University of Strathclyde Glasgow

Restoring Water Resources Through Soil Remediation: A Case Study on Smouldering Remediation

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THE AWARDS
UK Entrepreneurial University of the Year 2013/14
UK University of the Year 2012/13

GRPE
GLASGOW RESEARCH PARTNERSHIP IN ENGINEERING

Athena SWAN Silver Award

Mara Knapp, Andrew Robson, Rossane DeLapp, and David Kosson

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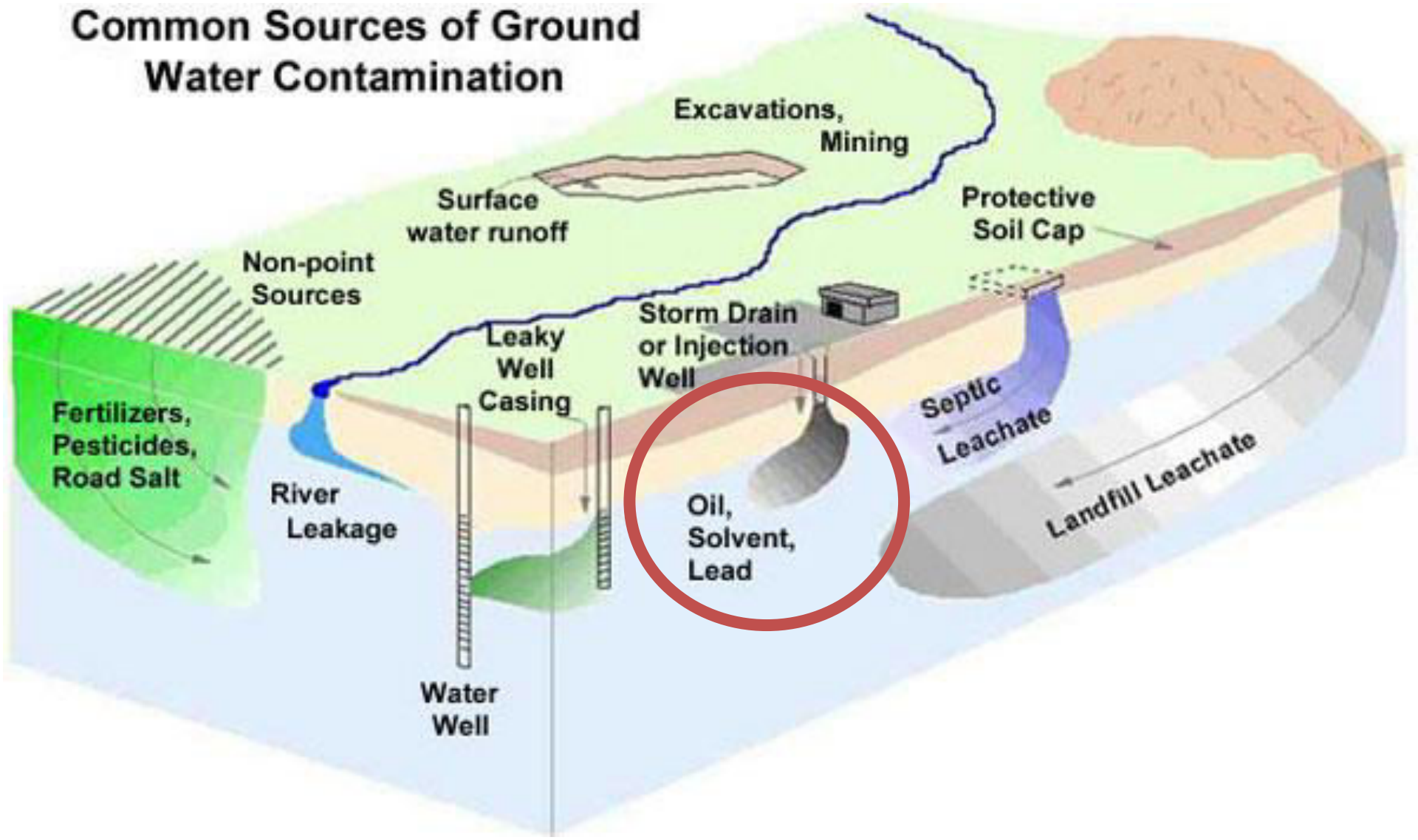
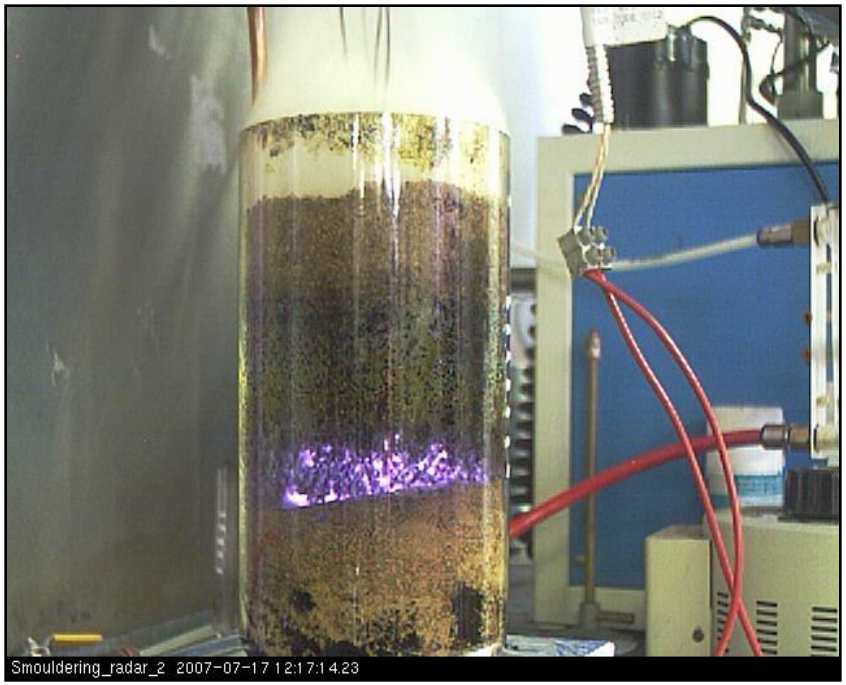
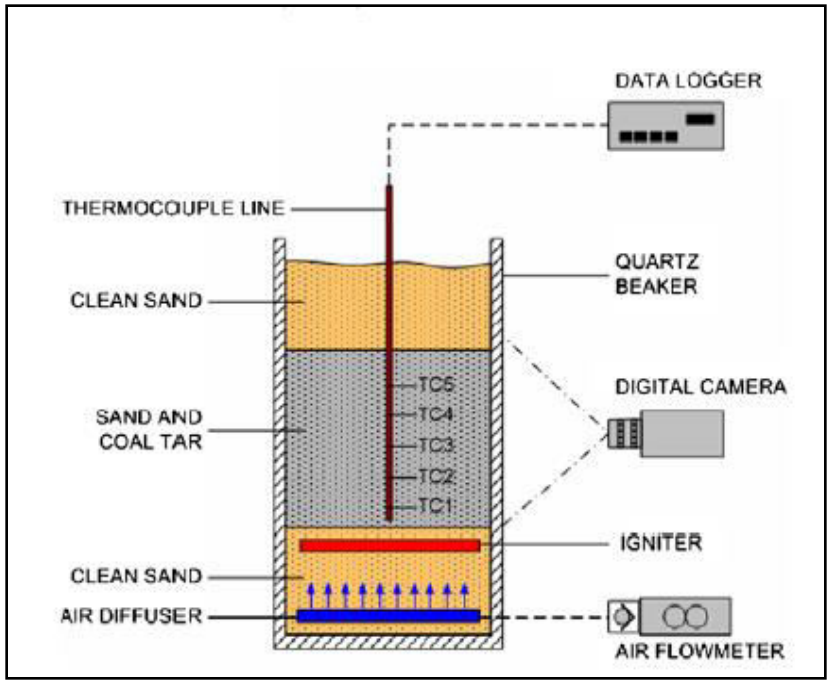


