
Steam-Air Injection

Pilot In-Situ Remediation of a PCE-Contaminated Aquifer

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3 rd Advanced Study Course IMAGE TRAIN

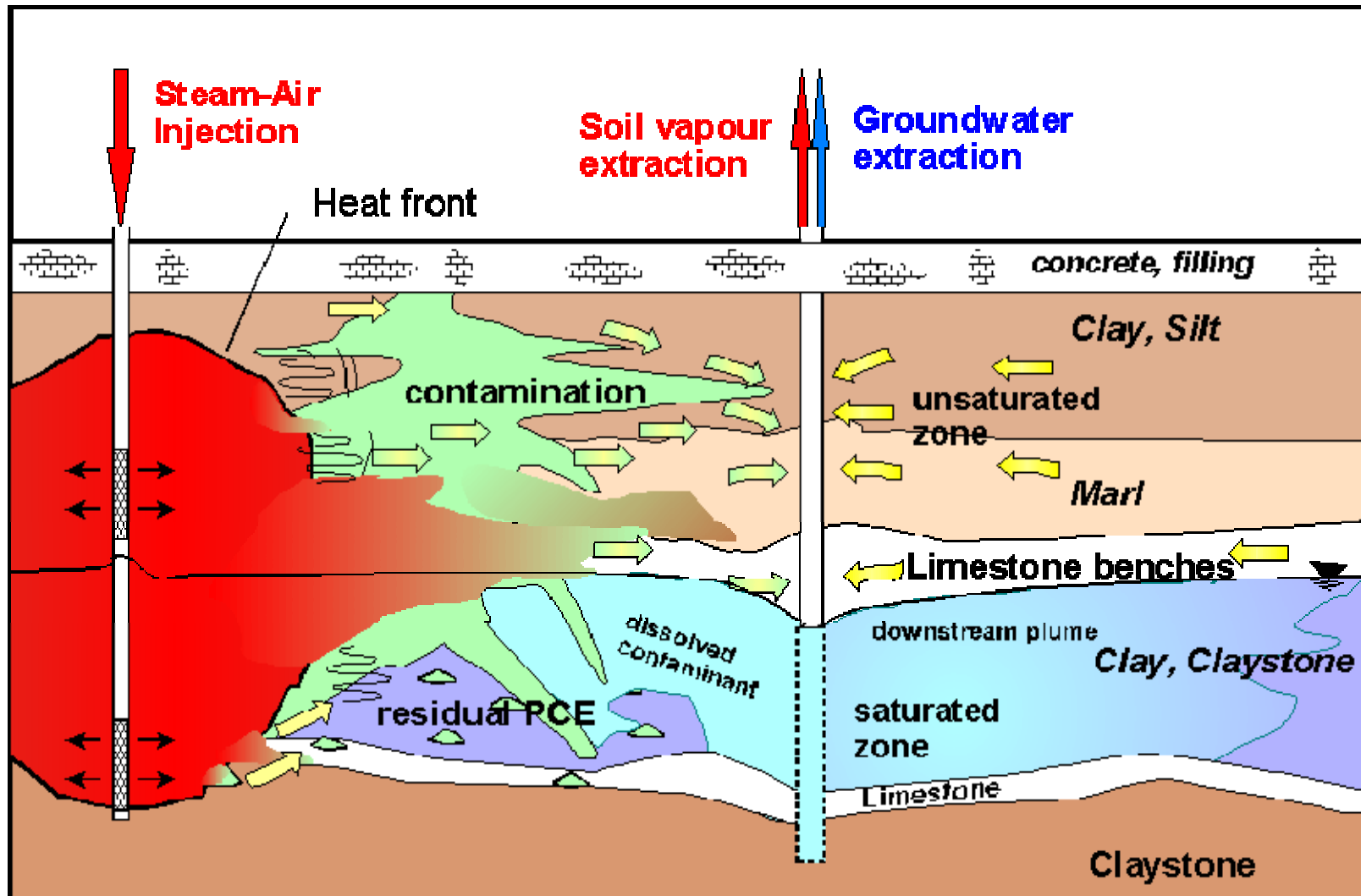
June 9th, 2004, *VEGAS*, University of Stuttgart



