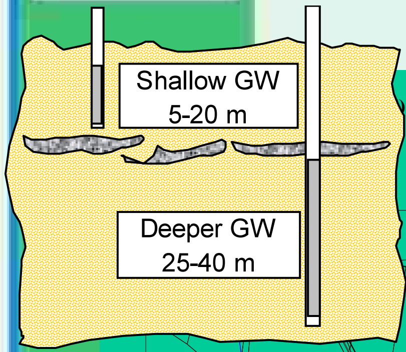
HIDROGEOLOGICAL SITUATION AROUND THE TPs

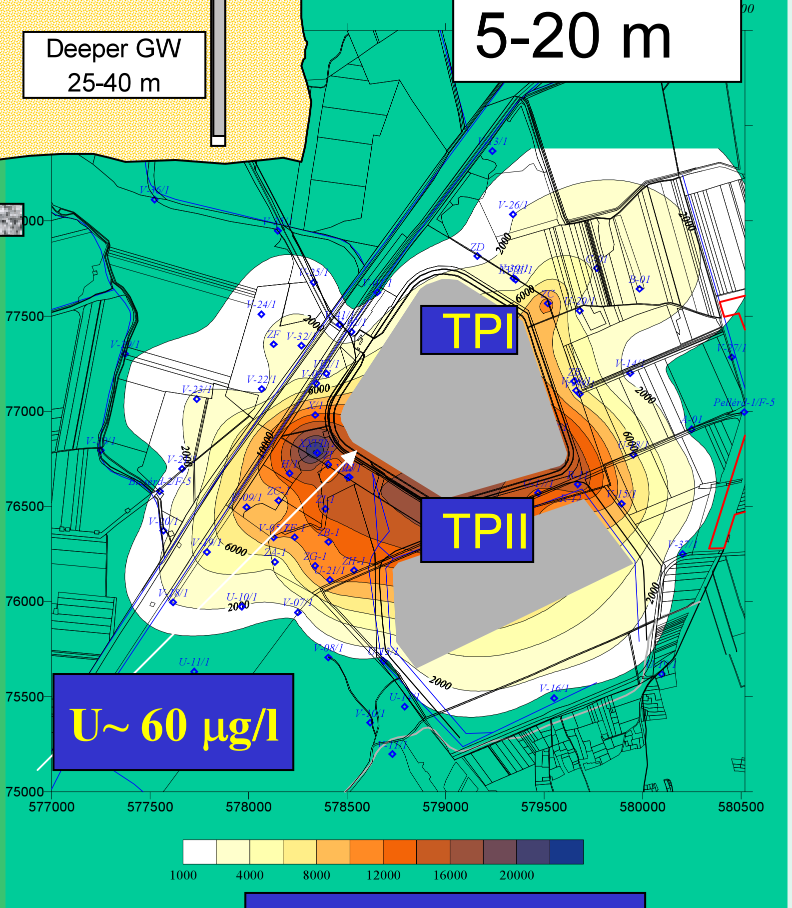
Geological Profile across the Tailings Pond



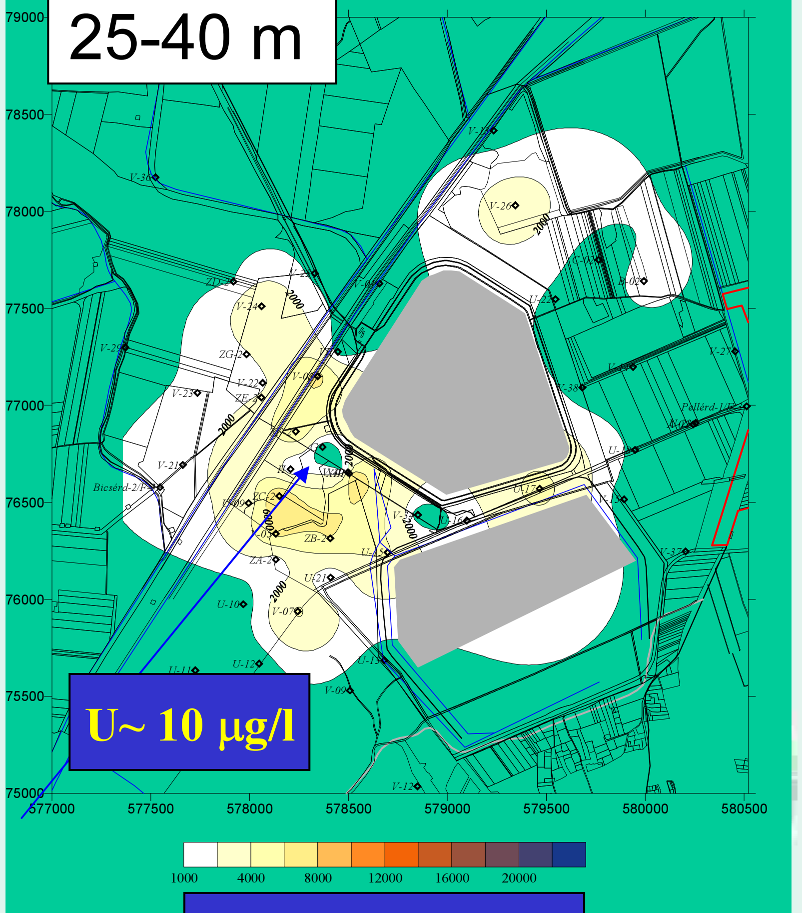
GROUNDWATER CONTAMINATION ON THE TPs AREA

GW cont. : high TDS (Mg, Na, Ca, SO4, Cl), inadequat neutralization of the barren pulp