http://imnh.isu.edu/digitalatlas/hydr/concepts/gwater/aquifer.htm

Smouldering Experiments





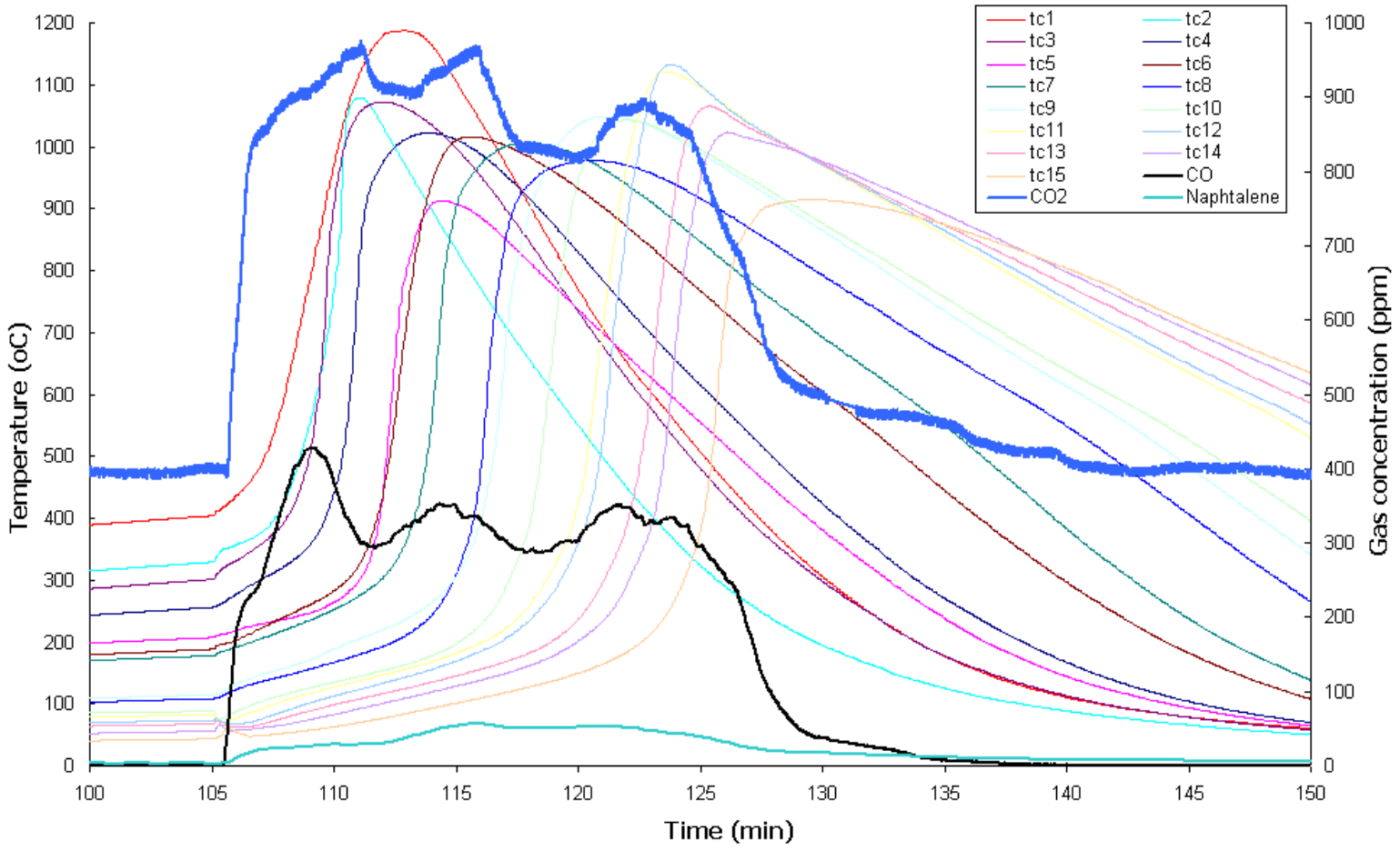
Switzer et al., 2014. Journal of Hazardous Materials, 268, pp. 51-60.

