# Addressing the restoration of degraded land in Europe using waste materials: A brownfield site in Wales

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CEMEPE conference, Skiathos, June 2007.

# TWIRLS: Treating Wastes for Restoring Land Sustainability

*LIFE* -Environment funded project

Aim: demonstrate effective re-use of industry and municipal wastes to produce soil-forming materials for remediating degraded land.

Slate Alfred McAlpine Blaenau Ffestiniog Quarry, N. Wales

UPM Kymmene UK, former Shotton Steelworks, N.Wales

Welsh Assembly Government, colliery spoil and restored sites

NAGREF, SSIA; TITAN Cement Co. S.A., schist quarry, Greece.

# The TWIRLS partnership

- Recycle organic and mineral wastes;
- Add value to wastes by composting;
- Produce ‘soils’ fit-for-use and safe;
- Restore degraded land to economic, social or conservation end-uses;
- Feed directly into Policy.

# Why Recycle Organic Wastes?

## Waste Minimisation

Europe produces around 2000 million tonnes of waste per year, growing by around 10% per year.

## Soil Protection

More than 16% of the EU's total land area is considered degraded in one or more of soil vital functions e.g. fertility, erosion control, water infiltration, microbial biodiversity and carbon sequestration. EU Thematic Strategy.

# Location of brownfield site


# Remediating soil contaminated with organic pollutants: Site history

- Former steelworks, developed during the 1950's and decommissioned in the 1980's; 30 ha
- Soil and groundwater contaminated with PAHs, VOCs, cyanide, phenols; ammonia in groundwater;
- Intervention: site capped with 4 m of estuarine sand (but variable) in 1990's;
- TWIRLS study: identified surface (bio)piles of moderately contaminated soil (max. 1 g PAH16 $kg^{-1}$) and zones of moderate BTEX (max. 0.25 mg $kg^{-1}$).

# Site history contd.

Sand capping to block source-receptor pathway.

Biopile soil moderate PAH and BTEX contaminants.

# Site history contd.


**Problem**

- low organic matter
- low water-holding capacity
- contaminated (PAHs & VOCs)


**Action**

- add organic matter as composted wastes
- co-compost soil to remove contaminants
- seed with biodiverse grassland mix

# Co-composting contaminated soil: field expt.

Contaminated soil only, composted.

Contaminated soil, green waste + biosolids composted.

Contaminated soil, biosolids + paper fibre composted.

Contaminated soil, green waste+biosolids+paper fibre composted.

In-vessel composting with 80 d aeration, then 120 d maturation

Spread directly back on contaminated land.

Samples analysed prior to composting, at end of maturation and after landspreading (then after 9 mo and 16 mo, so far).