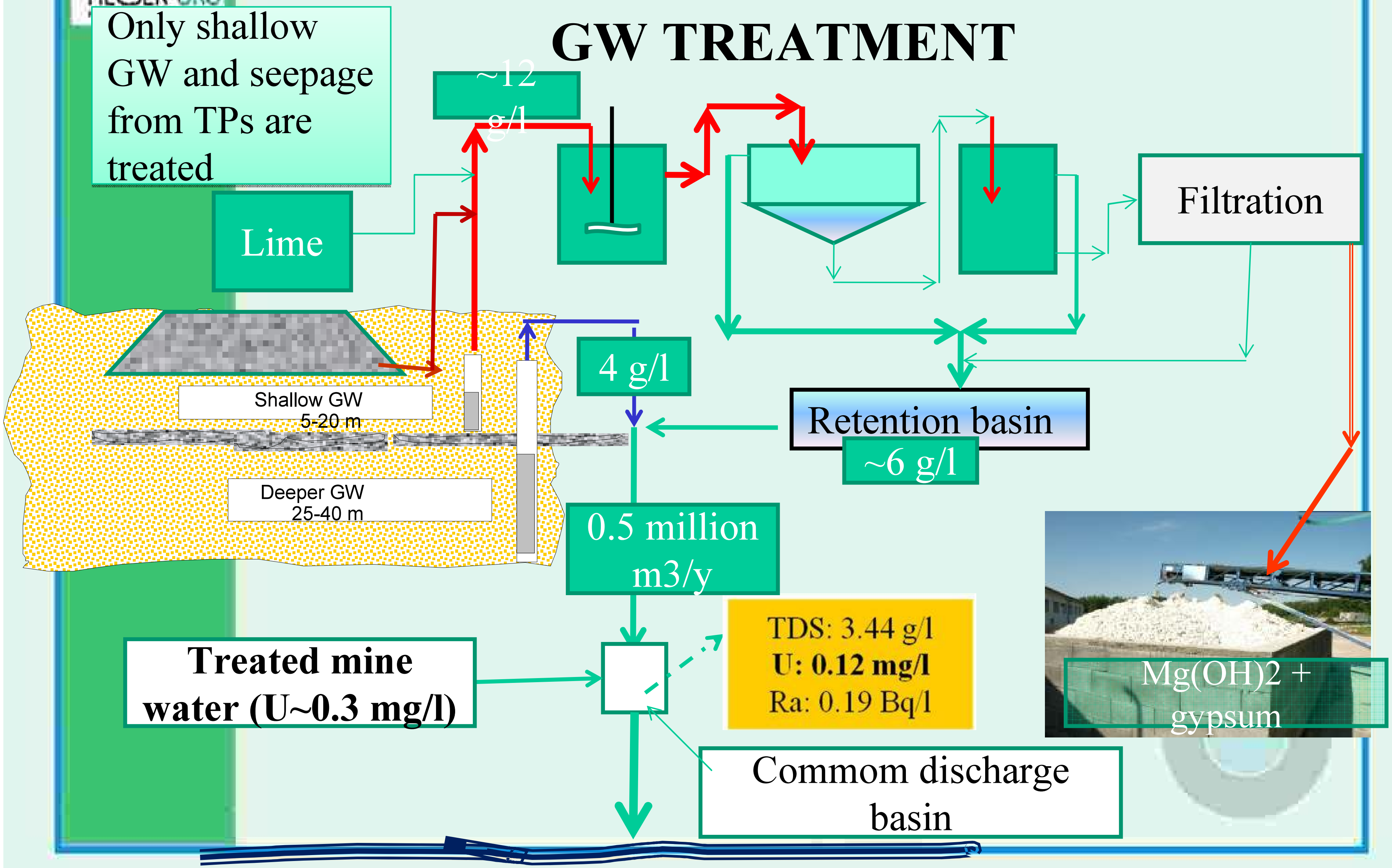


TDS~18 g/l

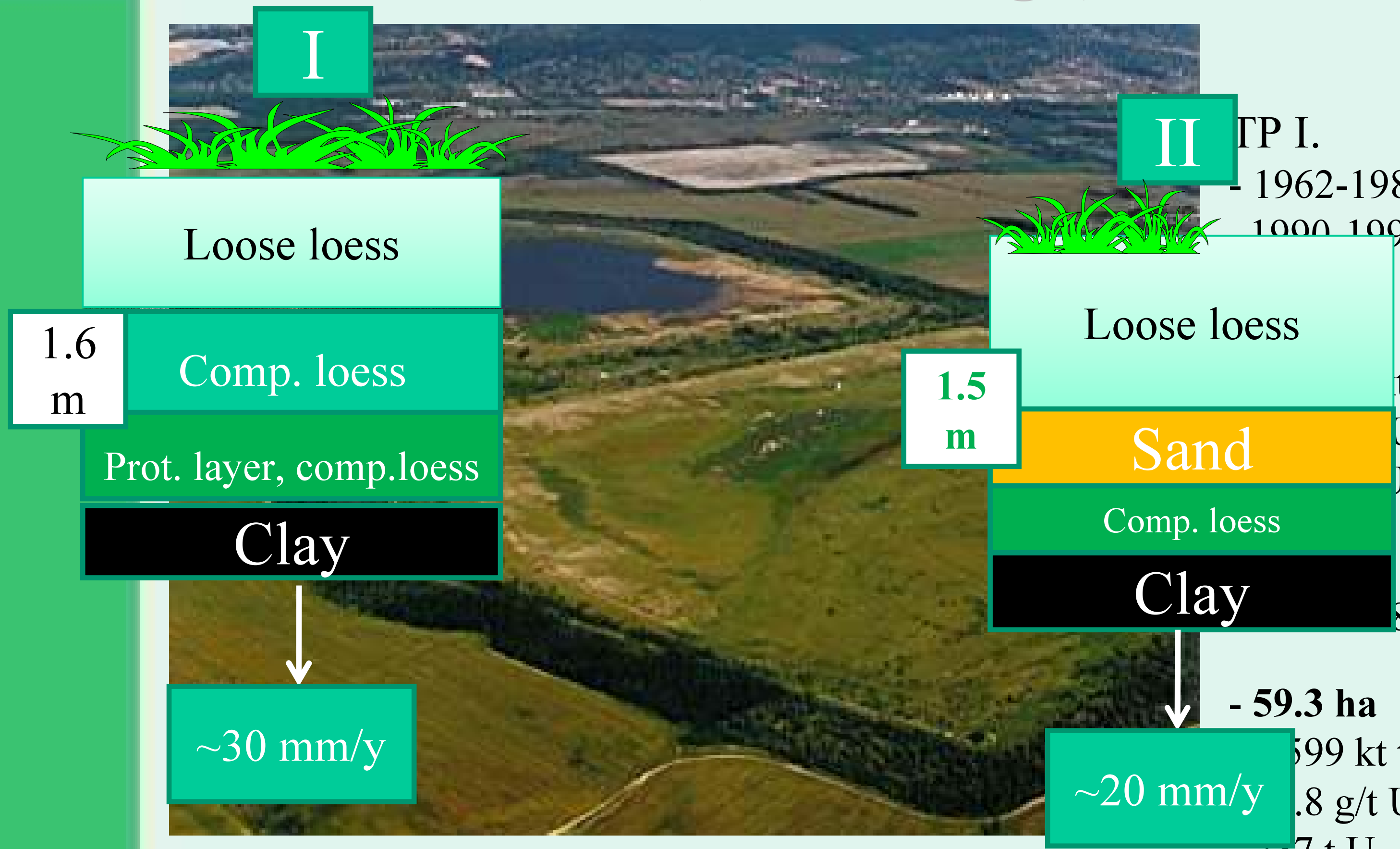


TDS~4 g/l

PRINCIPAL FLOW SHEET OF THE GW TREATMENT



REMEDIATION OF THE TPs (cover design)