Pironi et al., 2011. Environmental Science & Technology, 45 (7), *pp. 2987-2993.*

Switzer et al., 2009. Environmental Science & Technology, 43 (15), pp. 5871–5877.

Pironi et al., 2009. Proceedings of the Combustion Institute 32 (2), pp. 1957-1964.

Proof of the STAR Concept



Laboratory Experiments: Chemical Analysis

Coarse Sand

Sand + Fresh Coal Tar

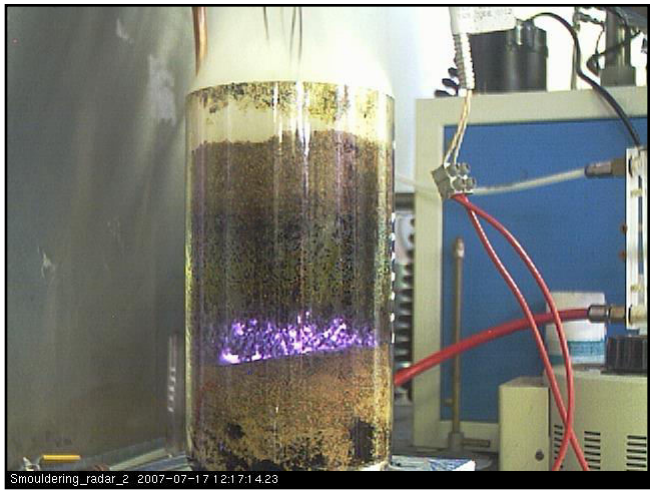
70,000mg/kg

Inside Combustion Zone

<0.1mg/kg

Outside Combustion Zone

up to 1000mg/kg

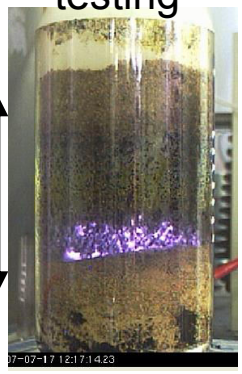


Scaling the STAR Process

Proof of concept

2006

Laboratory testing



2006 - present

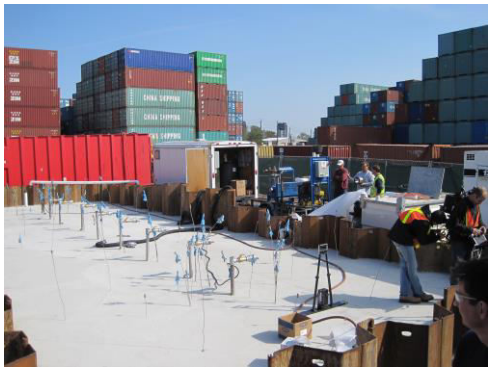
Intermediate testing

2007 - present

Ex situ demonstrations

2008

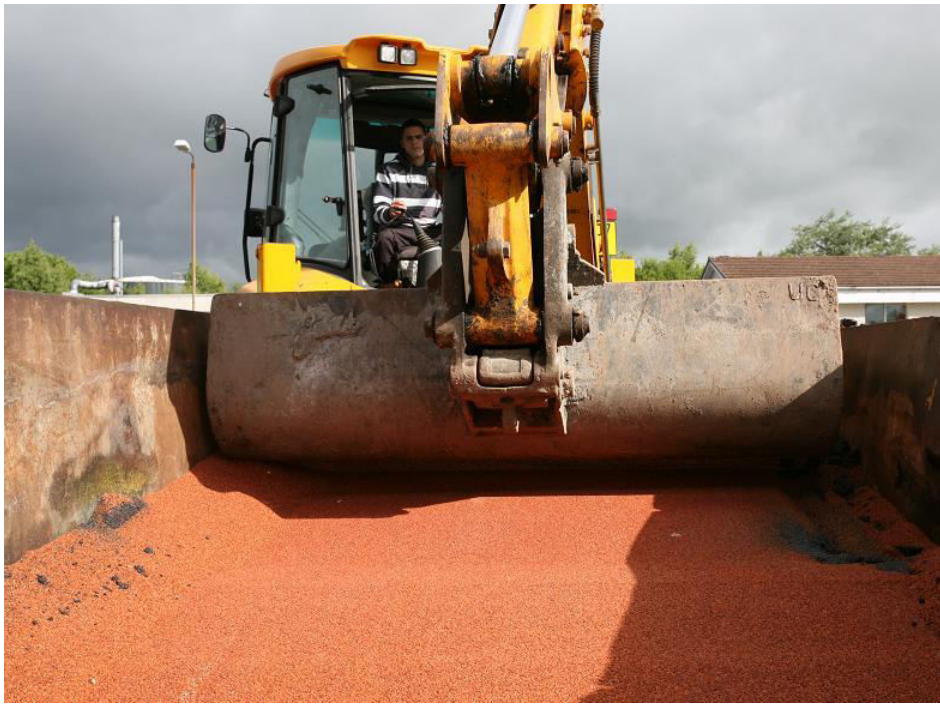
In situ demonstrations



Oct 2009 to present

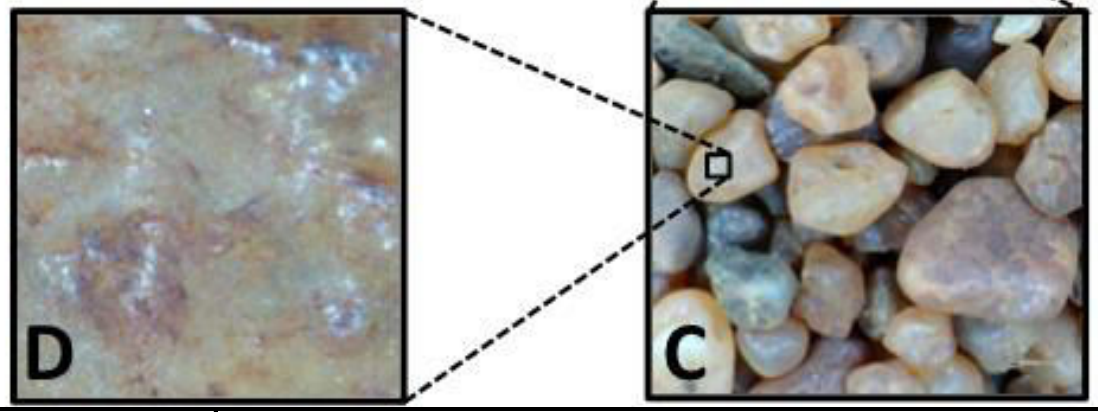
Smouldering Remediation
Ex Situ Demonstration

