

# VÝSLEDKY MEZINÁRODNÍCH VÝZKUMNÝCH PROJEKTŮ ISOSOIL A MODELPROBE

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**AECOM**

- 11 subjektů ze sedmi evropských zemí pod vedením Stockholmské univerzity (Švédsko)
- výzkum možností využití izotopové analýzy k hodnocení biodegradace a původu znečištění
- vývoj software k hodnocení izotopových analýz
- projekty financovány v 7. rámcovém programu

- 19 subjektů z deseti evropských států pod vedením Helmholtzova centra pro environmentální výzkum (Německo)
- vývoj nástroje, který kombinuje neinvazivní a málo invazivní inovativní techniky průzkumu znečištěných lokalit tak, aby průzkumy byly přesnější, méně zatěžovaly životní prostředí a byly tak v souladu s principy trvale udržitelného rozvoje

Beneficiary name	Beneficiary short name	Country	Date enter project	Date exit project
Stockholm University	SU	Sweden	1	36
ALS Laboratory Group AB	ALS	Sweden	1	36
Hellenic Centre for Marine Research	HCMR	Greece	1	36
Eidgenössische Technische Hochschule Zürich	ETH-Z	Switzerland	1	36
Masaryk University	MU	Czech Republic	1	36
Earth Tech CZ s.r.o.	ETCZ	Czech Republic	1	36
Technical University of Lodz	TUL	Poland	7	36
University of Bristol	UB	Great Britain	1	36
FQS Poland Sp. z.o.o.	FQS	Poland	7	36
Makolab SA	MLAB	Poland	7	36
IVL Swedish Environmental Research Institute	IVL	Sweden	1	36

## Key limitations to current assessment of widespread organic contamination of soils and site specific characterization

Conventional concentration-based approaches are insufficient to resolve important site-specific issues such as :

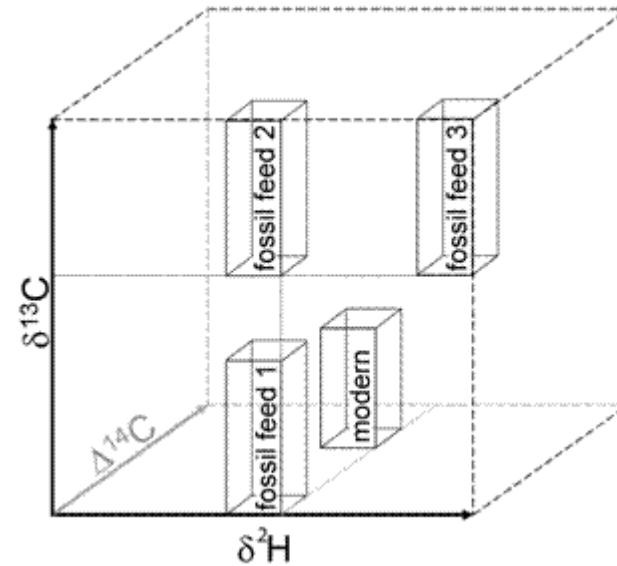
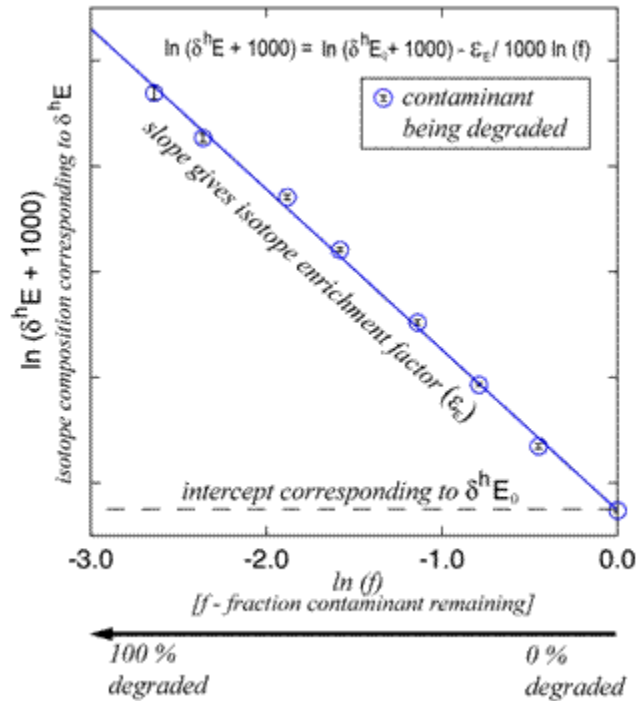
- I. the extent of *in situ* degradation (“natural attenuation”)
- II. accurate source apportionment (“environmental forensics”)

## Solution:

- **Compound-specific isotope analysis (CSIA) for both degradation monitoring and source apportionment based on the molecular-isotopic composition of contaminants**