TP I.
- 1962-1980,
1990-1997

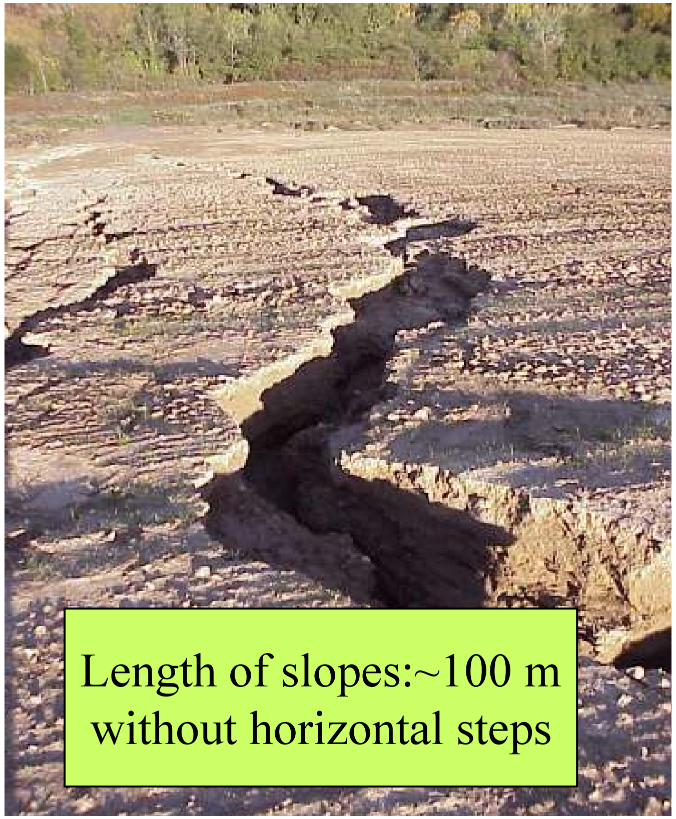
t tailings
U
J

89

- **59.3 ha**
599 kt tailings
.8 g/t U
- 257 t U

Tailings ponds were dewatered, fine tailings zone stabilised, and than covered

WATER EROSION OF THE SOIL COVER ON TAILINGS PONDS



Length of slopes:~100 m
without horizontal steps

Erosion was reduced by making furrow ditches
to divert the water flow

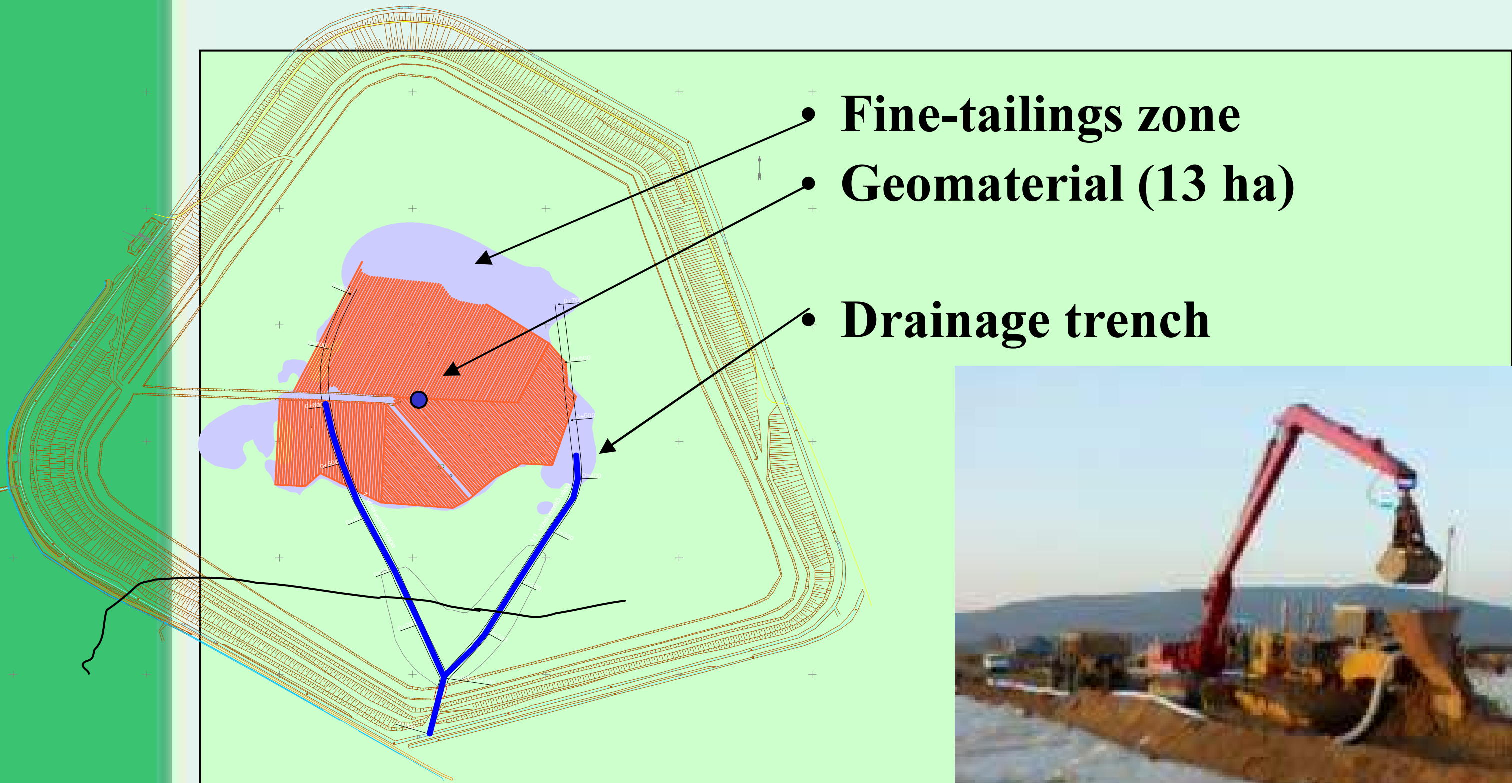
STABILIZATION OF THE FINE TAILINGS ZONE

Special task was the stabilization of the weak slime zone

Field test for receiving experience

Cooperation with Wismut and C &E

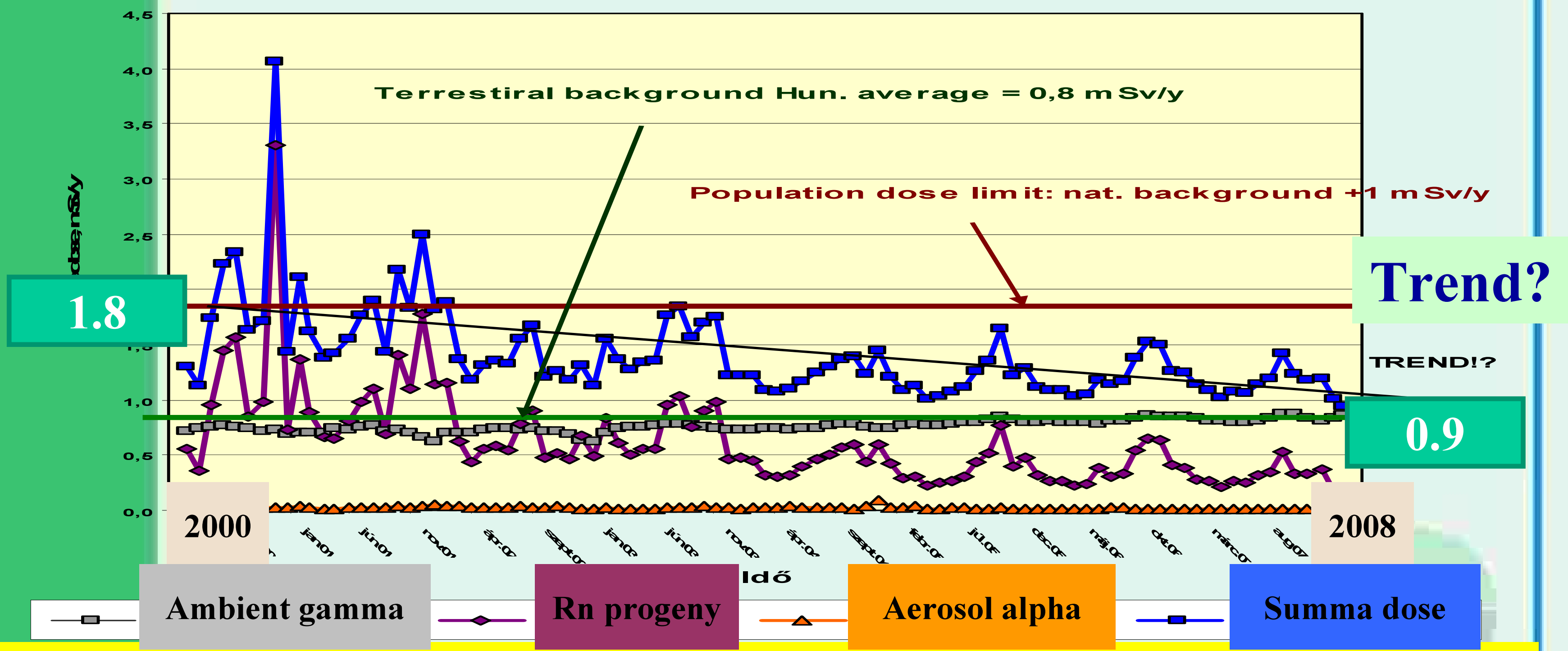
DRAIN IN FINE TAILINGS



Length: 1050 m depth:4-6 m
d:160 mm Q~ 40 m^3/d (~0.076 $m^3/m^2/d$)

Long term change of effective dose components in the vicinity of taikings ponds (Pellérd, nearby village) 2000 – 2008.

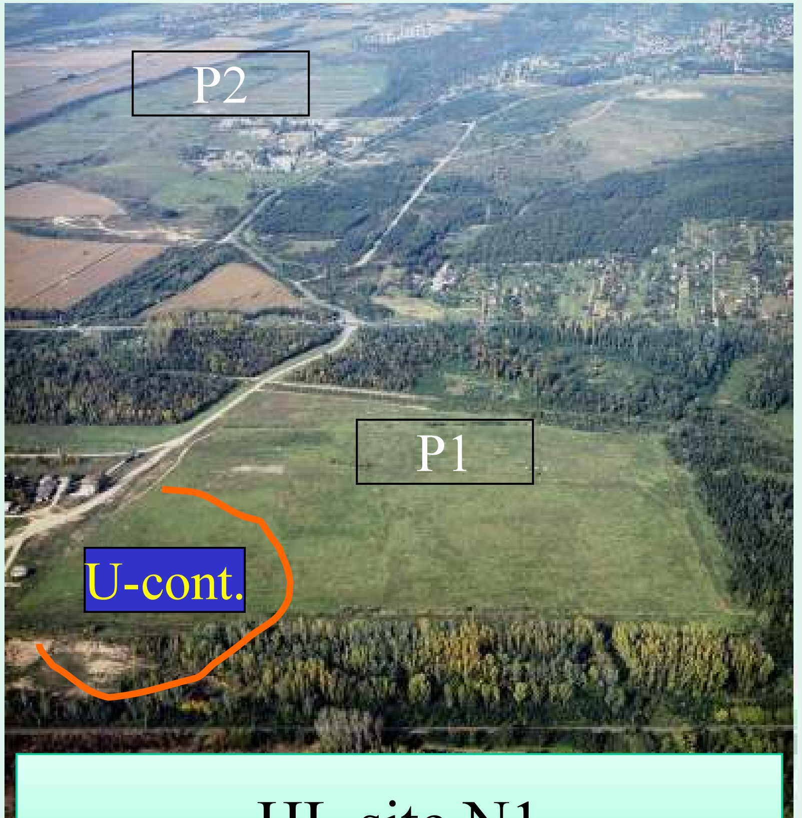
Effective dose component dropped by ~1 mS/y



After finishing the covering of tailings pond I., natural background values are expected.

IN-PLACE WATER TREATMENT (on WP and former HL)

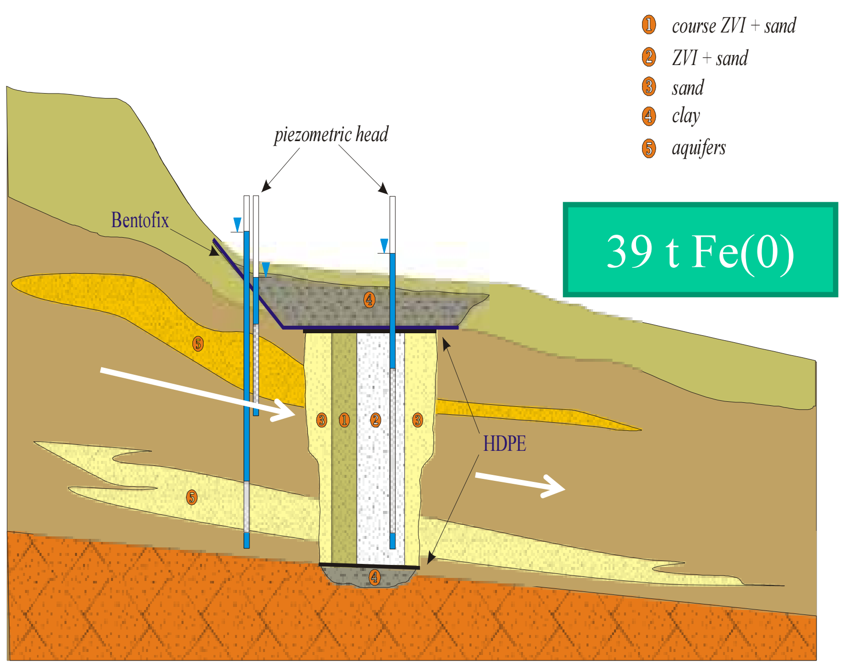
Seepage from WR (Frici-táró, ~40 m^3/d)



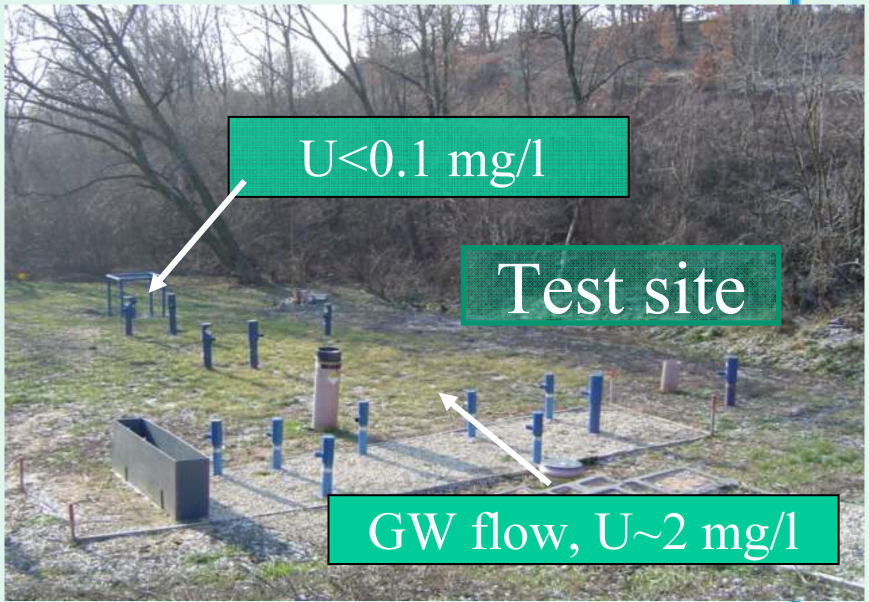
HL site N1

EXPERIMENTAL PERMEABLE REACTIVE BARRIER
(for in situ water treatment)