# In-Vessel Composting: EcoPOD® system

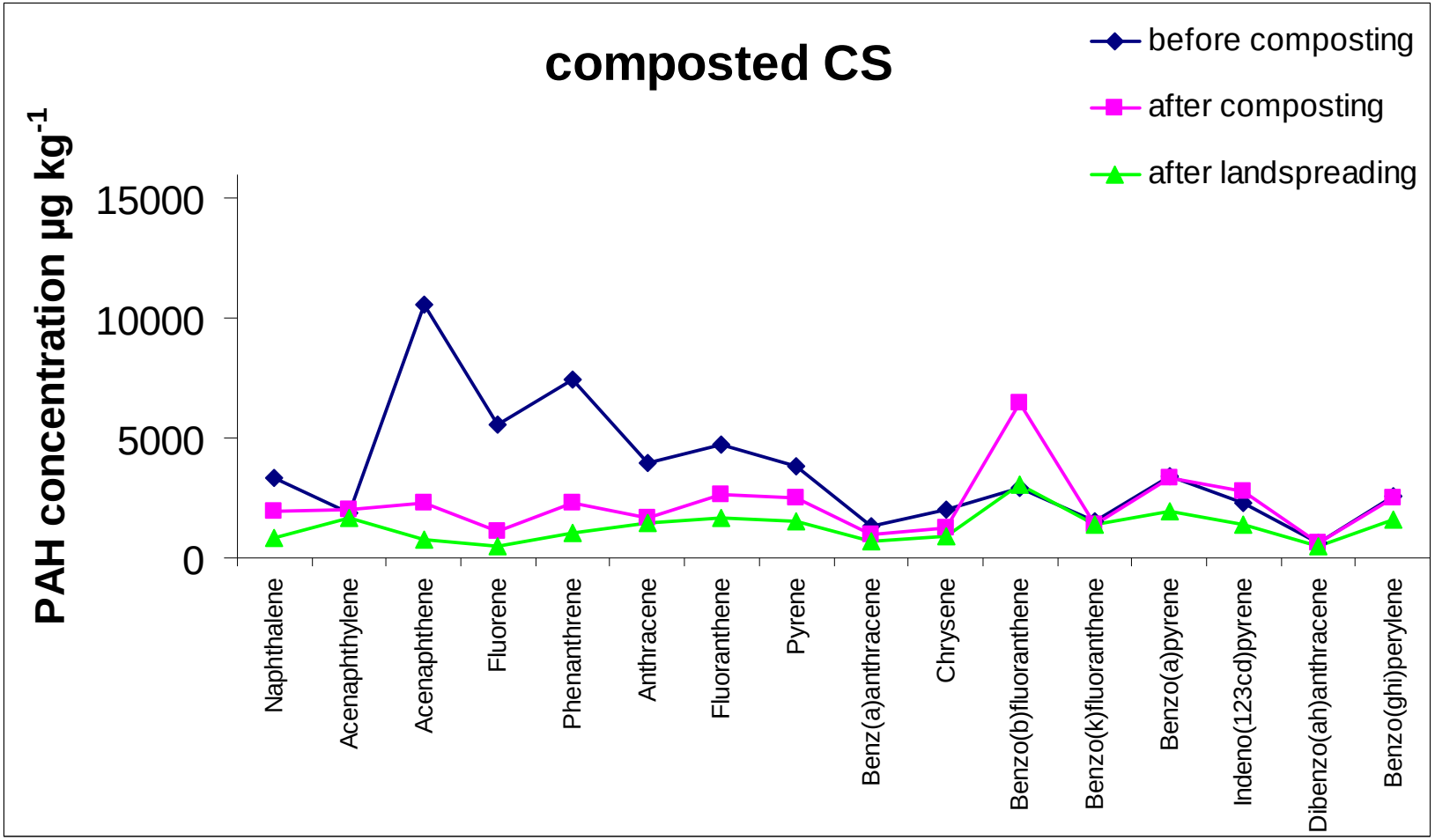

Mixing feedstocks

Filling pods

Aeration ducting

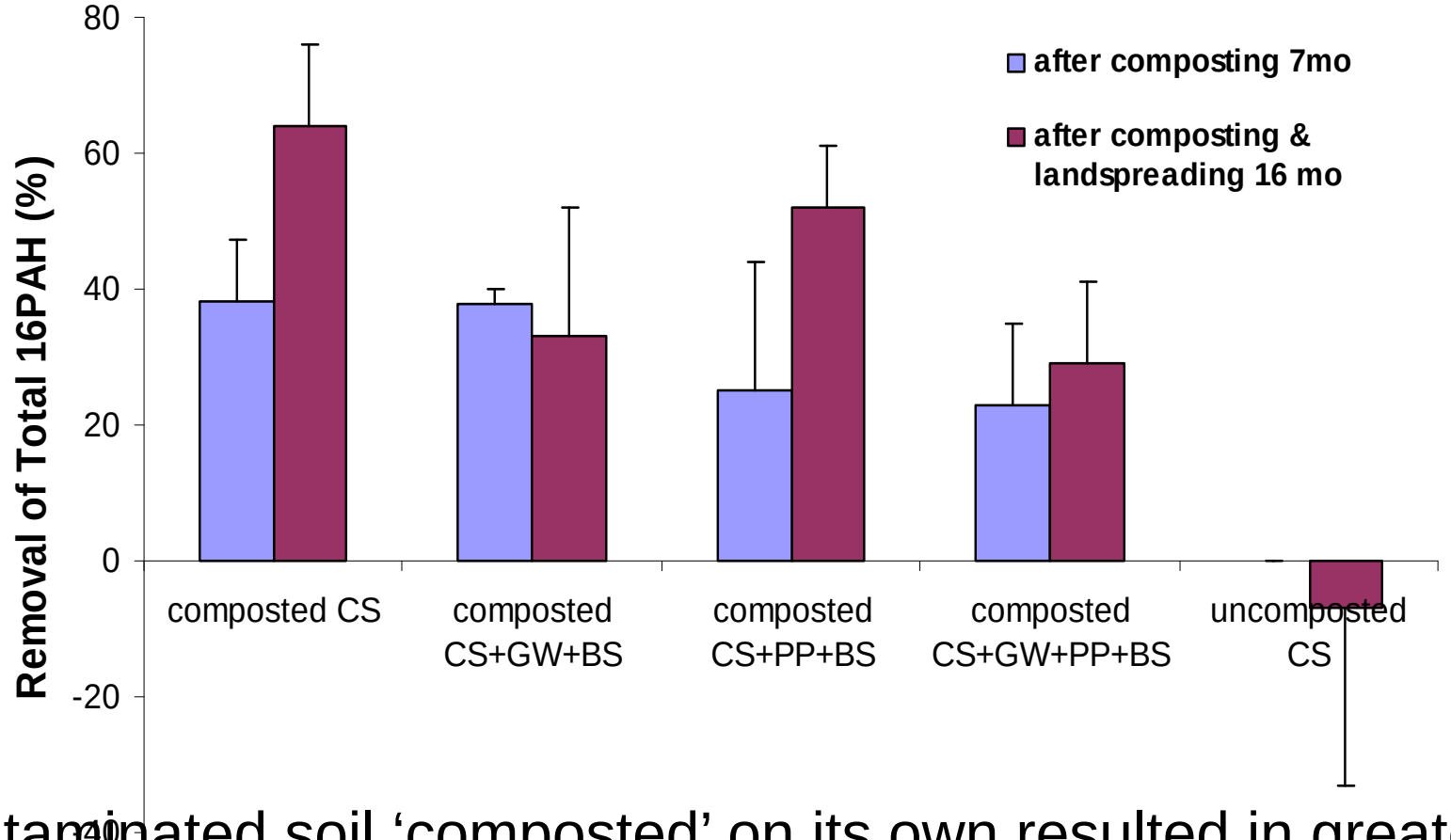
Temperature probes for process control

# Concentrations of 16 PAH species after composting and landspreading contaminated soil.




Low molecular weight PAHs (2 – 3 rings) were reduced the most during composting.

# Percentage PAH (USEPA 16) removal after composting and landspreading contaminated soil. Values represent means ± SEM (*n* = 6).