# Monitoring biodegradace

# Rozlišení zdroje kontaminace (fossilní/recentní – např. PAU)



**Call Topic:** Improved technologies and tools for site characterization and monitoring of contaminated soils including chemical analysis

**Expected Impact:** A precise and reliable site characterisation and monitoring design

**isoSoil Objectives**

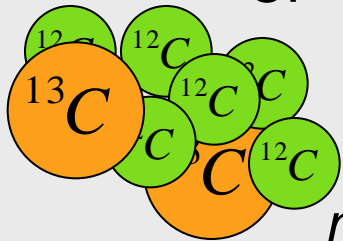
- Development of compound-specific isotope analyses (CSIA) of  $^{13}C/^{12}C$ ,  $^2H/^1H$ ,  $^{15}N/^{14}N$ , and  $^{37}Cl/^{35}Cl$  as powerful novel tools for improved site-specific characterization and monitoring of microbial and abiotic degradation
- Establishment of generally applicable isotope enrichment factors for common soil contaminants and their microbial and abiotic degradation reactions
- Development of new analytical methods for higher throughput in CSIA of  $^{37}Cl/^{35}Cl$  and  $^{81}Br/^{79}Br$
- Development of web-based commercial software for end-user interpretation of CSIA results for "degradation monitoring"

## Stable Isotope Fractionation



“natural conditions”  
substrate

$^{12}\text{C}:^{13}\text{C} = 99:1$

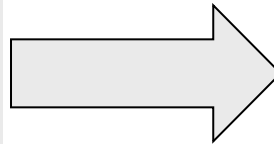
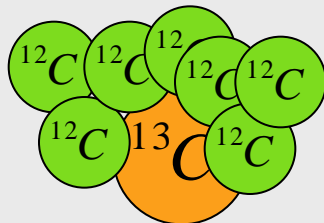
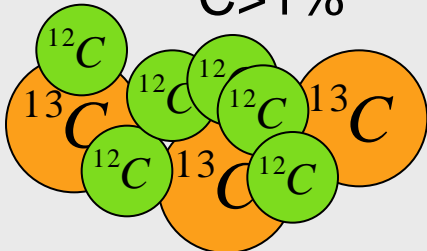


*microorganisms*

residual substrate + product

$^{13}\text{C} > 1\%$

$^{12}\text{C} > 99\%$



## Method for:

qualitative and  
quantitative  
characterization of  
**biodegradation**  
in the field