Design of experimental Permeable Reactive Barrier



Fe +sand~1:1

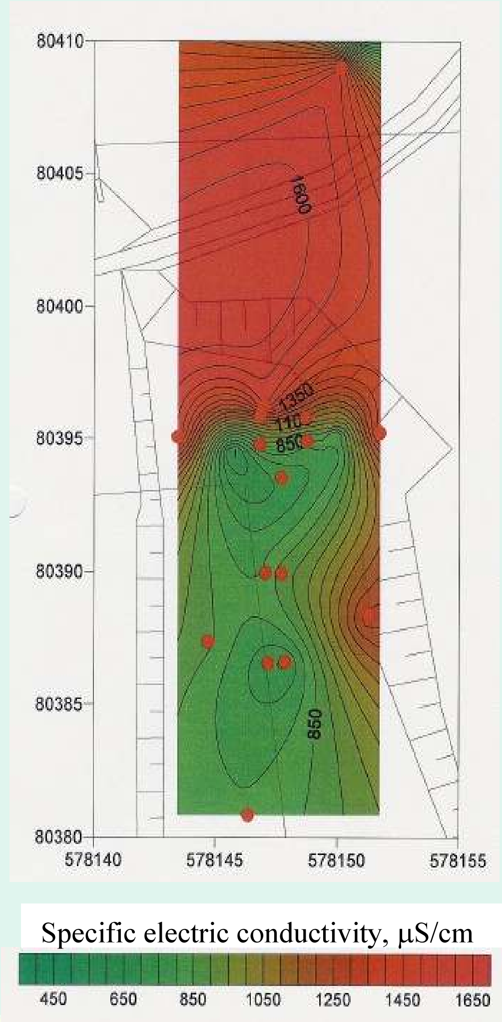


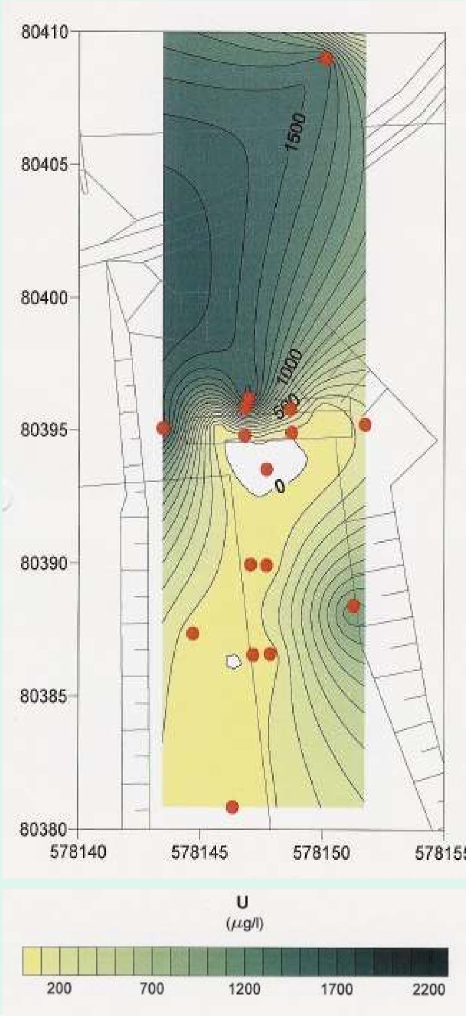
28 monitoring wells

Installed: August 2002

PEREBAR- EU-sponsored project

LONG-TERM PERFORMANCE OF THE INSTALLED EXPERIMENTAL PRB





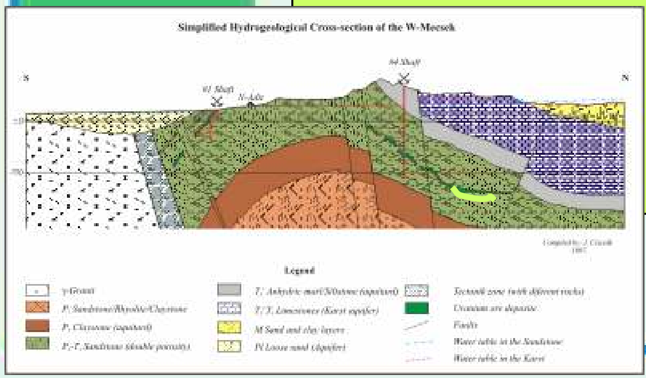
Monitoring

Ore reserves
(left behind on the site)

- Mining and processing of U-ore was terminated in 1997 because of economical reason
- Total estimated <u>solid</u> ore reserve (U~0.12%):
  - **39 Mt** (up to –1300 m depth)
- From which mined out **<u>solid</u> ore was 20 Mt** (28 Mt in form of run-off-mine ore)
- Reserves left behind: **19** Mt

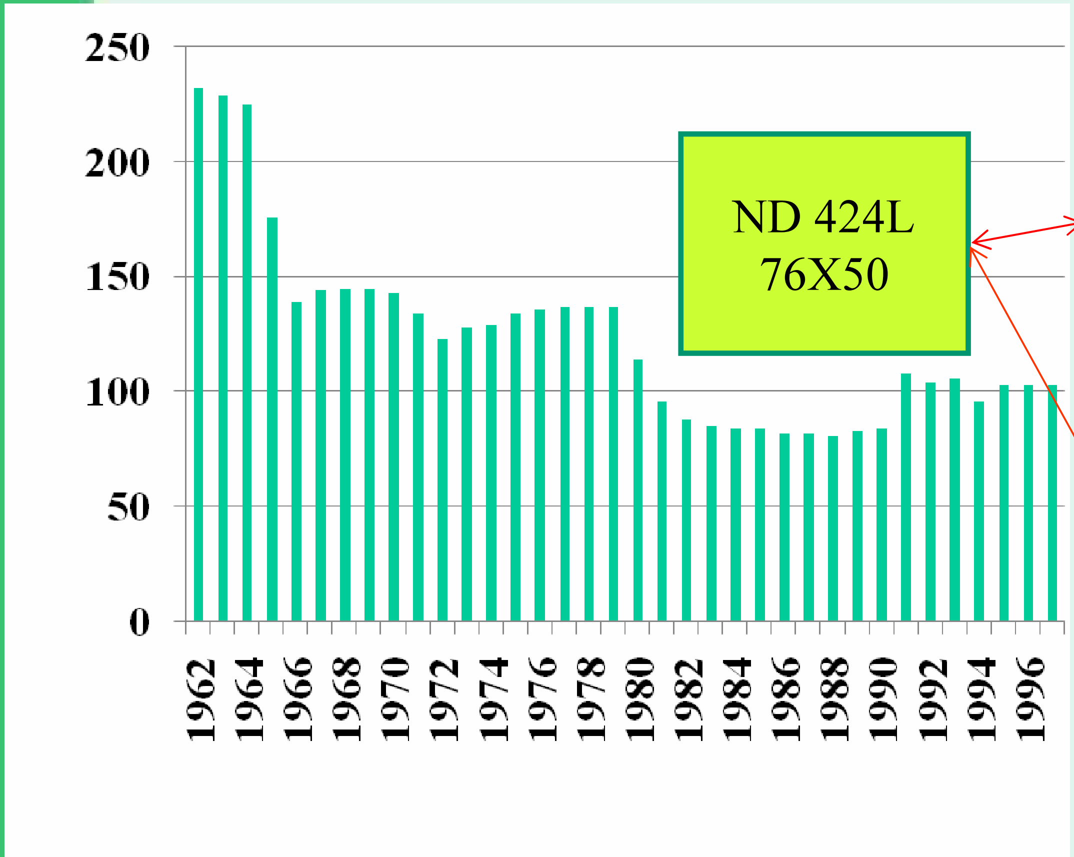
  12 Mt (1200-1300 m)

  7 Mt (1000-1200 m)



THANK YOU FOR YOUR KIND ATTENTION

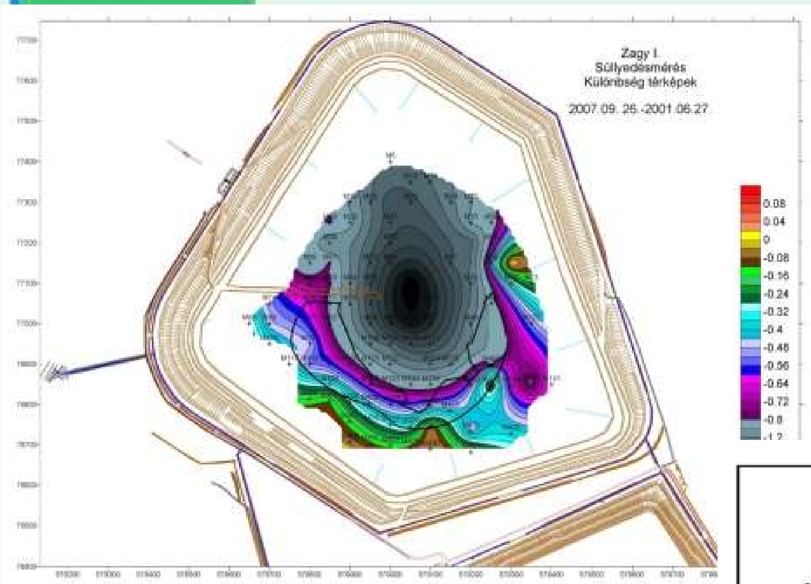
DEVELOPMENT OF THE RADIOMETRIC SORTING PROCESS OF THE ORE



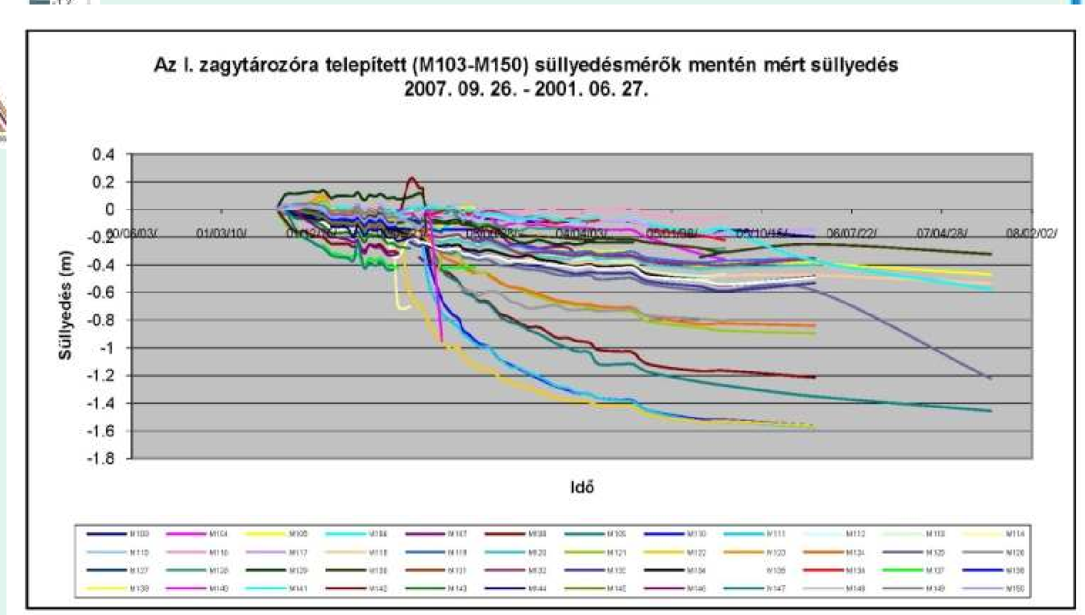
Decreasing the background and installation more sensitive detectors

Detection efficiency: 5600 imp/s/gU

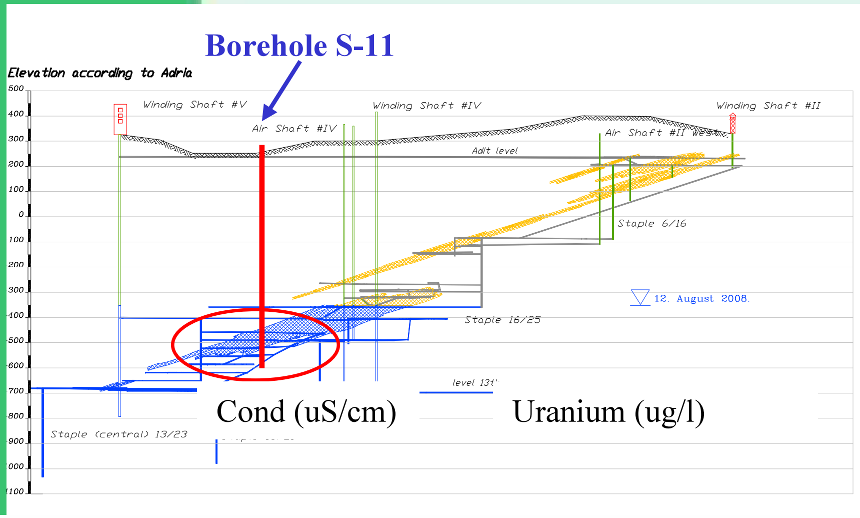
3.4.4 SUBSIDENCE ON THE SLIME ZONE (2001-2007)