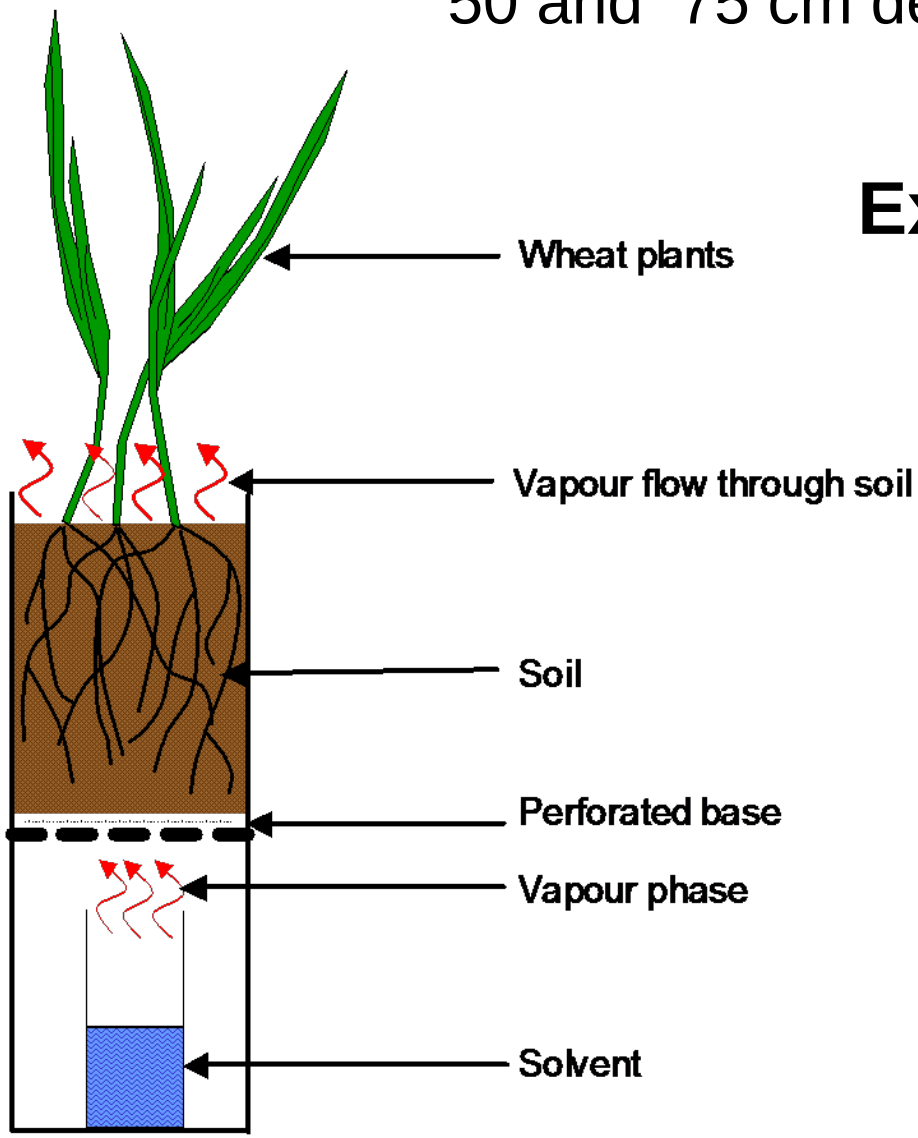



Contaminated soil ‘composted’ on its own resulted in greatest dissipation of PAHs during composting and landspreading.