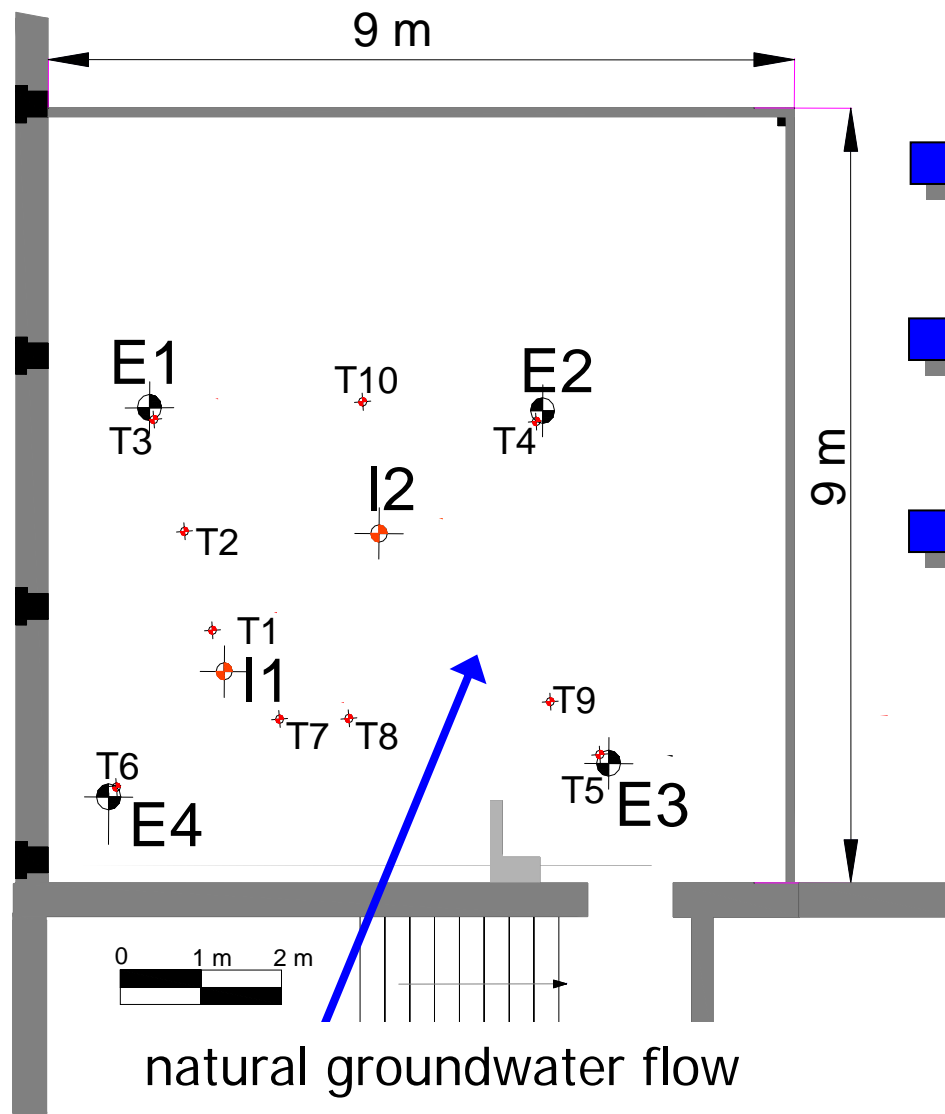
Field Site "Albstadt" - Situation

- former metal washing basin (PCE)
 - contamination source: ~ 50 m² and 6 m depth
 - history:
 - pump-and-treat (1994-1998)
 - soil vapor extraction (1995-1998)
 - in-well stripping (1999-2001)
 - groundwater concentration exceeded 5000 x threshold value according to BBodSchG
- ➔ steam-air injection during production**