Conc (TPH) = 31,000 mg/kg ± 14,000 mg/kg



Conc (TPH) = 10 mg/kg ± 4 mg/kg

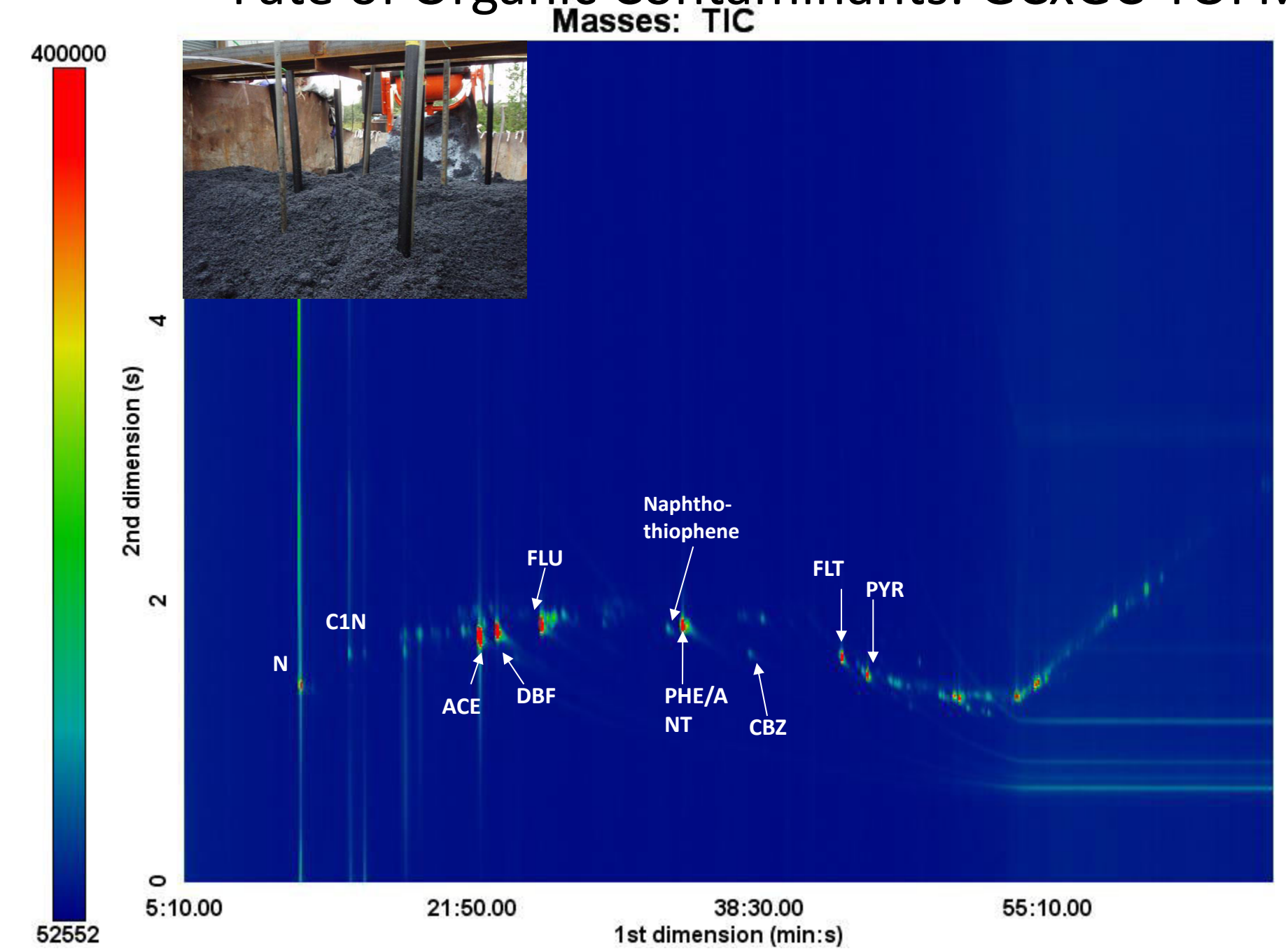
Switzer et al., 2014. Journal of Hazardous Materials, 268, pp. 51-60.



Treatment	Grains	Analysis points	Quartz	Tridymite	Cristobalite	Dumortierite	Geothite	Hematite
untreated	5	9	1	0	0	0	0	0
500°C	3	5	0.60	0	0	0	0.40	0
1000°C	3	9	0.56	0.22	0	0	0	0.22
smouldering remediation	12	37	0.32	0.16	0.08	0.22	0.14	0.05