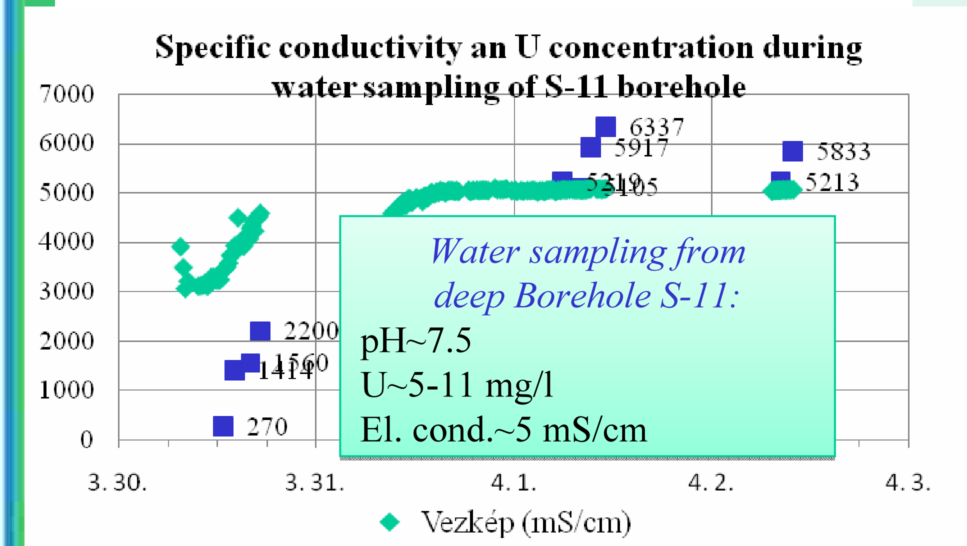


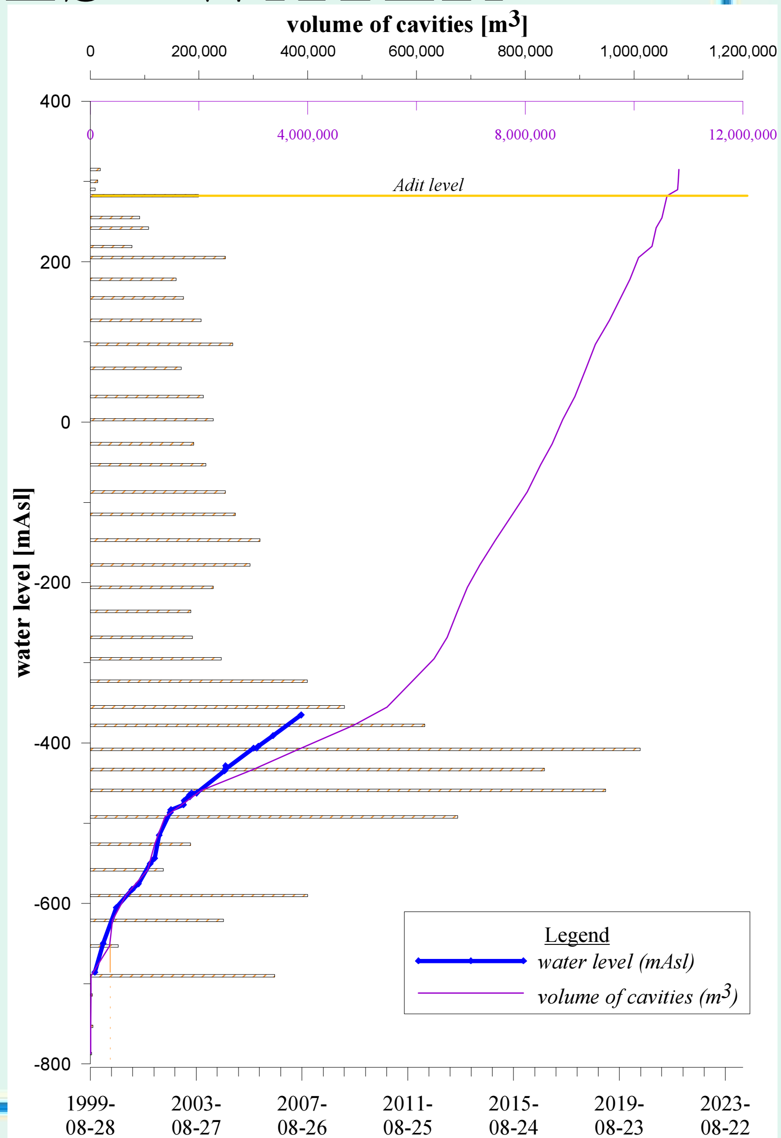
Maximum: 1.6 m/7 years,
Presently~2 cm/y



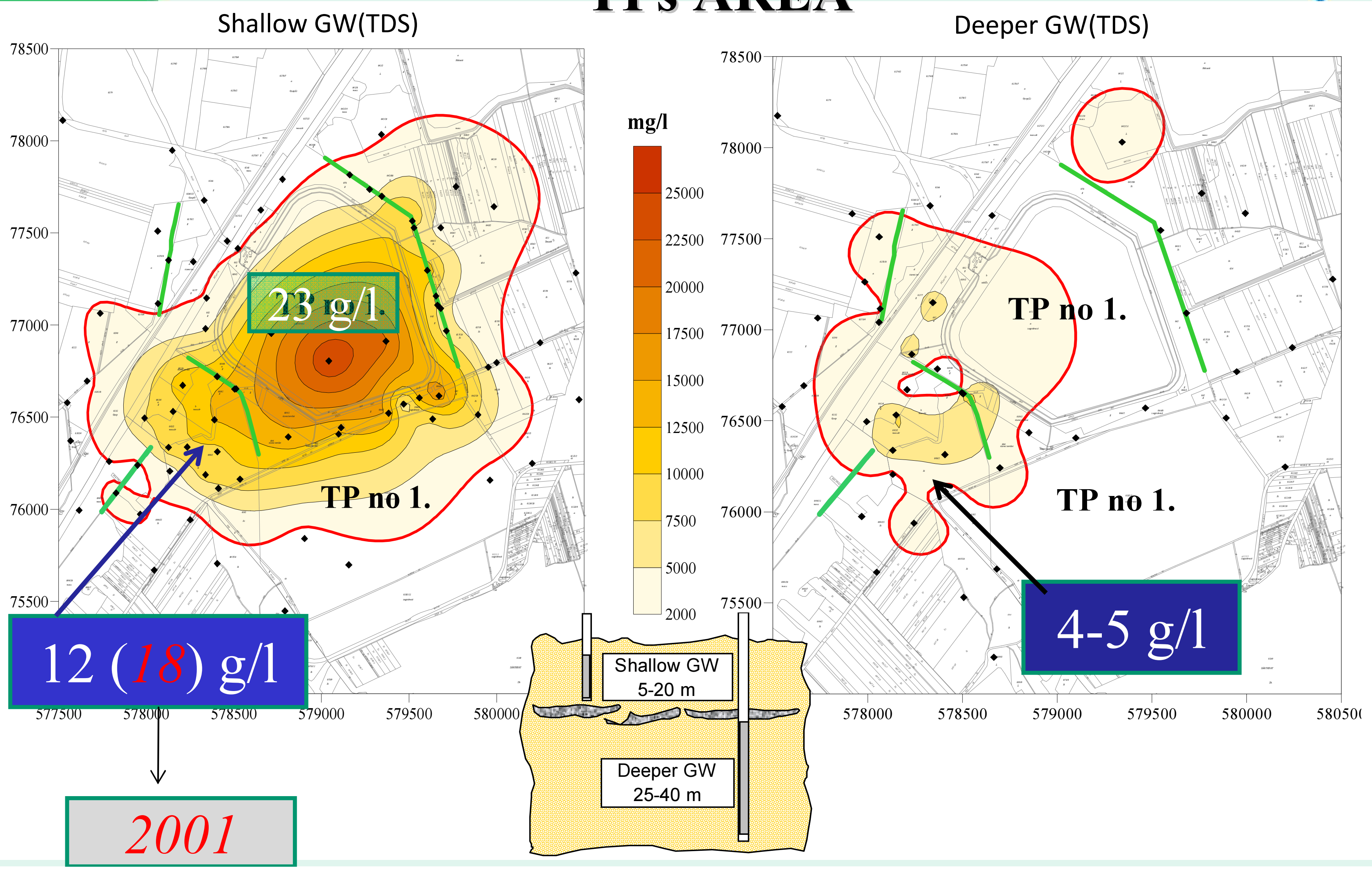
3.1.2 URANIUM CONCENTRATION IN DEEP MINES' WATER