Fischer et al. 2007 EST 41, 3689-3696

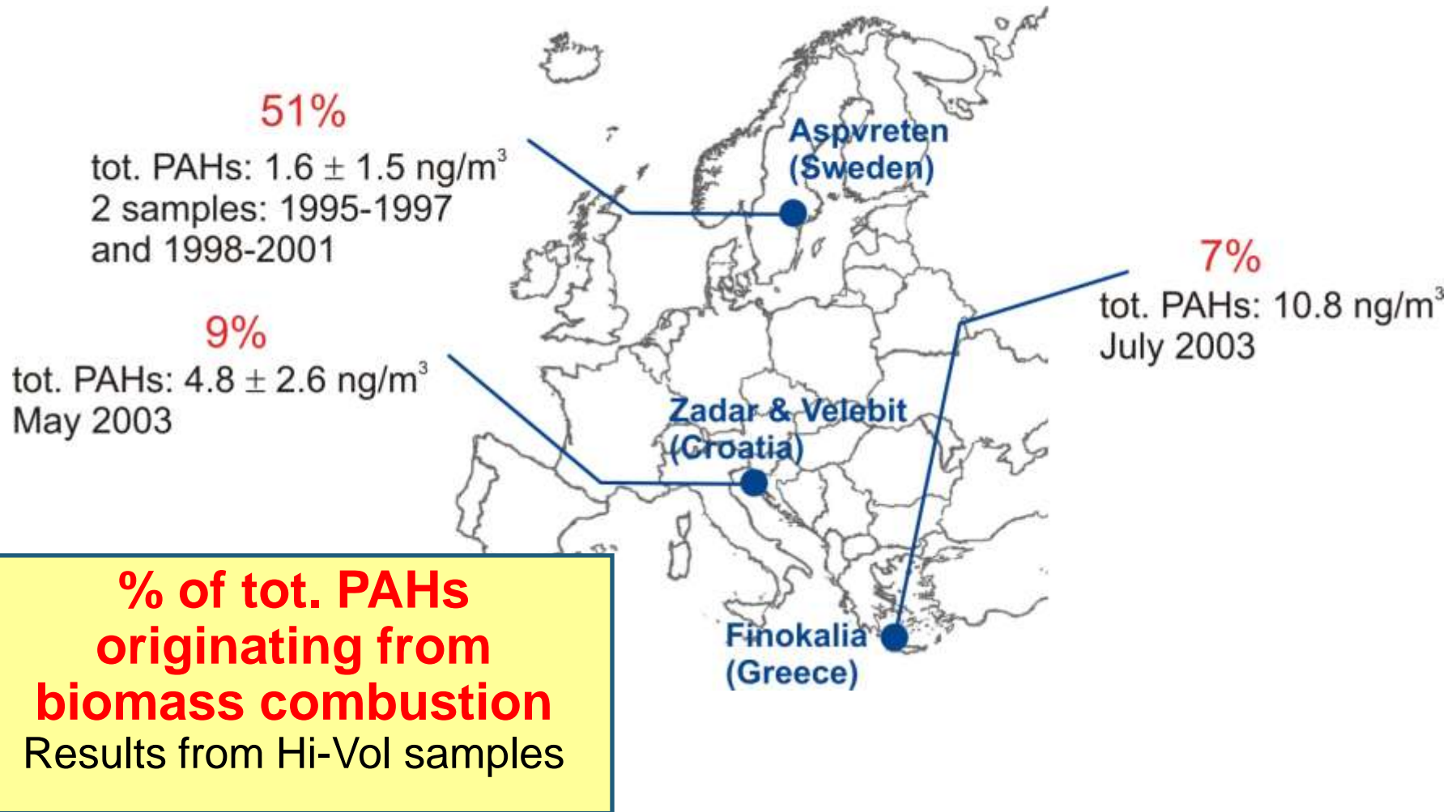
Fischer et al. 2008 EST 42, 4356-4363

Fischer et al. 2009 RCM 23, 2439-2447

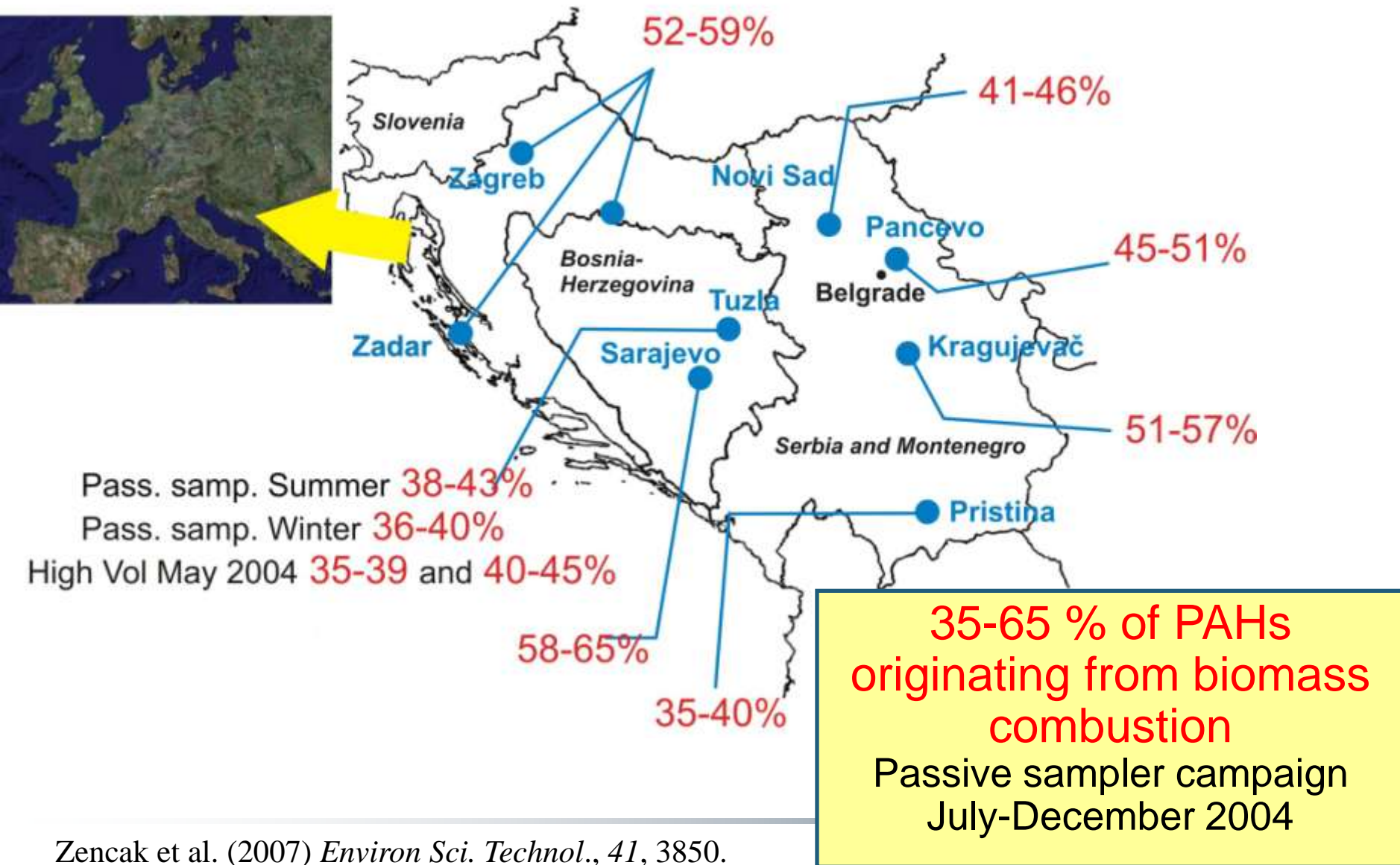