# ‘Polishing’ by Phytoremediation

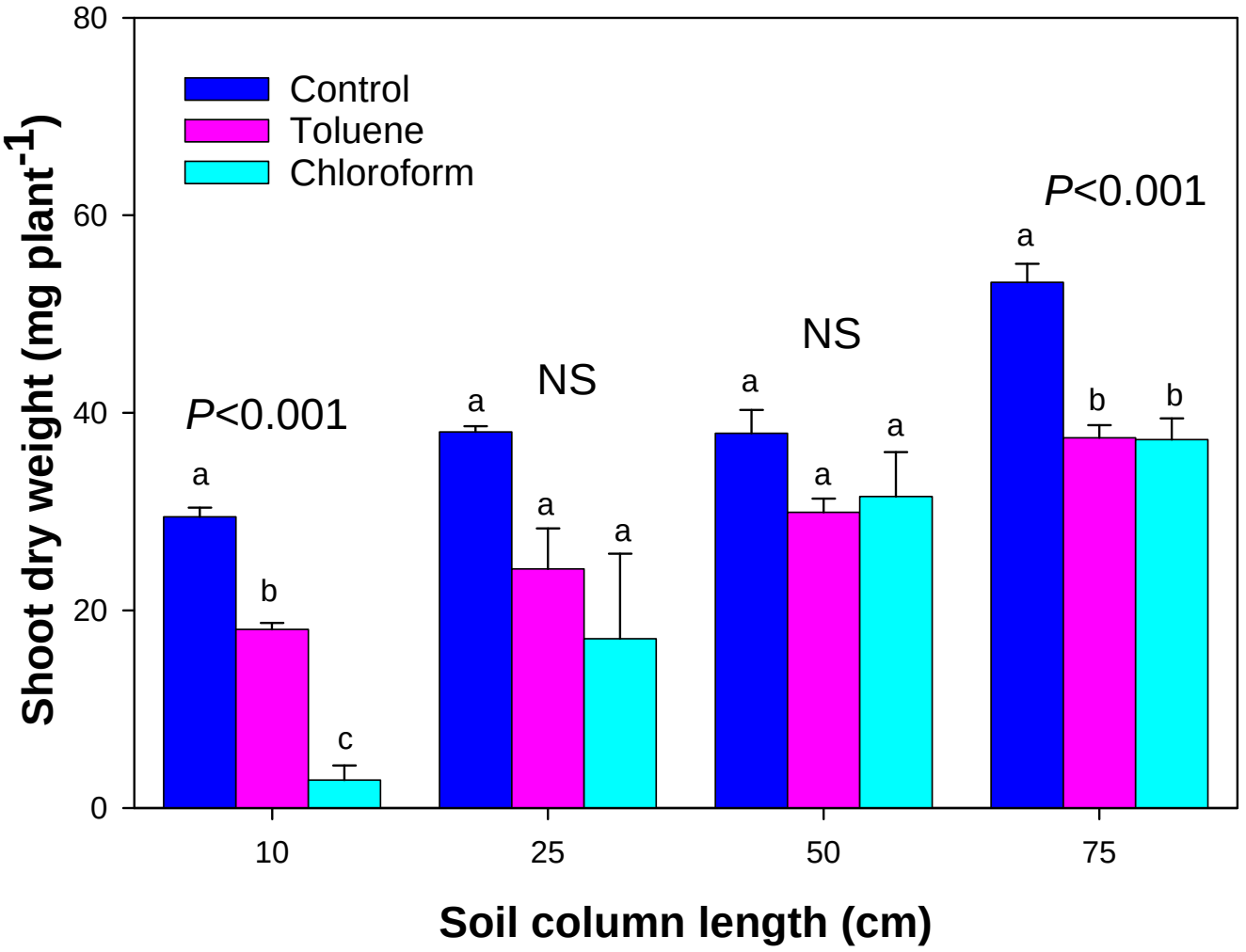
Experiments to test whether *Populus nigra* and mesotrophic grassland can further polish co-composted soil after landspreading.

# Effects of upward movement of selected VOCs through soil on shoot growth and microbial activity in soil cores 10, 25, 50 and 75 cm deep.