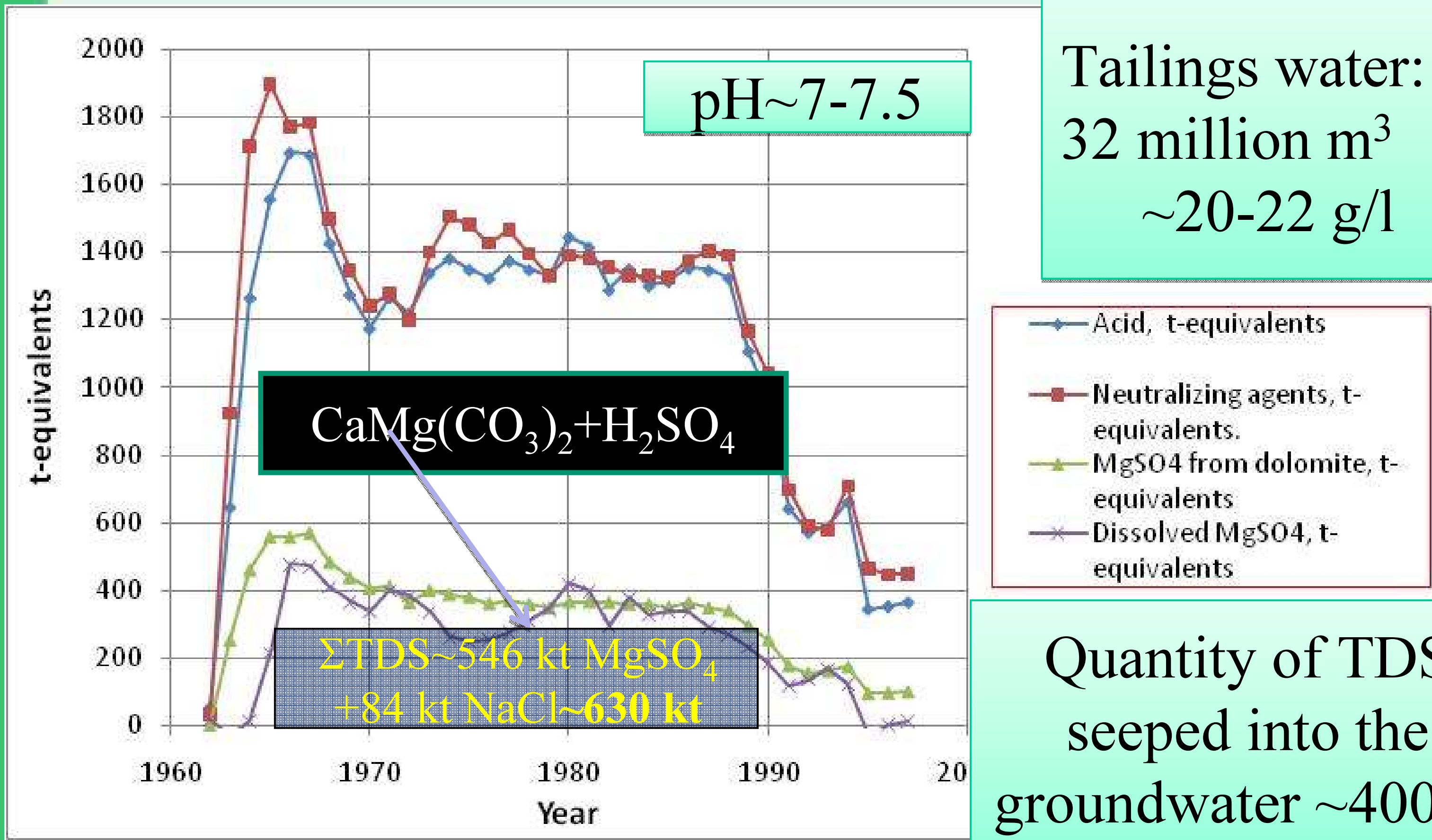


3.4 GROUNDWATER CONTAMINATION ON TPs AREA



2.4 ESTIMATION OF THE TDS IN TAILINGS WATER

(Balance of acid and neutralizing agents [lime, lime stone grinds, dolomite from the ore] in the mill process)

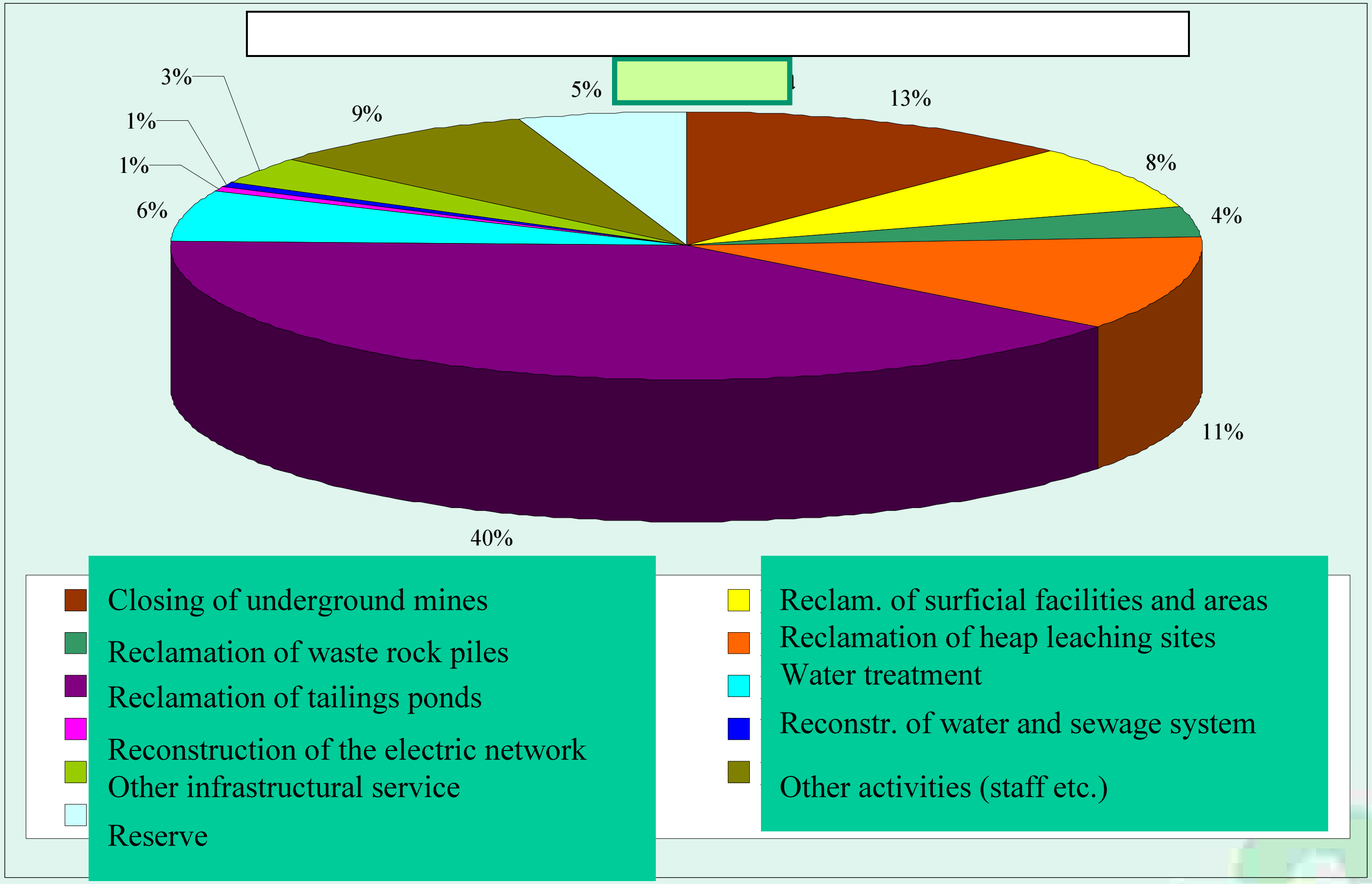


Tailings water:
32 million m^3
~20-22 g/l

Quantity of TDS seeped into the groundwater ~400 kt

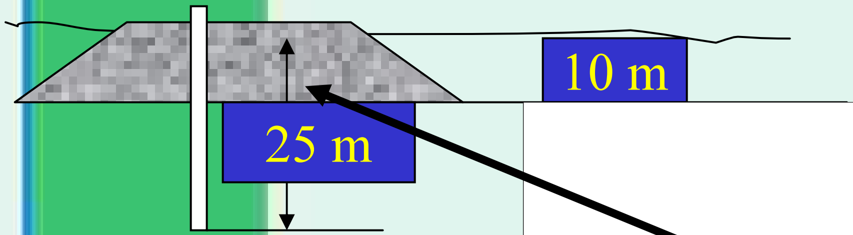
Most part of the Mg leached from the ore remained in the tailings water

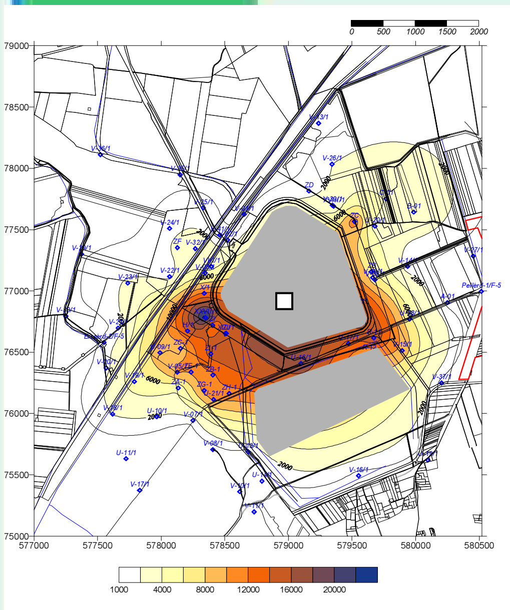
The distribution of the total cost between the sub-projects

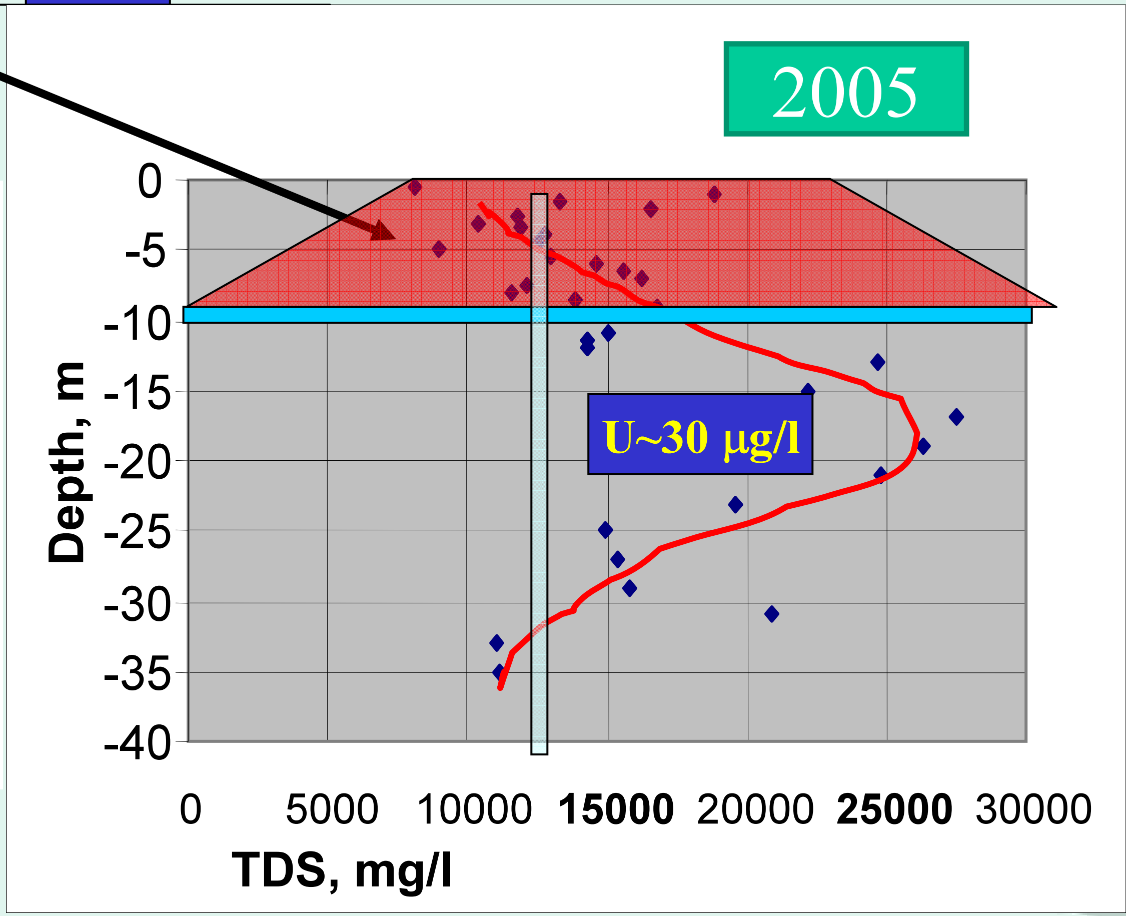


Planned cost of remediation (1997-2002): 18,5 Billion HUF (74 Million EU)