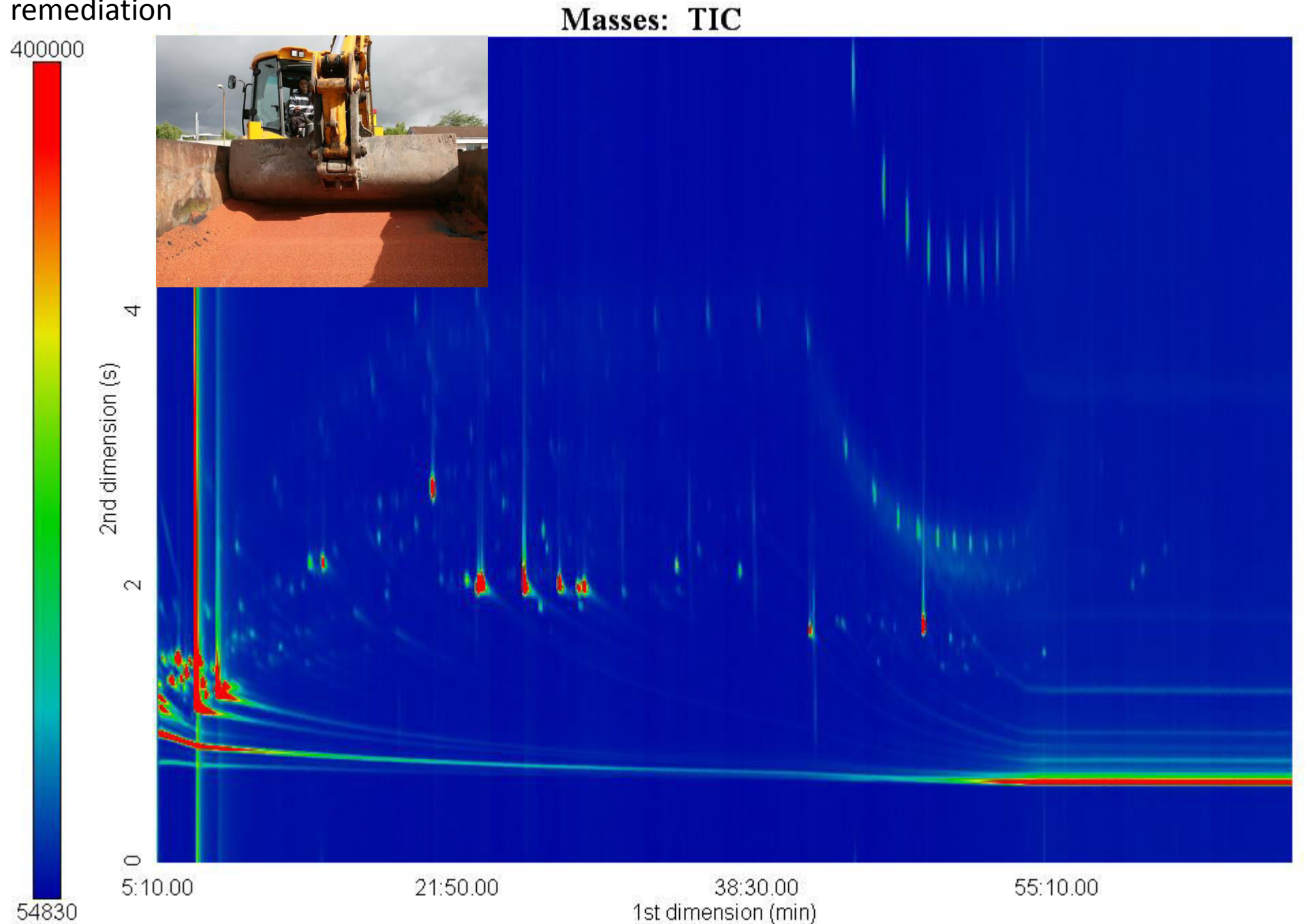
Coal tar

Fate of Organic Contaminants: GCxGC-TOFMS

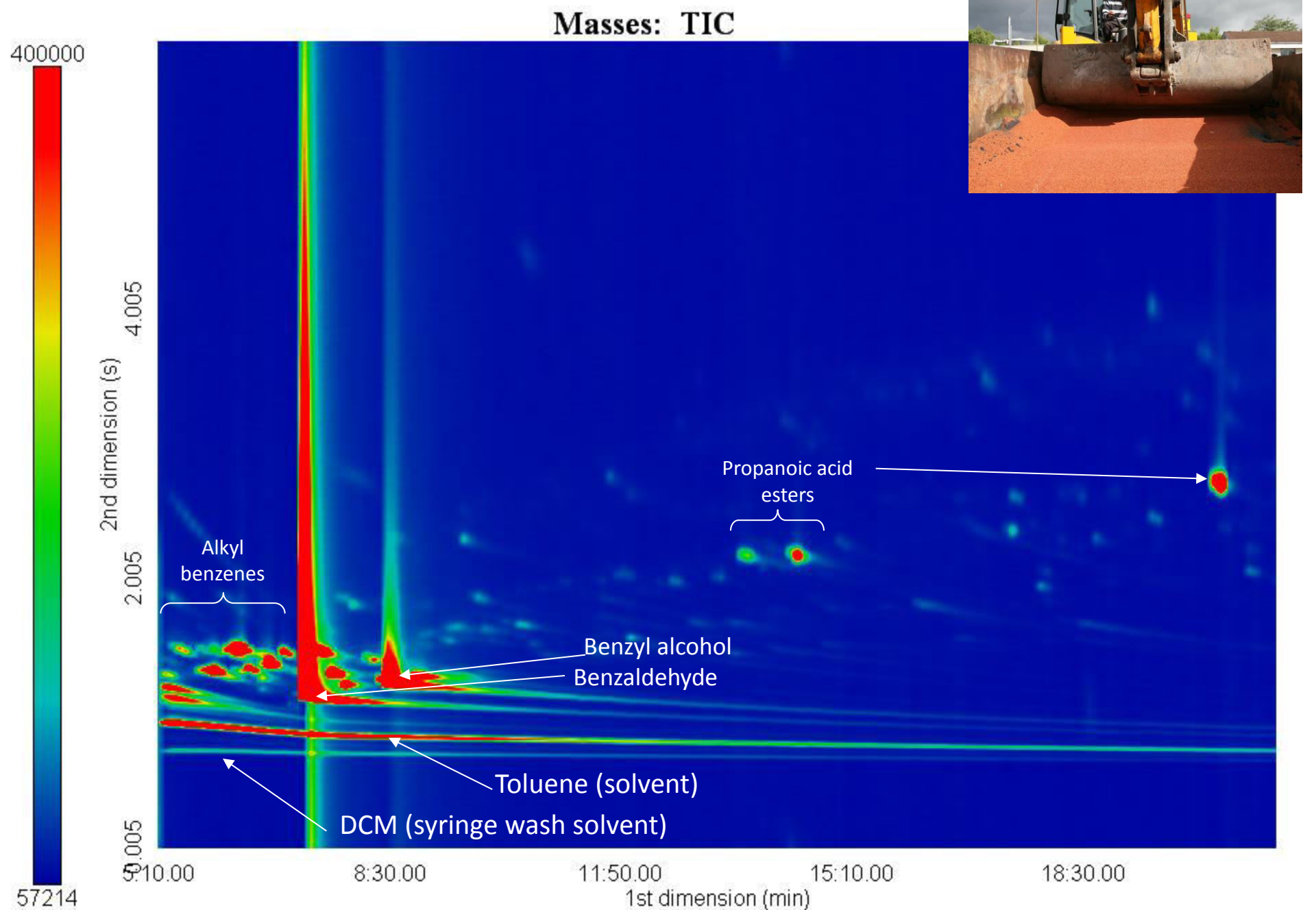


After remediation

Fate of Organic Contaminants: GCxGC-TOFMS