Vogt et al. 2008 EST 42, 7793-7800

Rosell et al. 2007 EST 41, 2036-2043

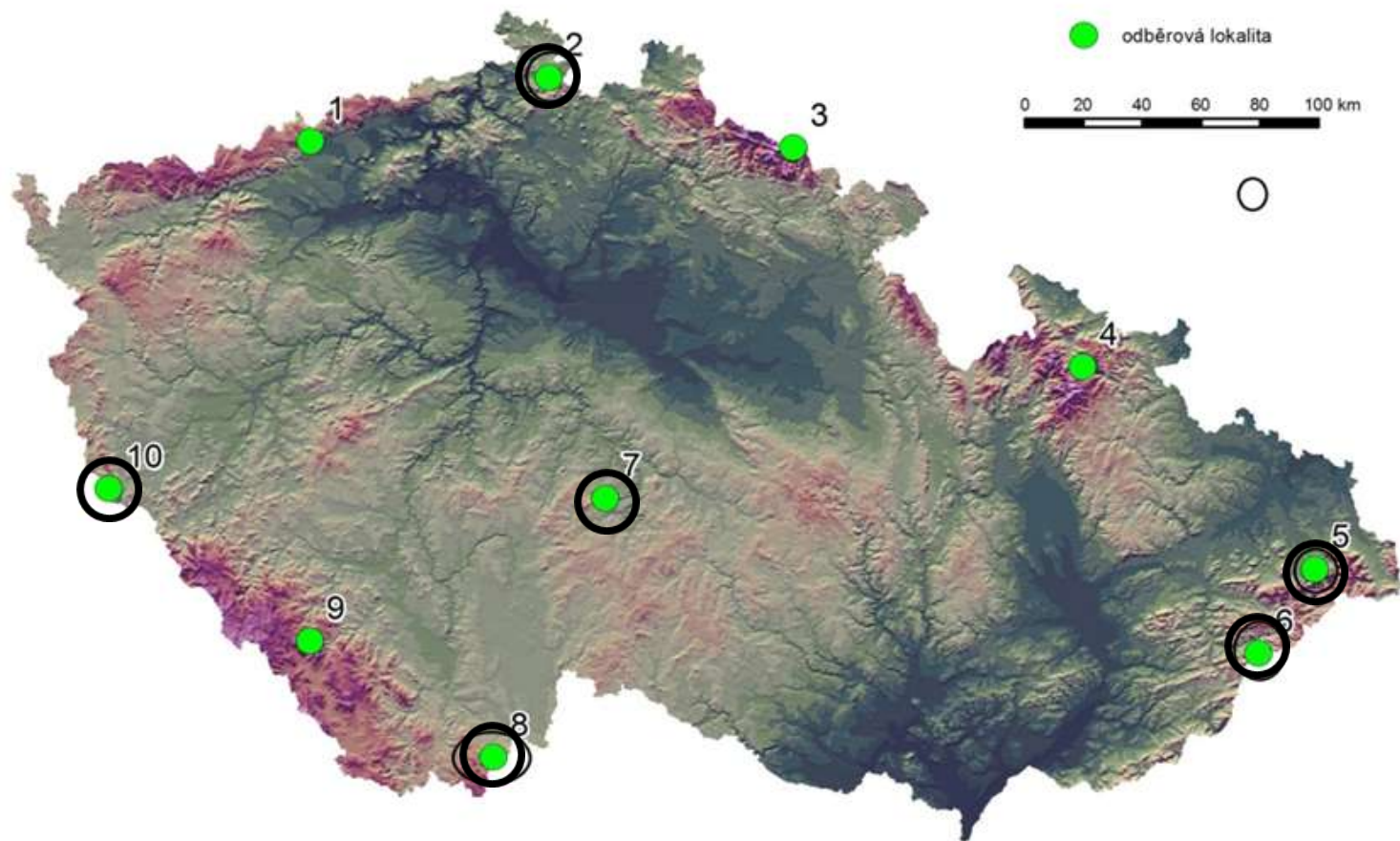
# <sup>14</sup>C Source Apportionment of PAHs in Ambient Air