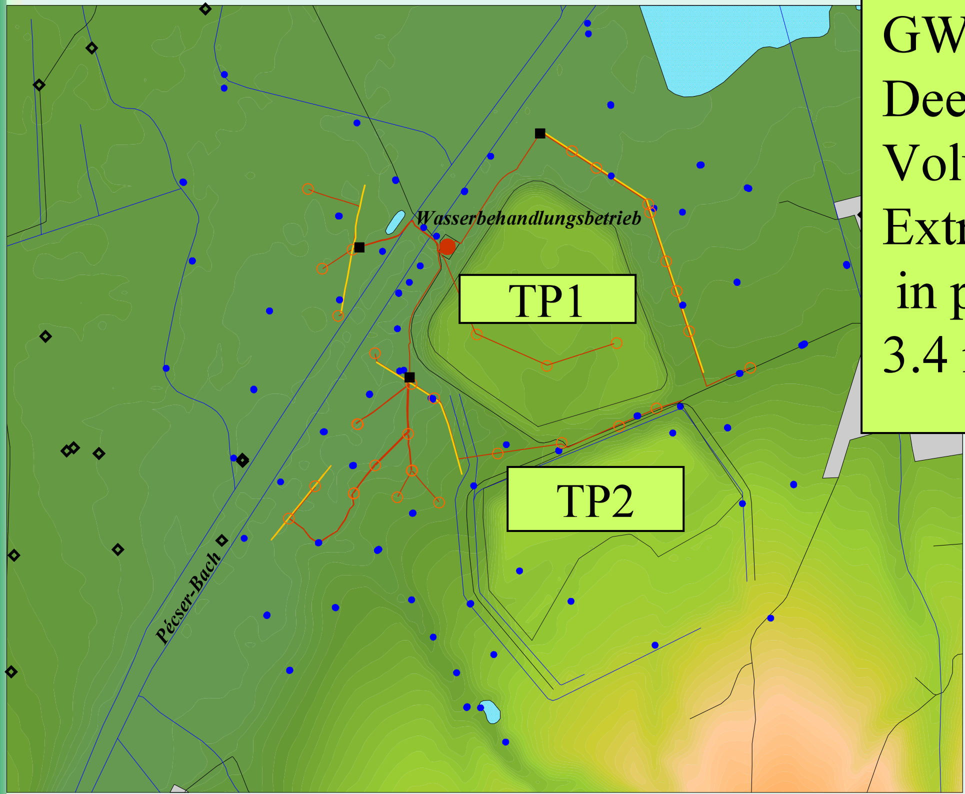
3.4.1 CONTAMINATION UNDER THE TPs







3.3.3 GROUNDWATER RESTORATION

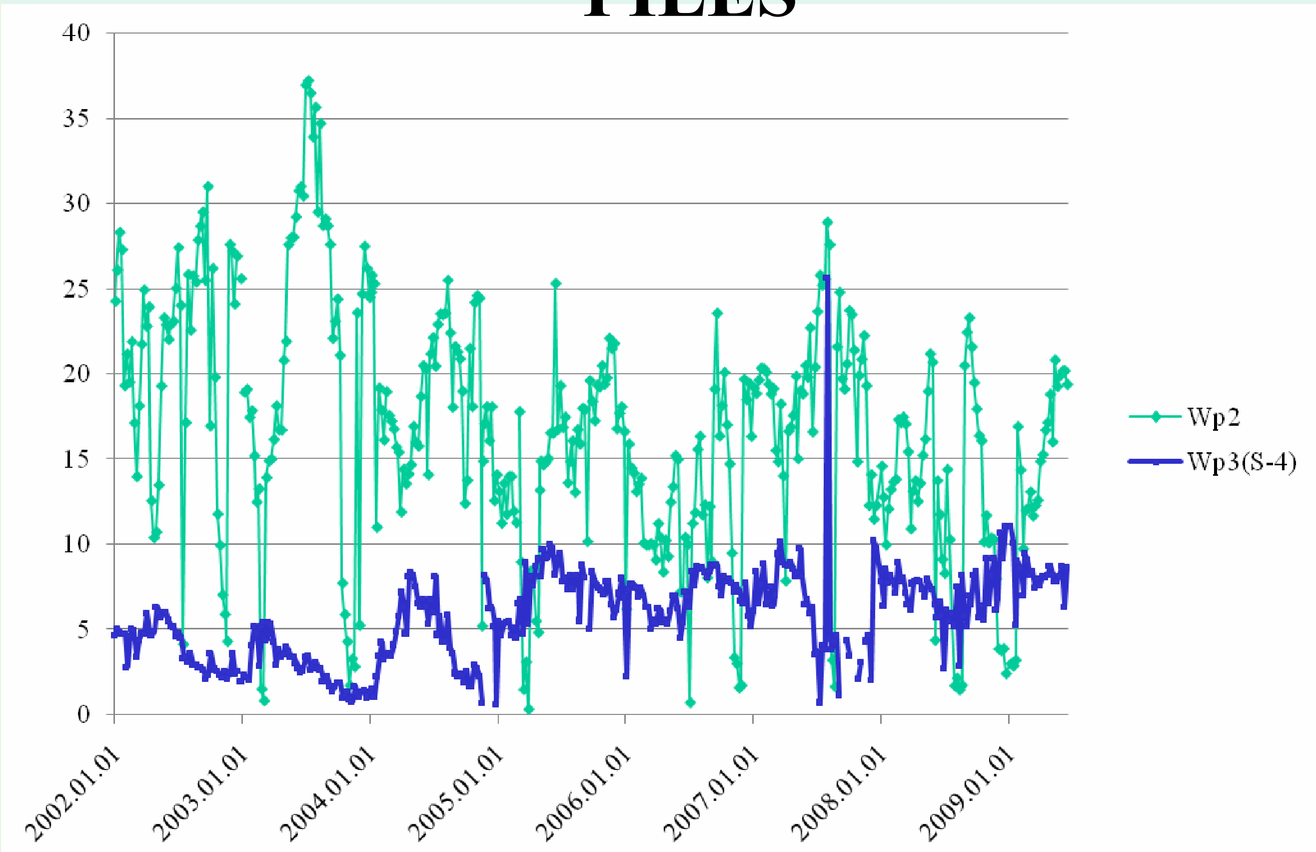


GW extraction wells: 27
Deep dranage: 3.2 km
Volume of the extracted
Extracted volume of water
in period of (2001-2008) was
3.4 million m^3, 44 kt of TDS.

Yearly operation cost:
800 000 US $ (~1.9 US $/m^3)

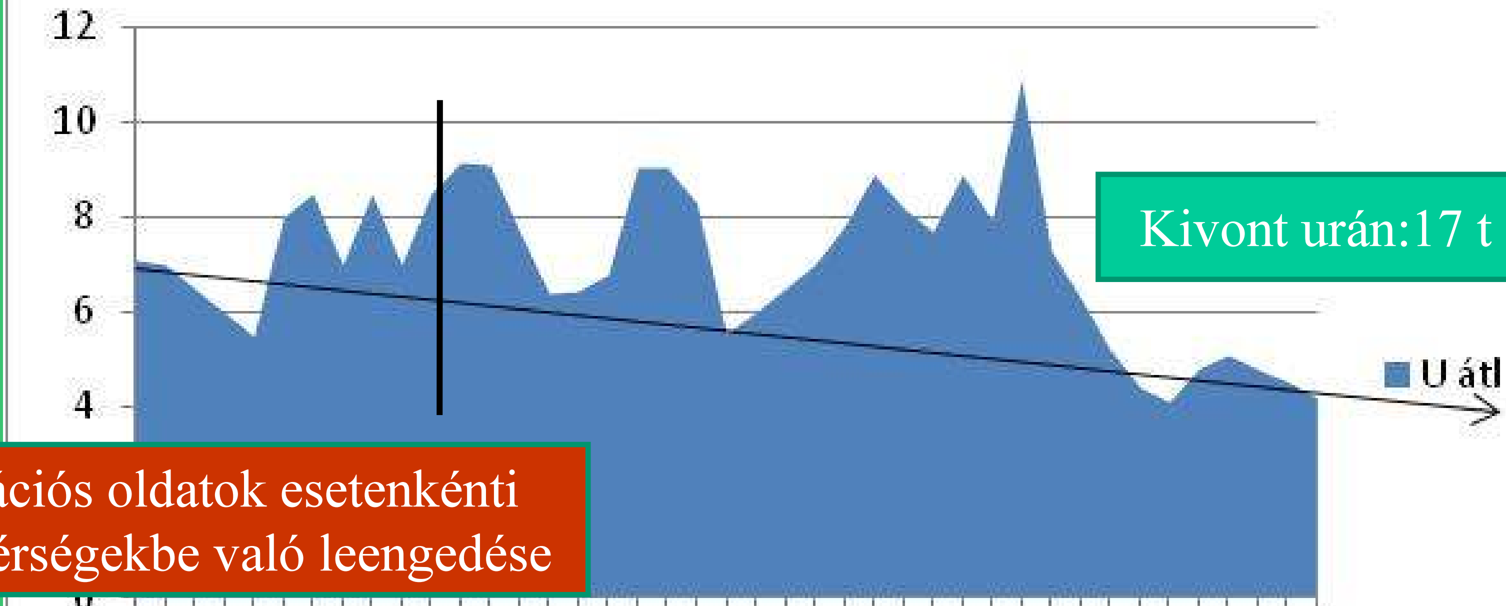
Water treatment: pump and treat with lime milk.
Sludge : Dry 3-4 kt/a)