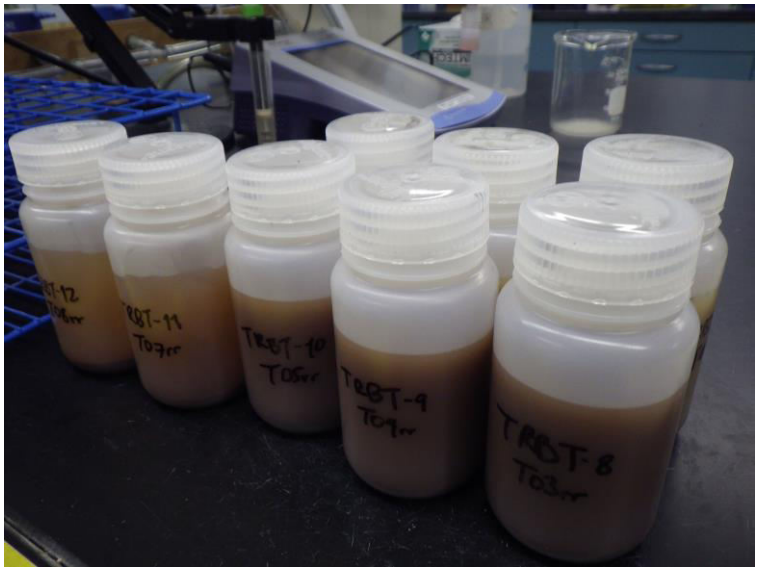


After remediation: front section zoomed

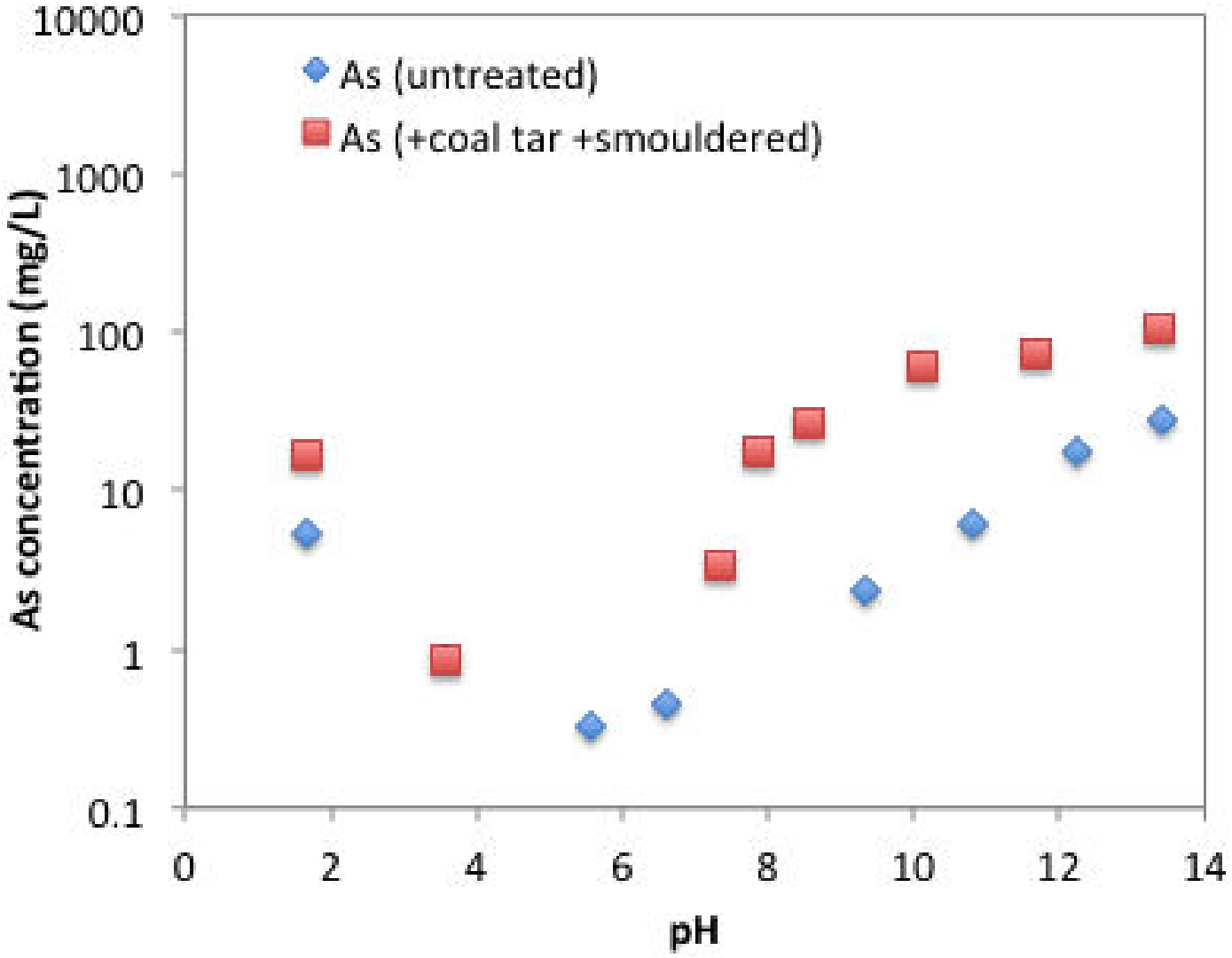


Potentially Toxic Element Availability