# Spatial resolution: CCSRA-PAHs in Balkan Air

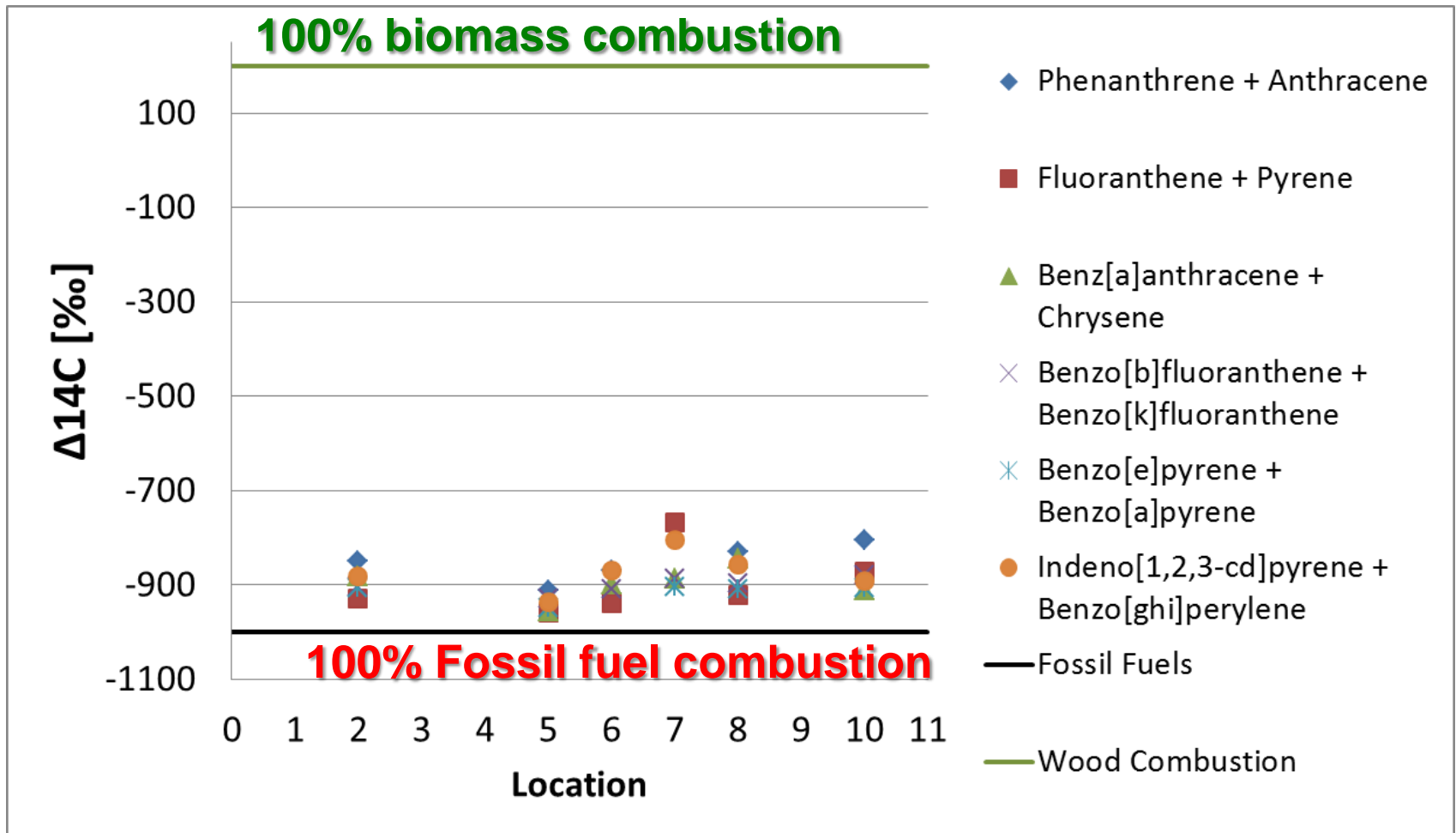


# Isosoil $^{14}\text{C}/^{13}\text{C}$ -PAH soil sites

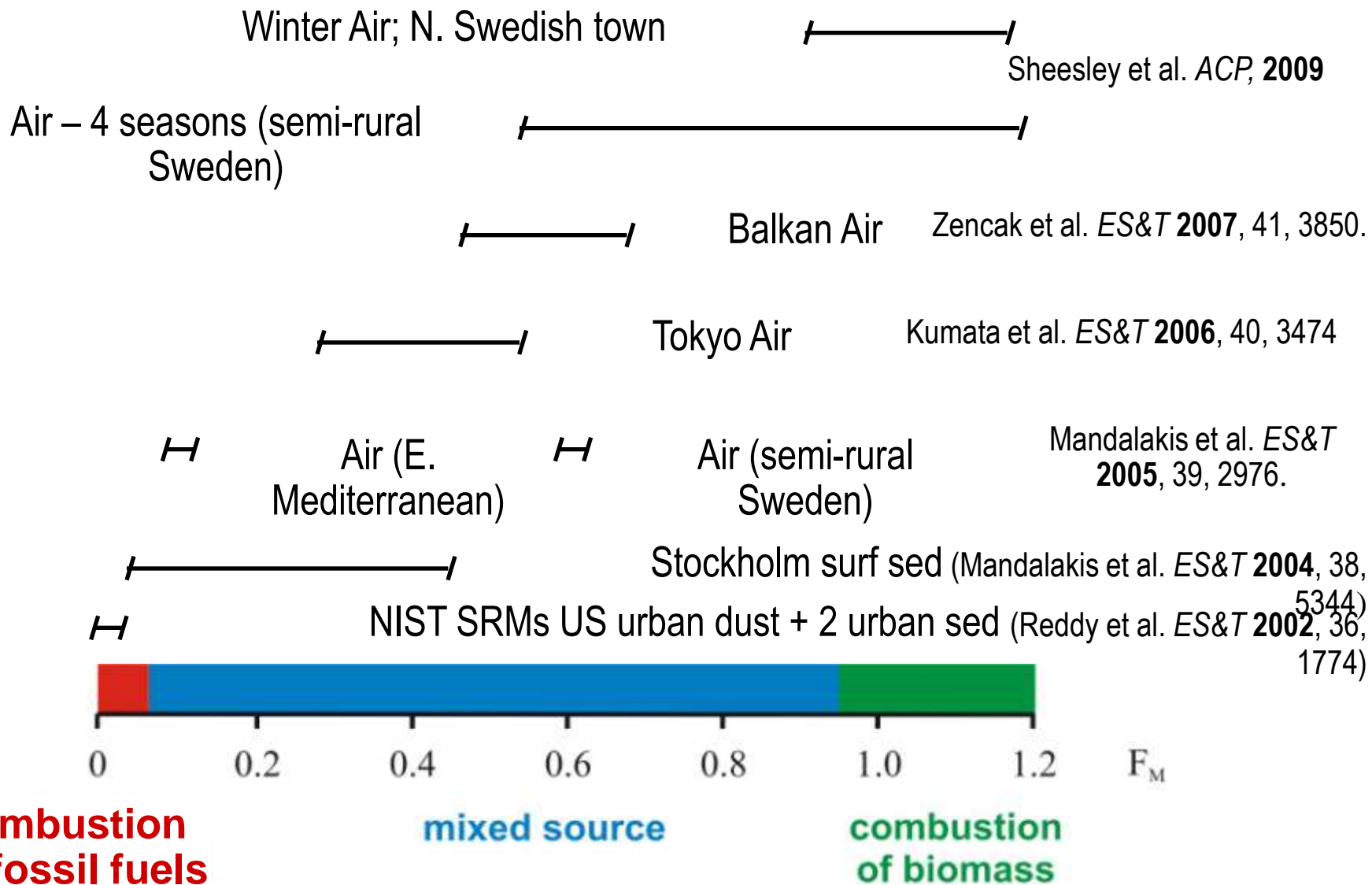




# $\Delta^{14}\text{C}$ -PAHs in the Czech Republic



# Natural abundance $^{14}\text{C}$ of environmental PAHs



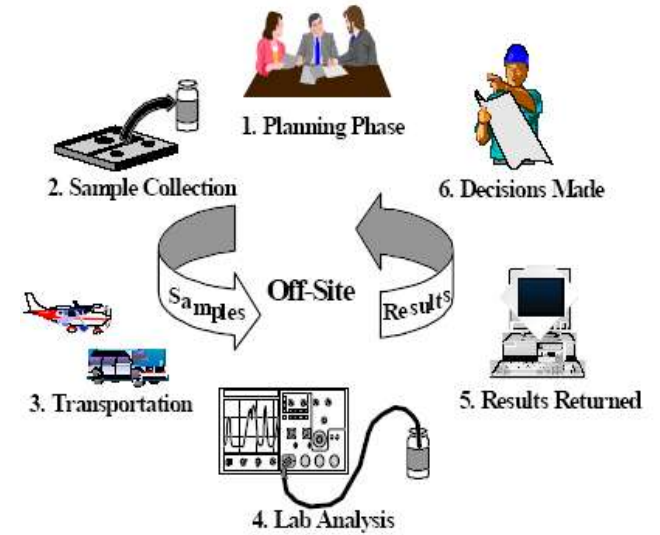
# ModelPROBE

Monitoring and Evaluation

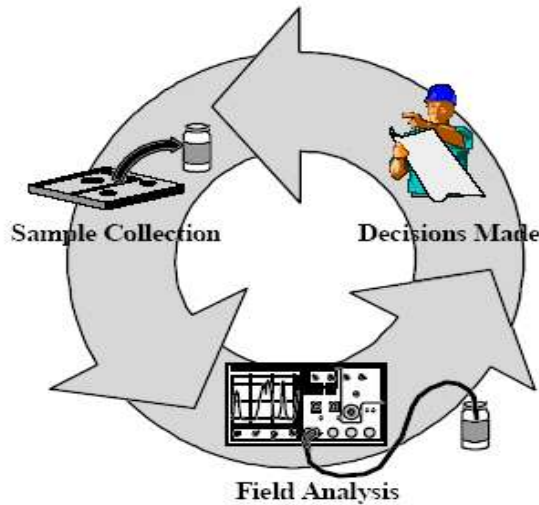


Beneficiary Number *	Beneficiary name	Beneficiary short name	Country	Date enter project	Date exit project
1 (coordinator)	Helmholtz Centre for Environmental Research	UFZ	Germany	1	46