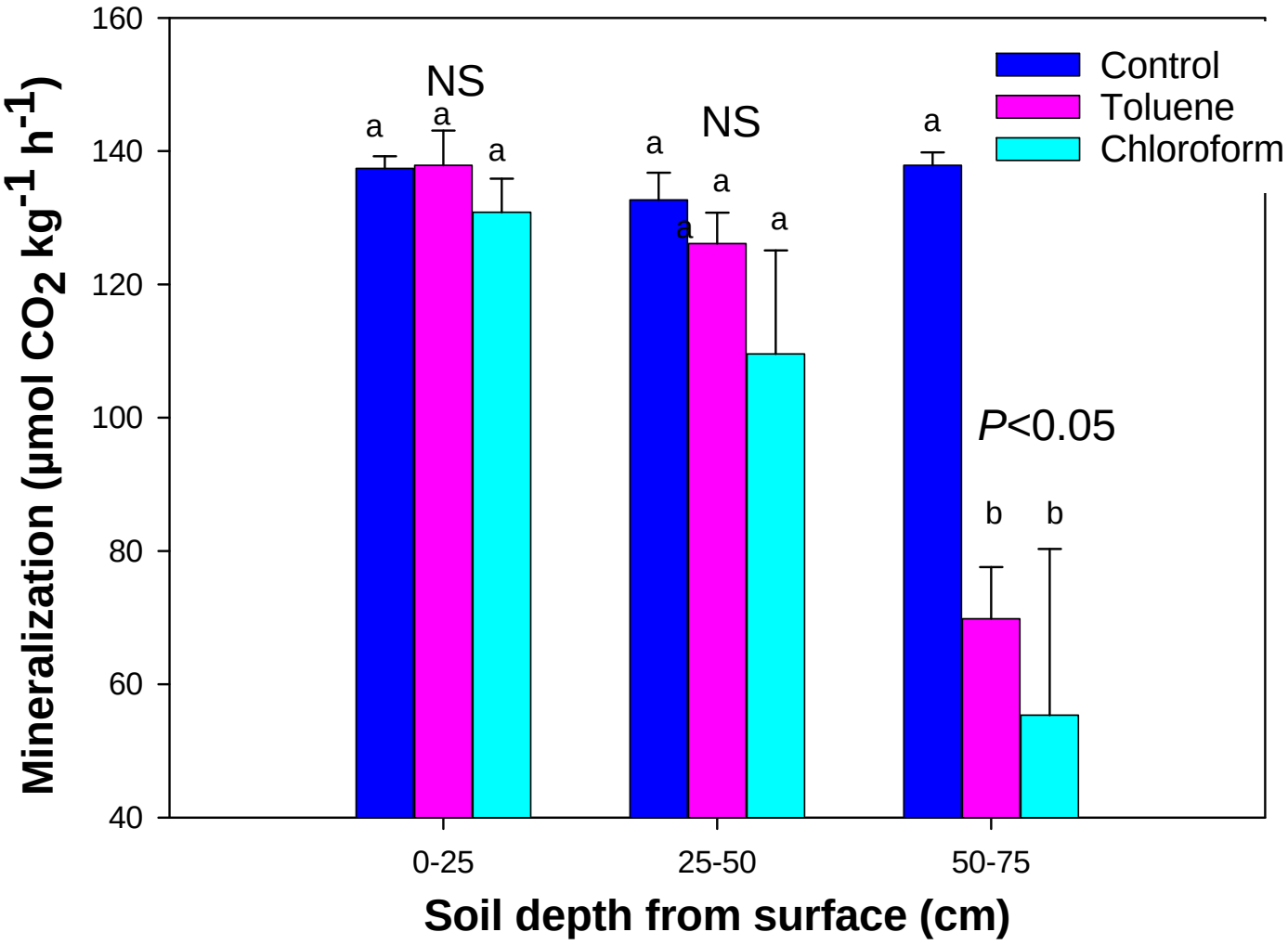



## Experimental set-up

Expt. 1. Effect of vapour phase solvent flow through soil on plant shoot mass in soil columns of differing depths. Mean values ± SEM (*n* = 3).



Expt. 2. Effect of vapour phase solvent flow through soil on microbial activity in the top, middle and bottom 25 cm-sections of 75 cm soil columns. Mean values ± SEM (*n* = 3).



# Conclusions

- Covering land polluted with volatile organic compounds may not be sufficient to block the source-receptor pathway;
- Vertical migration of vapour phase solvents through the soil profile is harmful to soil microbial and plant biomass;
- Composting and landspreading processes both resulted in dissipation of aged PAHs in soil;
- Co-composting contaminated soil with organic material may initially occlude PAHs from dissipation;
- Microbial mineralization studies will evaluate whether organic material facilitates PAH biodegradation in the medium-term.