Geology and Remediation Concept



Plan View Steam-Air Injection



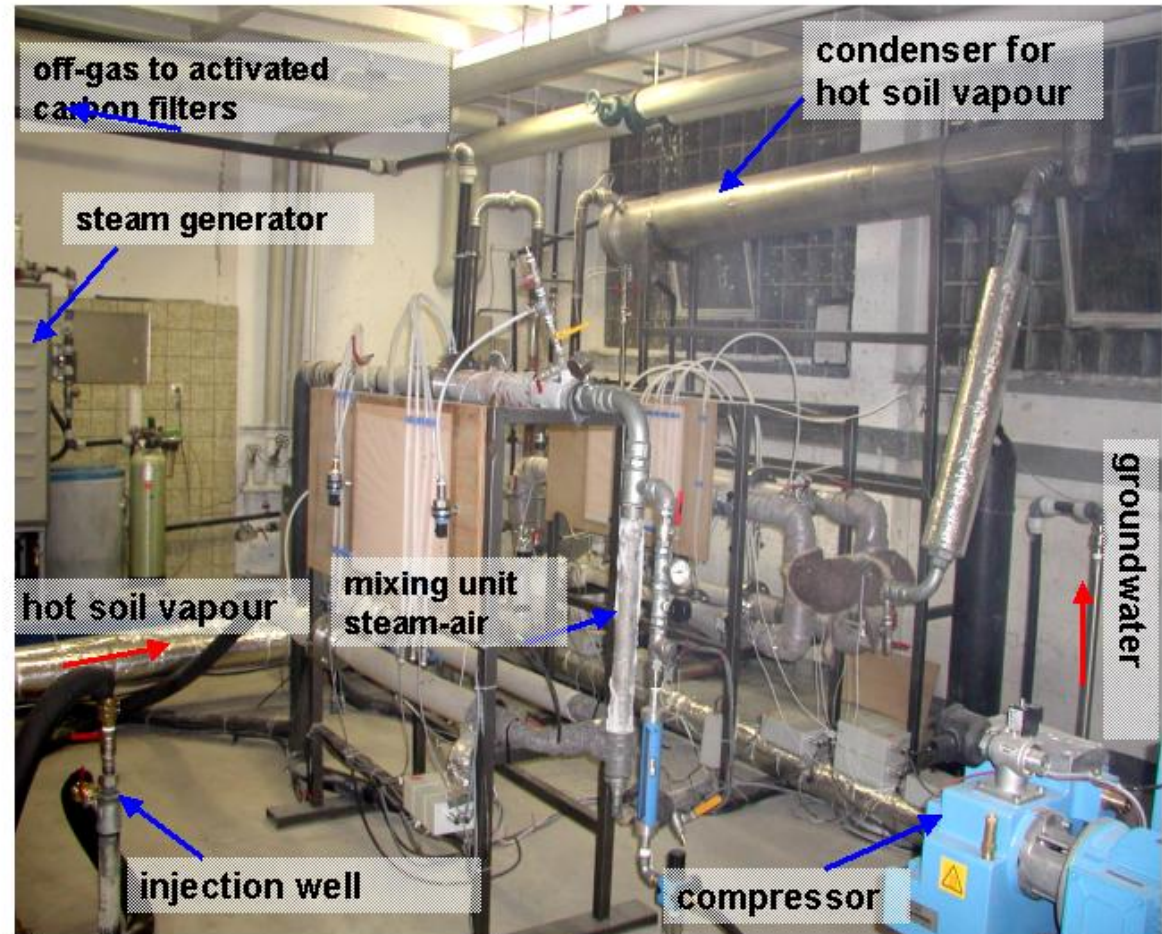
- 2 wells for steam-air injection
- 4 extraction wells (soil vapor + groundwater)
- 10 thermocouple bundles in wells

Remediation Unit

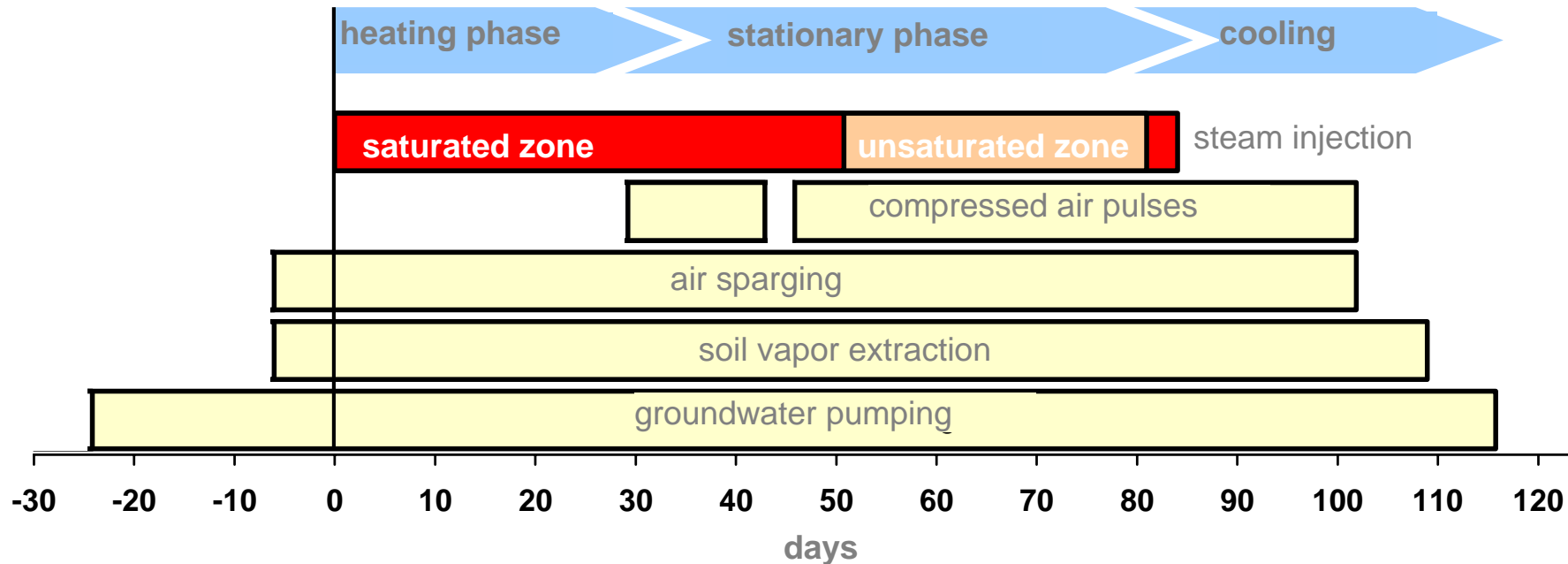
view of the remediation unit in the basement of the factory building