2	University of Padua	UPD	Italy	1	46
4	Institute of Methodologies for Environmental Analysis, Italian National Council of Research (CNR)	CNR	Italy	1	46
5	Technical University of Denmark	DTU	Denmark	1	46
6	Earth Tech CZ Ltd.	ETC	Czech Republic	1	46
8	University of Lancaster	ULanc	UK	1	46
9	University of Aarhus, National Environmental Research Institute	AU-NERI	Denmark	1	46
11	Université Catholique de Louvain	UCL	Belgium	1	46
12	University of Rome	URom	Italy	1	46
13	Saint-Petersburg State University	USP (SpsSU)	Russia	1	46
14	CREATEC, Potenza	CREATEC	Italy	1	46
15	Christian Albrechts University of Kiel	CAU	Germany	1	46
16	University of Bonn	UBO	Germany	1	46
17	DELTAEC (GeoDELFT)	DLS	The Netherlands	1	46
18	MPBF, Mess- und Probenahmetechnik Berndsen und Fais, GbR	MPBF	Germany	1	46
19	Institut de Physique du Globe de Paris	IPGP	France	1	46
20	Federal Environment Agency of Austria, Vienna	UBA-A	Austria	15	46

## Konvenční přístup

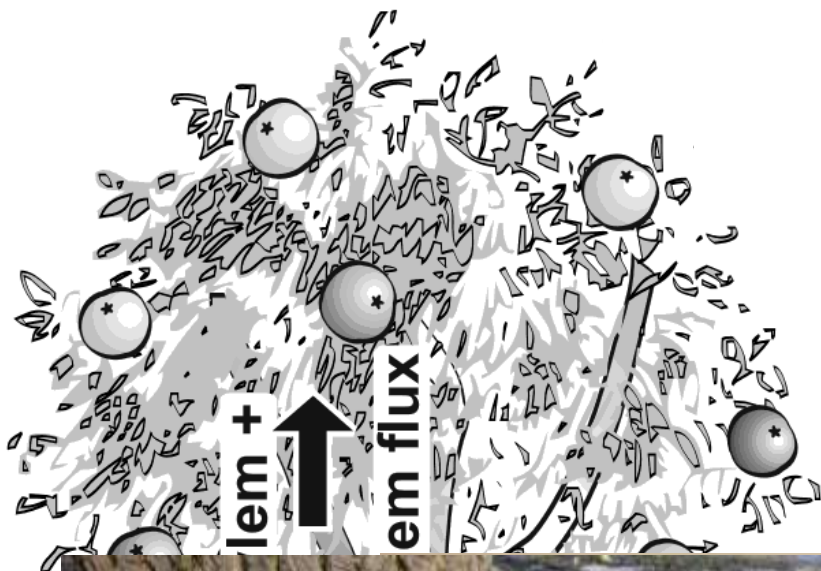


Planning Phase



## Přístup ModelProbe

# Site survey using tree monitoring technique



## Why Trees?

- ▶ a "standard plant" transpires approx. **1 liter/day/m<sup>2</sup>**
- ▶ wood adsorbs compounds