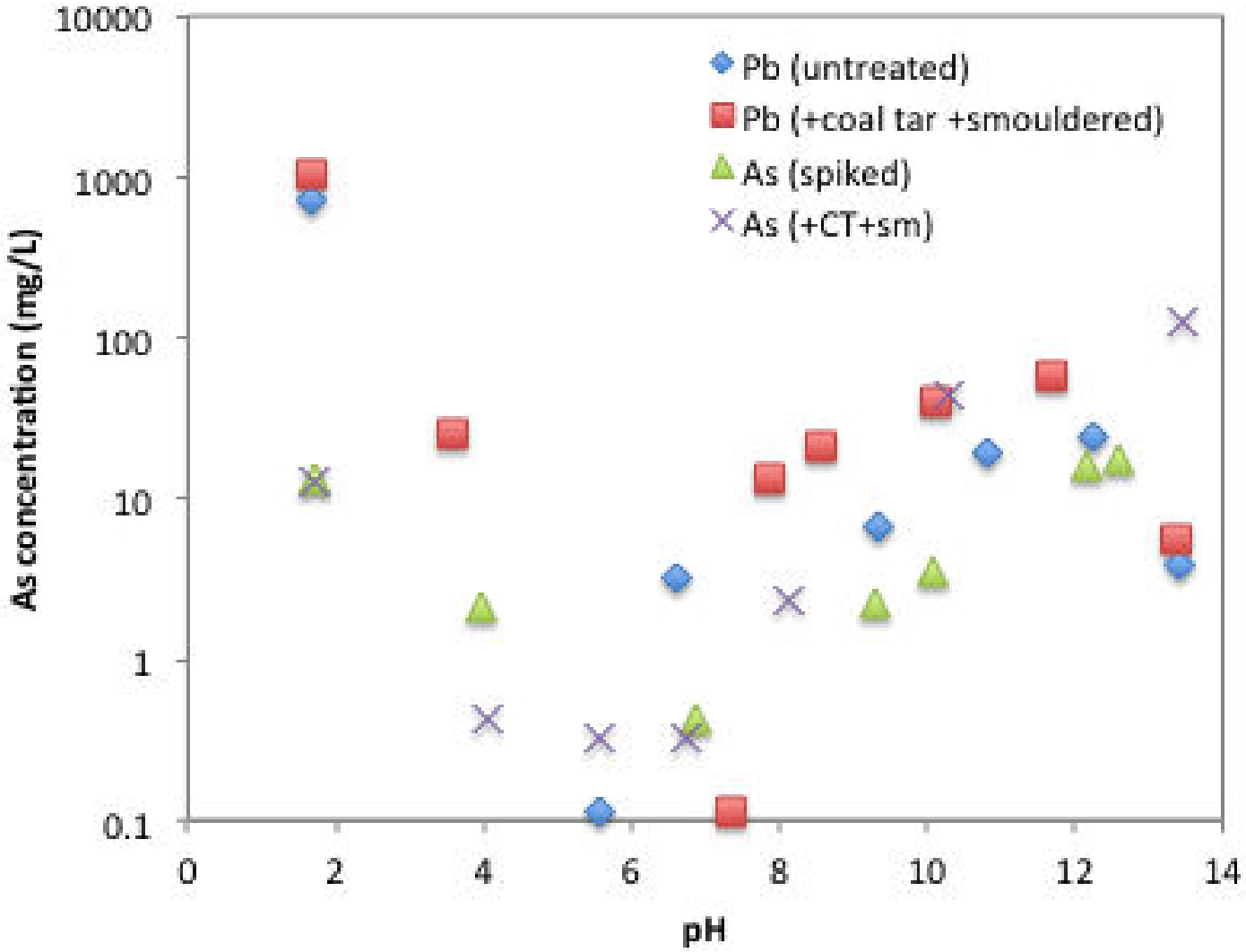
- USEPA M1313: pH dependent leaching
- USEPA M1314: column leaching (L/S ratio⇧)
- 2 soils: field-obtained loam and made ground