drilling of the injection and extraction wells and thermocouple wells

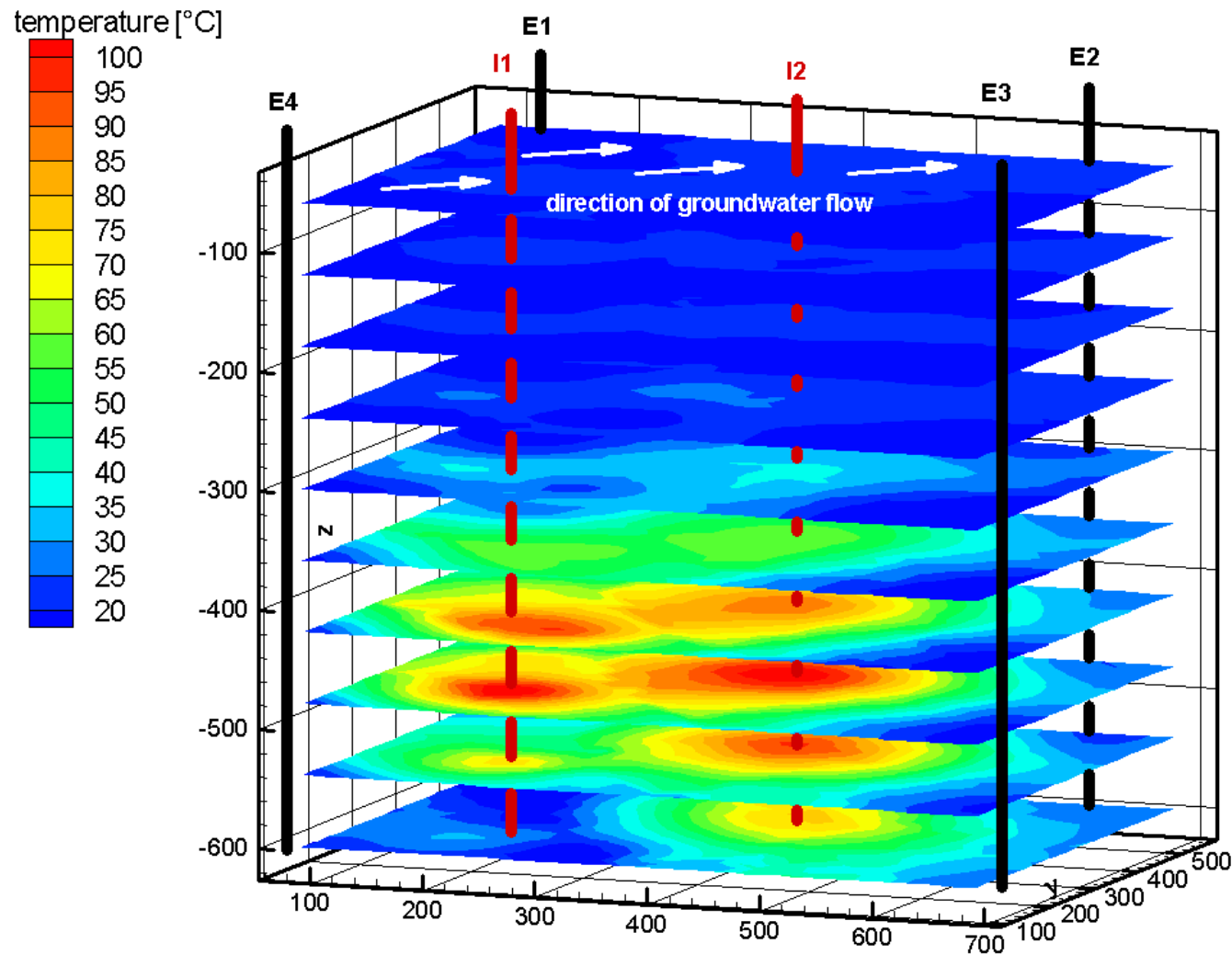


Remediation Process



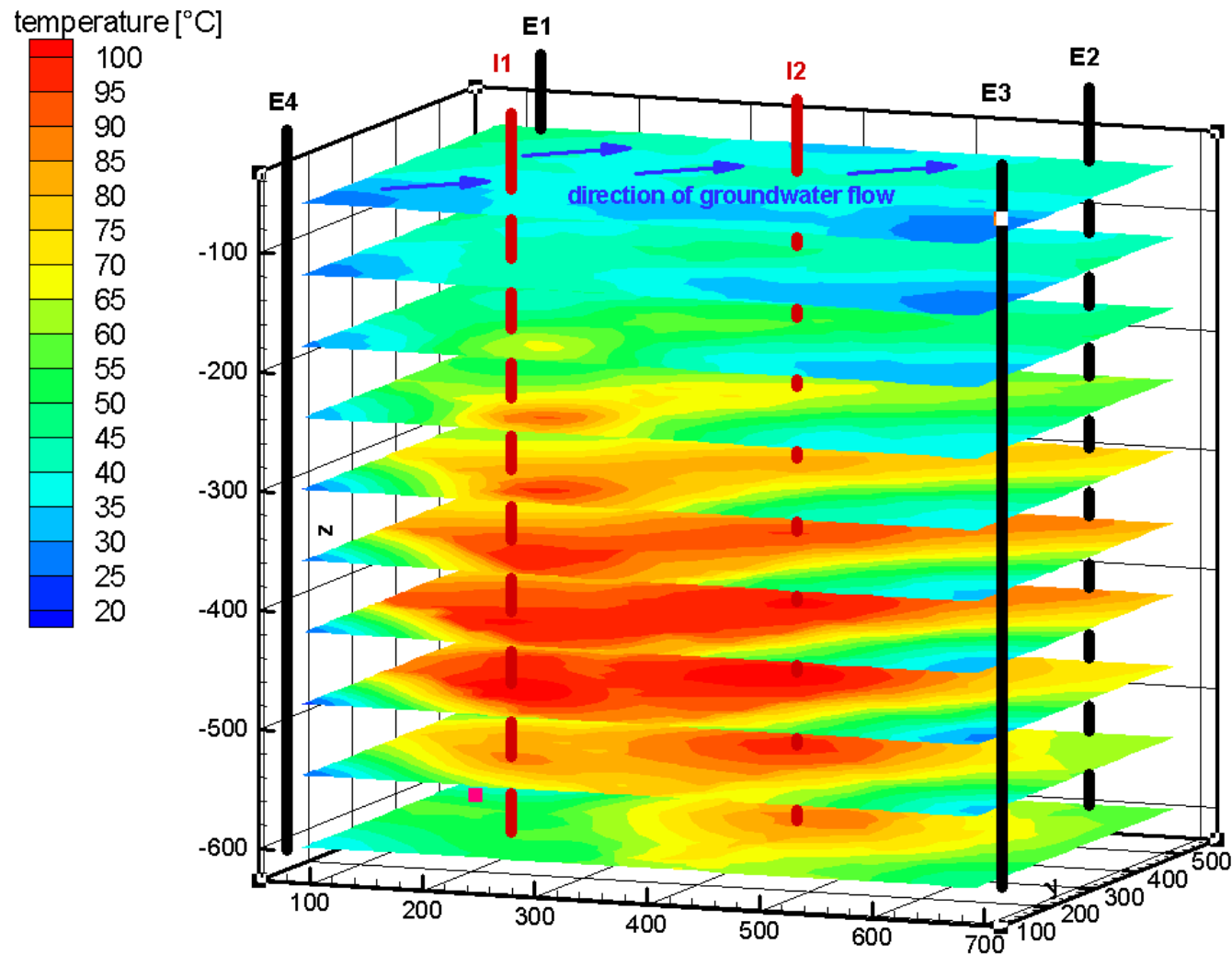
- continuous measurement of the contaminant concentration in extracted soil vapour
- adjustment of the operational mode according to the progress of the remediation