3.1.1 URANIUM IN THE SEEPAGE OF WASTE ROCK PILES



It can be expected that the uranium attenuation will be slow process

A bányavíz urántartalmának időben való változása



Kivont urán:17 t

Perkolációs oldatok esetenkénti bányatérségekbe való leengedése

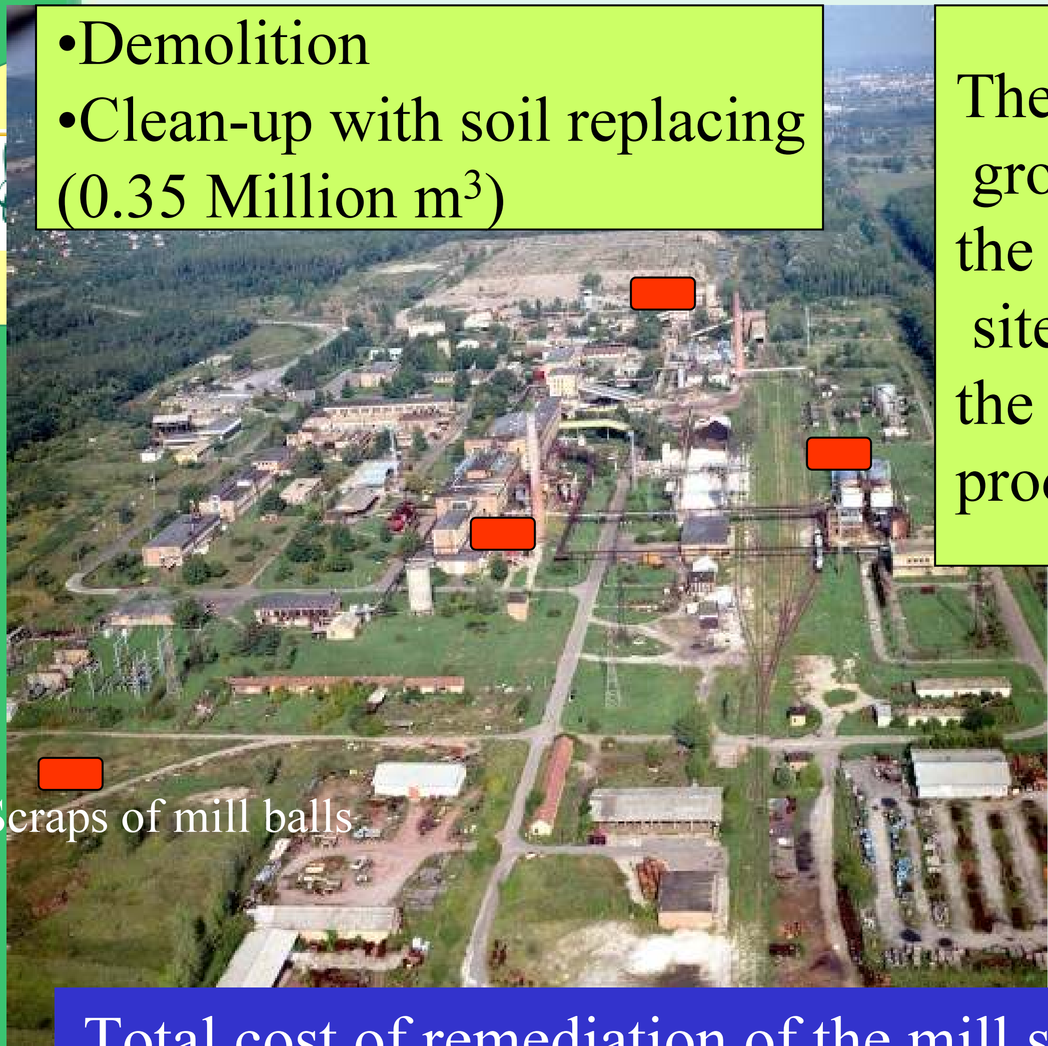
Az urántartalom 4 mg/l körüli értékre csökkent 2008-ban

A perolációs oldatok elősegítették az urán gyorsabb kioldódását a bányatérségből

REMEDIATION OF THE MILL SITE

- Demolition
- Clean-up with soil replacing (0.35 Million m³)

The most contaminated ground was found on the ore and acid storage site, as well as under the yellow cake production facilities.

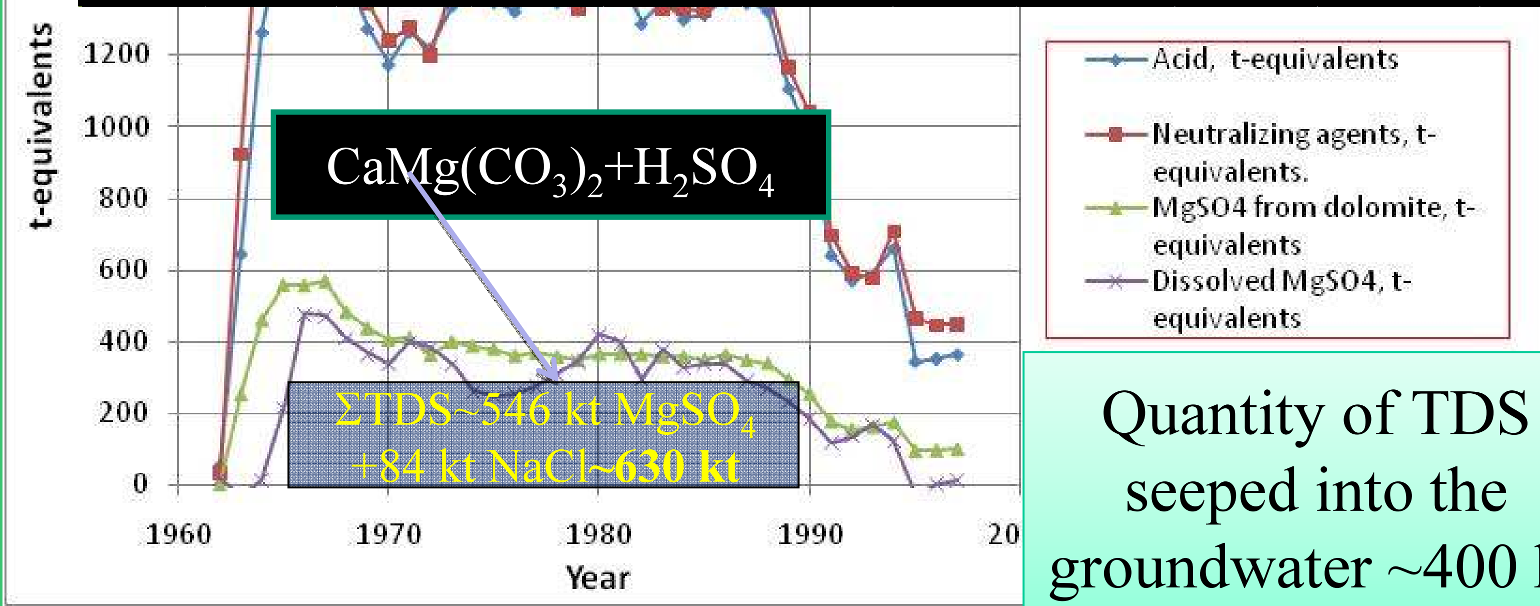


Total cost of remediation of the mill site:~ 5 million US $; ~0.37 US $/kgU

Assasement of the quantity of dissolved compounds disposed on tailings ponds

(Balance of acid and neutralizing agents in the mill process)

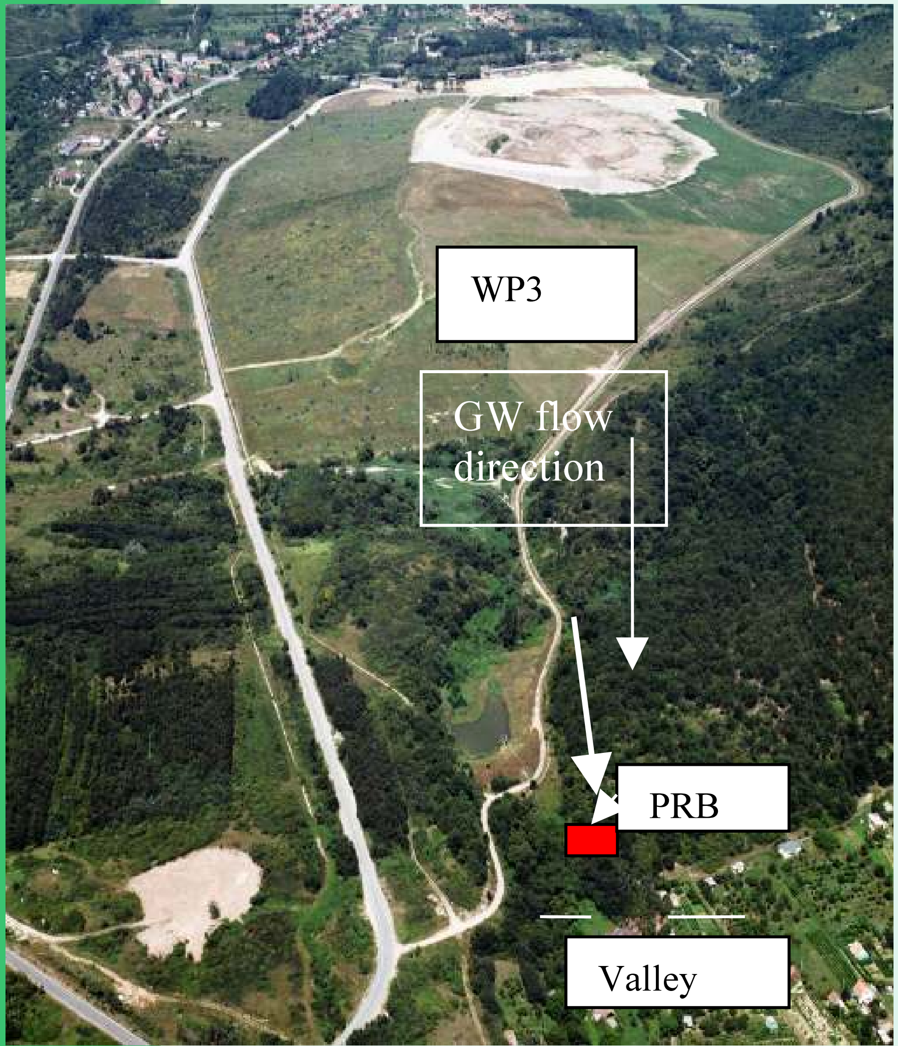
Estimated composition of the seepage from TPs										
Na^+	K^+	Ca^{2+}	Mg^{2+}	Mn^{2+}	$SO4^{2-}$	Cl^-	NO_3^-	TDS	U	Ra
g/l									mg/l	Bq/l
1.1	0.18	0.60	2.80	0.70	13	2.4	0.18	21	<0.1	5



Quantity of TDS seeped into the groundwater ~400 kt

Most part of the Mg leached from the ore remained in the tailings water

PERMEABLE REACTIVE BARRIER



The installation is located in a narrow valley at the foot of WPN3, linking the mining area with drinking water aquifer (*Zsid-valley*)

LONG-TERM PERFORMANCE OF THE INSTALLED EXPERIMENTAL PRB