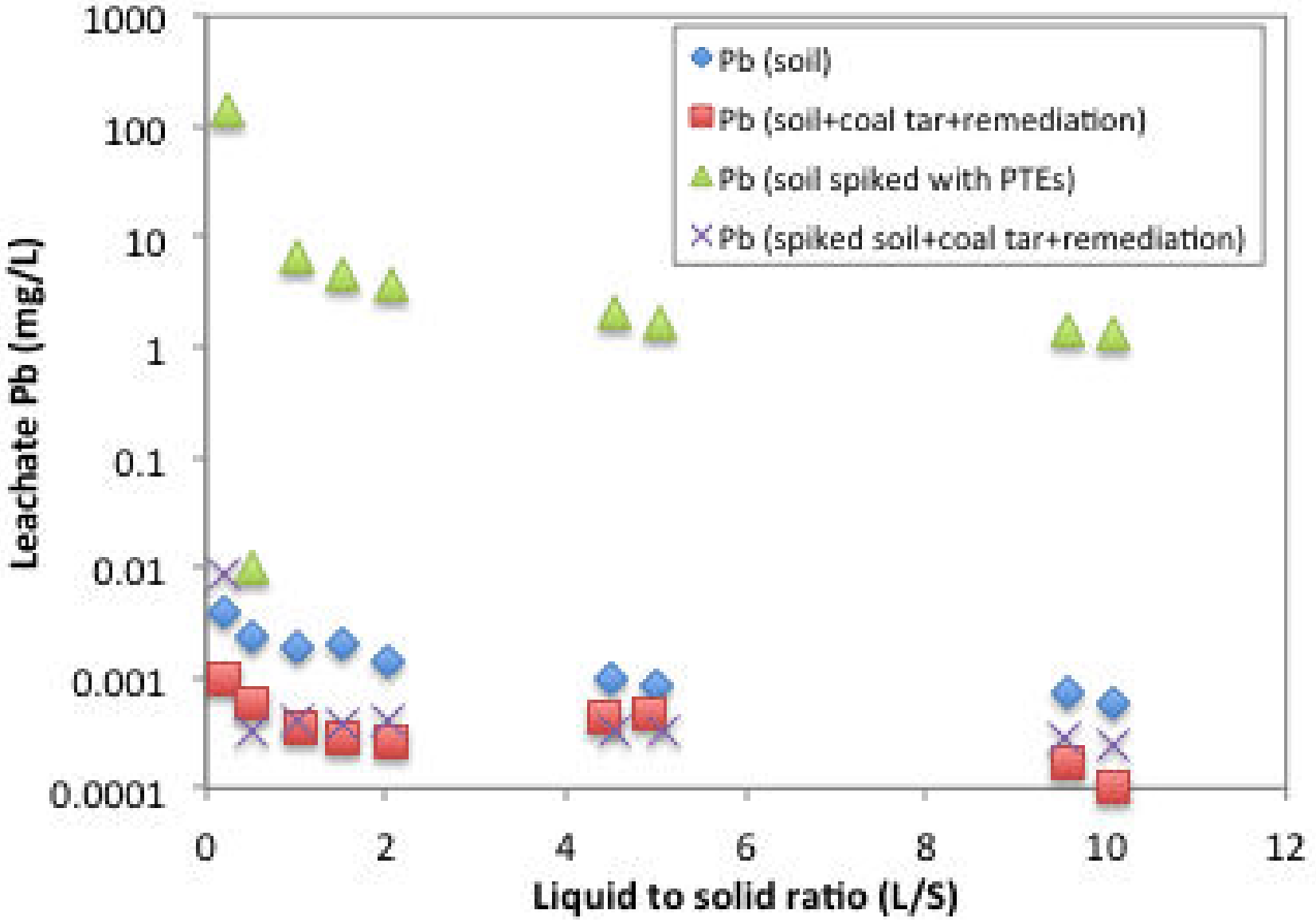
M1313 Results: Arsenic



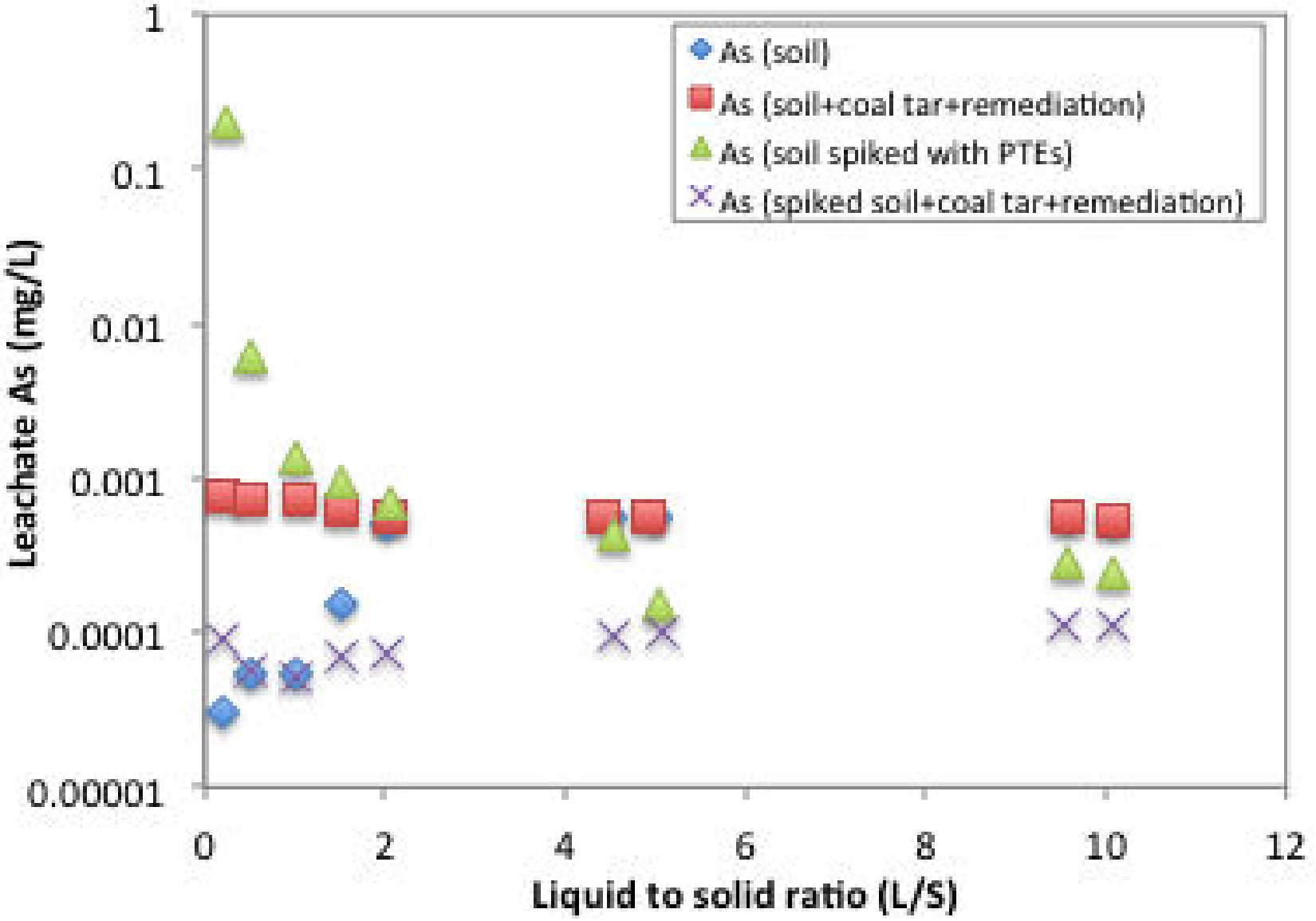
M1313 Results: Lead



M1314 Results: Lead



M1314 Results: Arsenic



Conclusions and Future Work

- Contaminant source removal makes significant progress toward aquifer restoration
- Trace contaminants require further attention:
  - pH effects
  - Reductive conditions
  - Soil mineralogy changes
- Groundwater re-infiltration modelling

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