Temperature Distribution



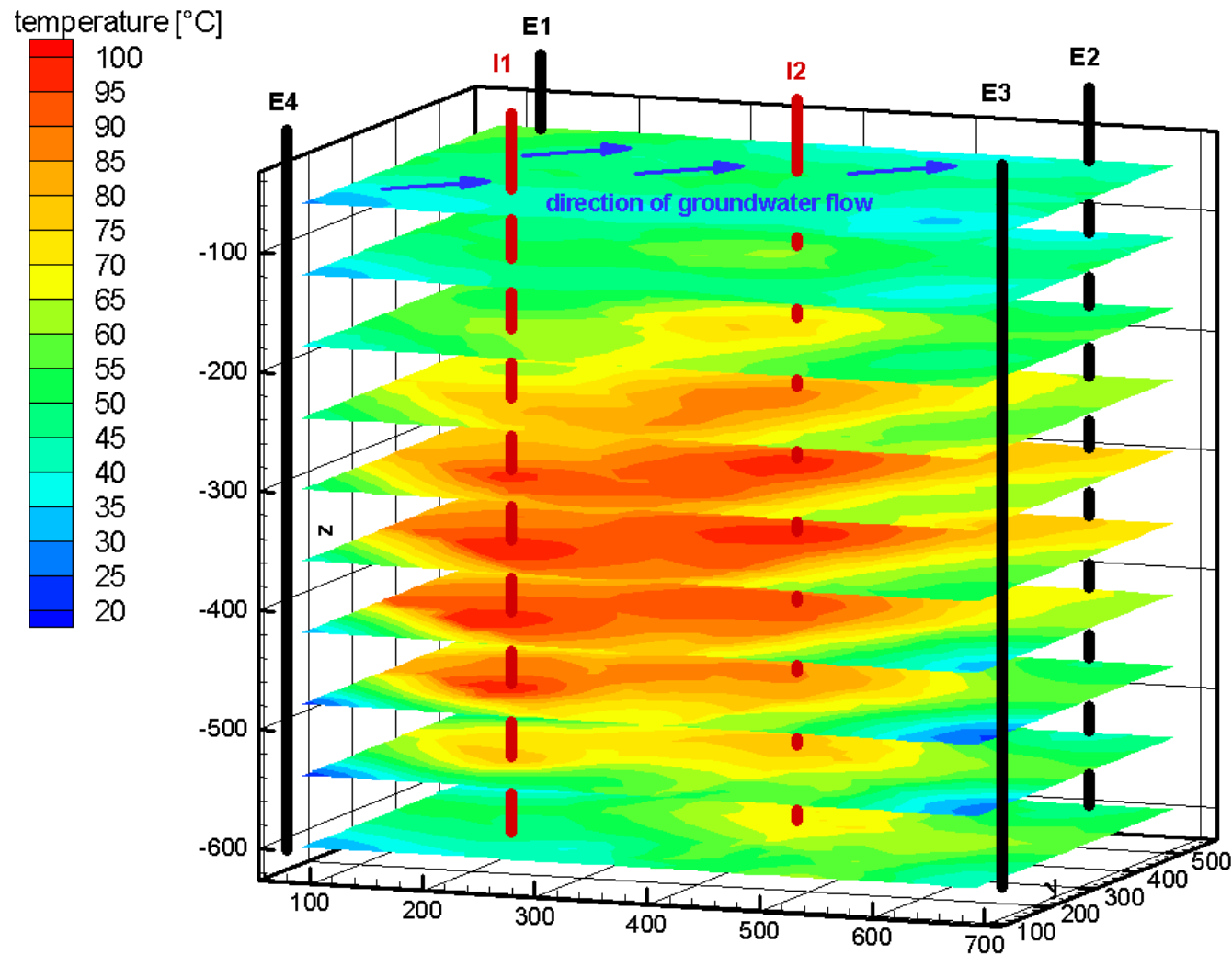
5 days after the start of the steam injection

Temperature Distribution



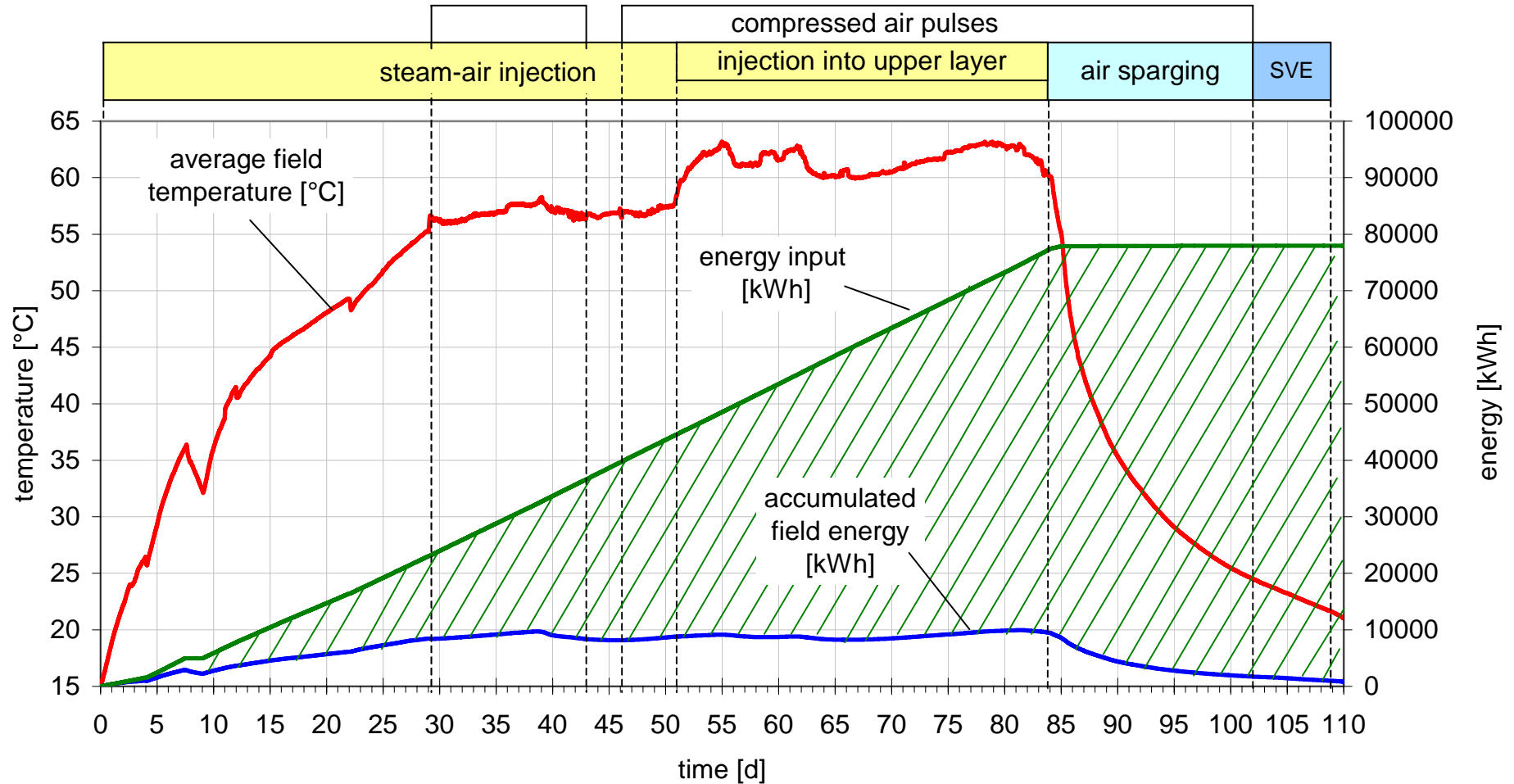
40 days after the start of the steam injection

Temperature Distribution



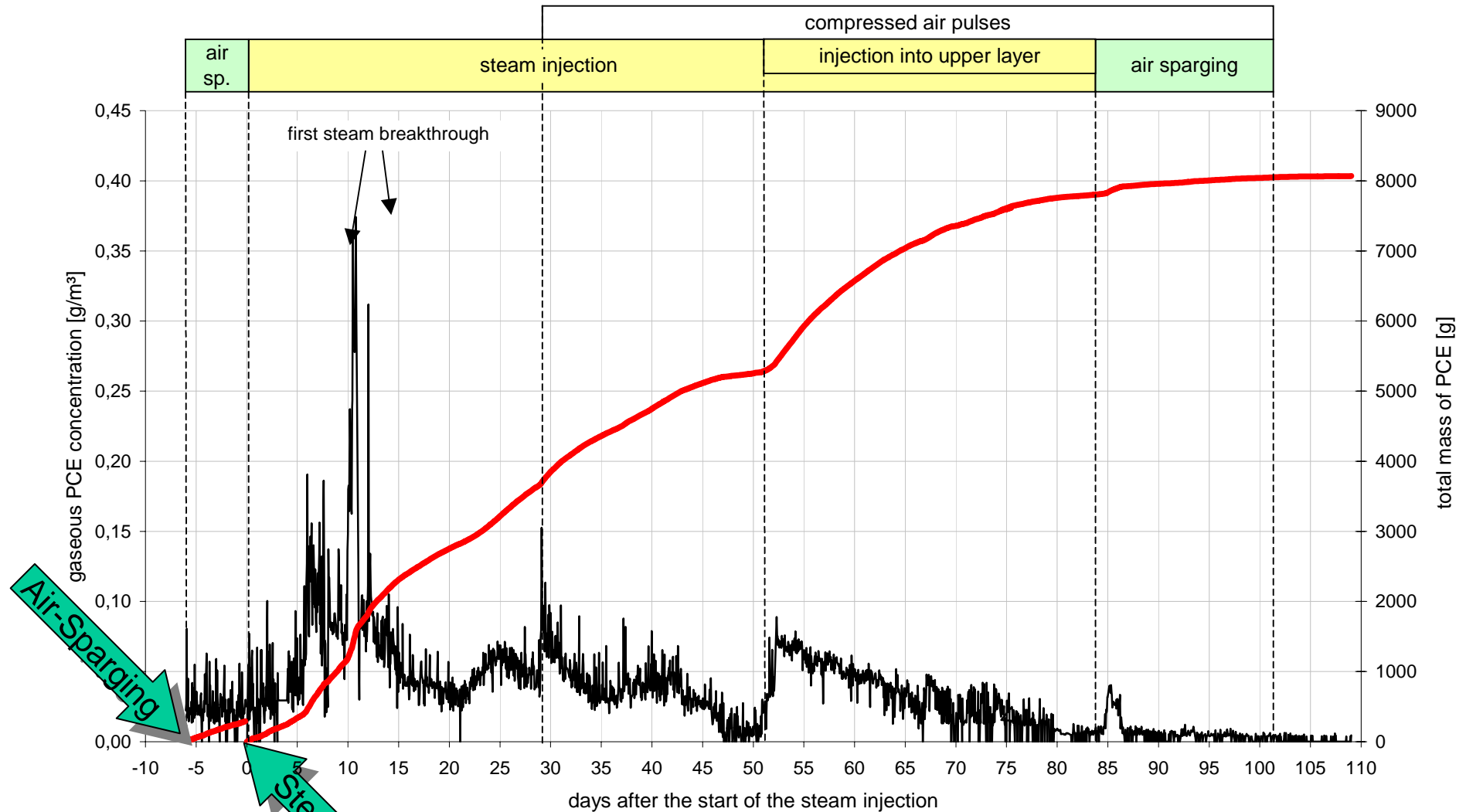
65 days after the start of the steam injection

Energy

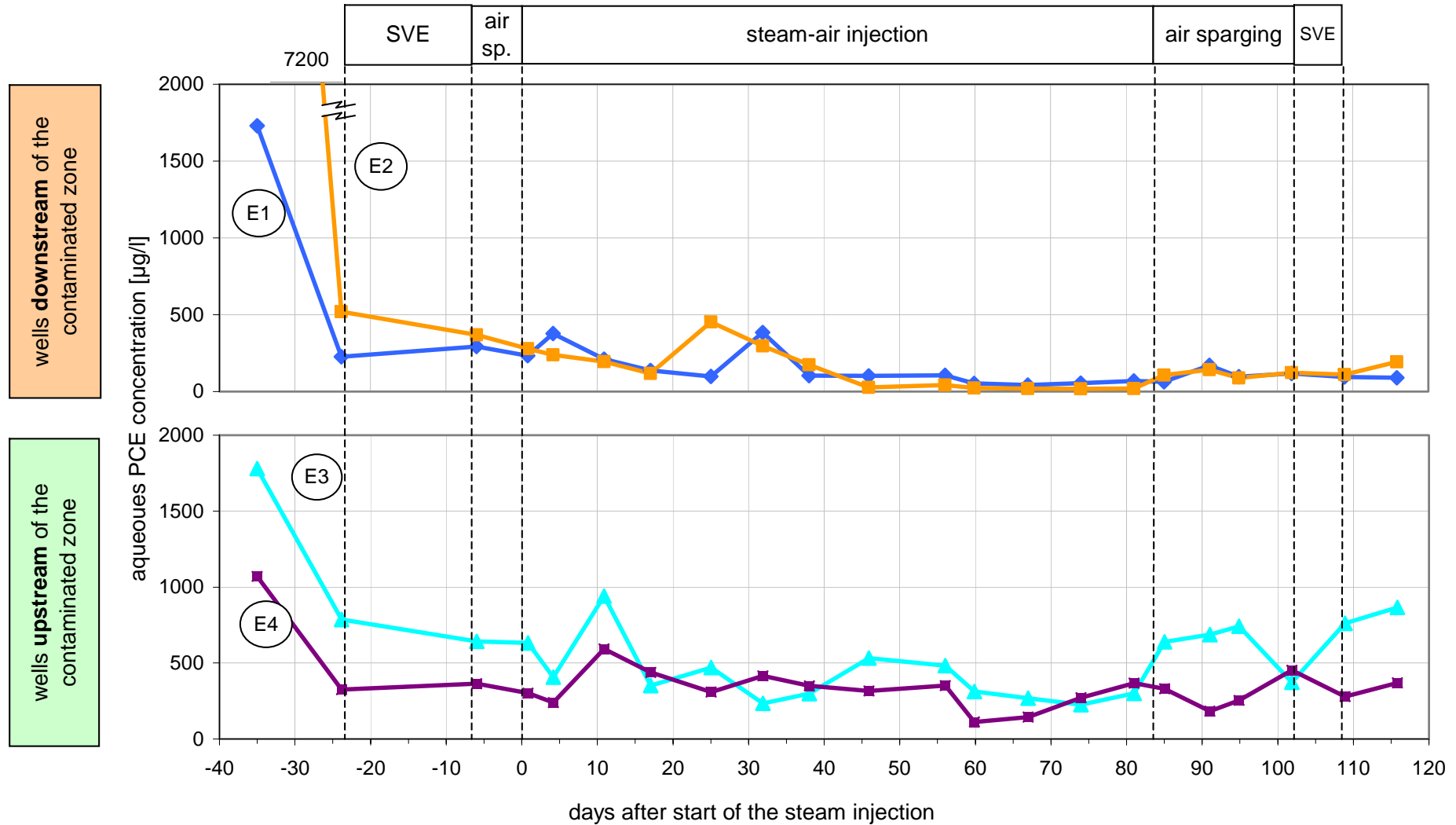


■ **75% of the energy losses by groundwater extraction**

PCE Removal by SVE



PCE Concentration in Groundwater Wells



Cost Comparison

- **conventional remediation: 600 000 € in 7 years**
- **steam-air injection: 150 000 € in 8 months**
 - 11 000 € for electrical energy**
 - 40 000 € for drilling works and field preparation**
 - 20 000 € for engineering**
- **costs per cubic meter:**
 - **steam-air injection: 600 €**
 - **conventional remediation: 2400 €**

Summary

- remediation successfully finished after 2 ½ months:
11.4 kg PCE removed, 8.4 kg by SVE
- soil samples dating 2000: 11 kg PCE
soil samples before remediation: 0.5 kg PCE
- 95% reduction of downstream concentration, daily
emissions < 5% of threshold value
- a second PCE source zone located upstream: inflowing
groundwater is contaminated with PCE
- total costs ~ 25% of former applied standard
remediation methods

**Thank you for your patience
and your attention**

Any questions ??

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