Tree core sampling



Analysis of wood

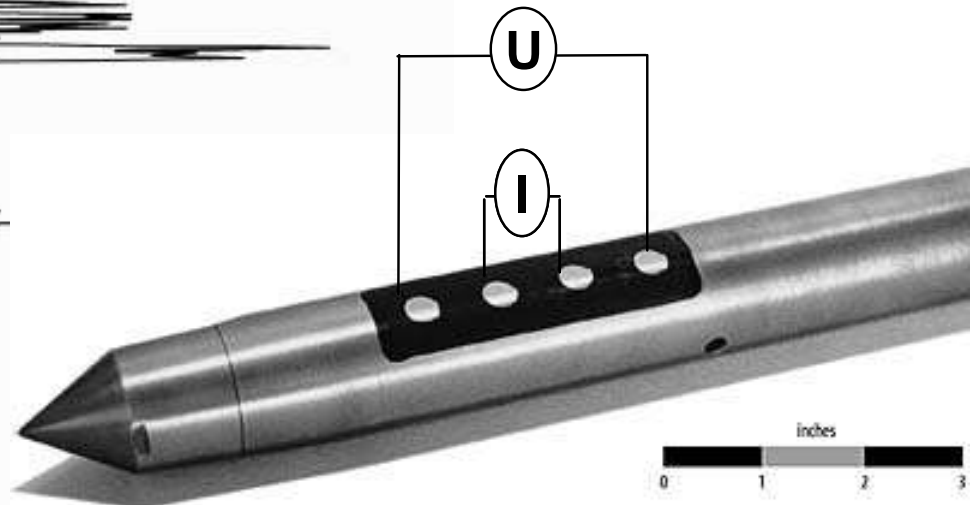
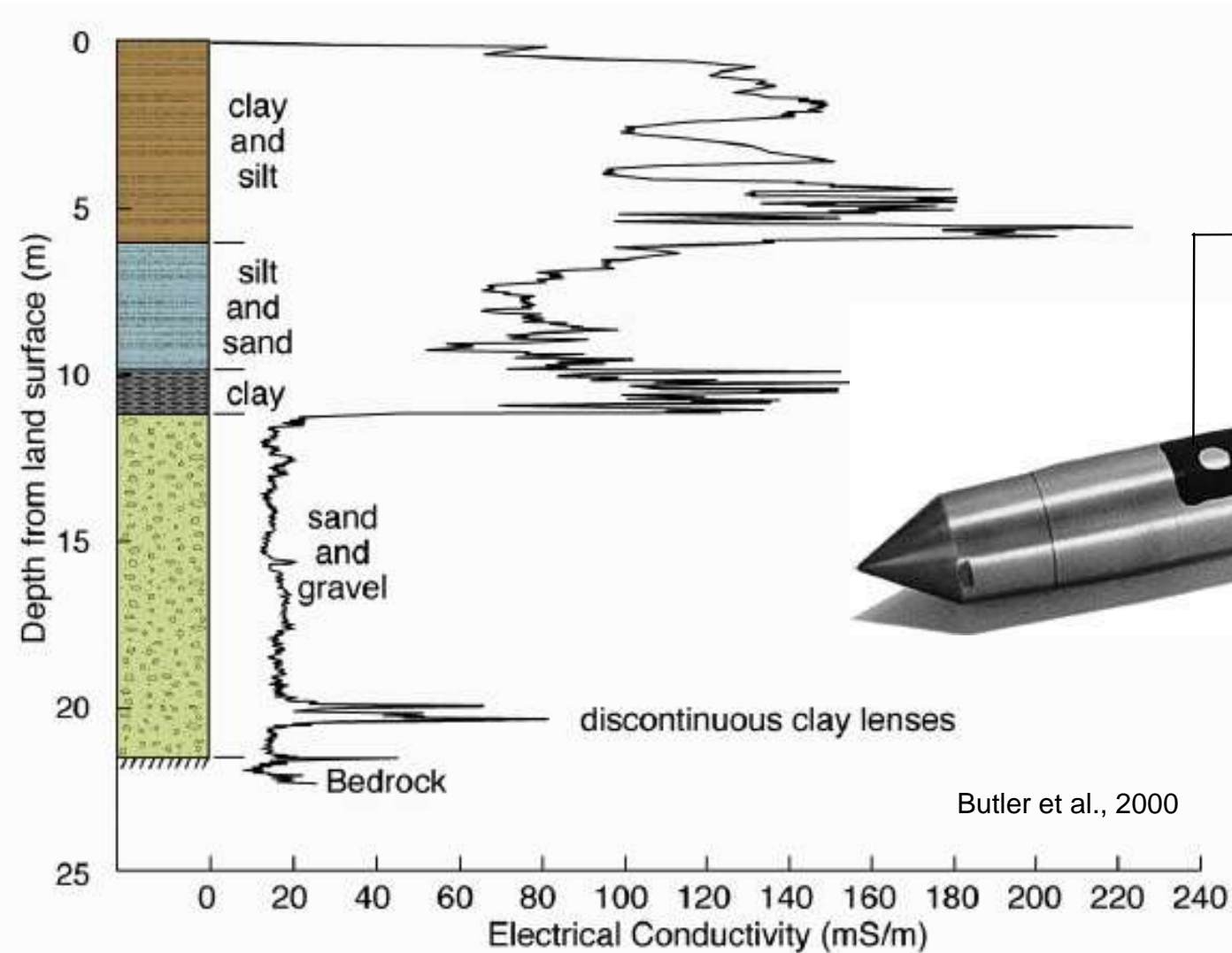


using Direct Push equipment



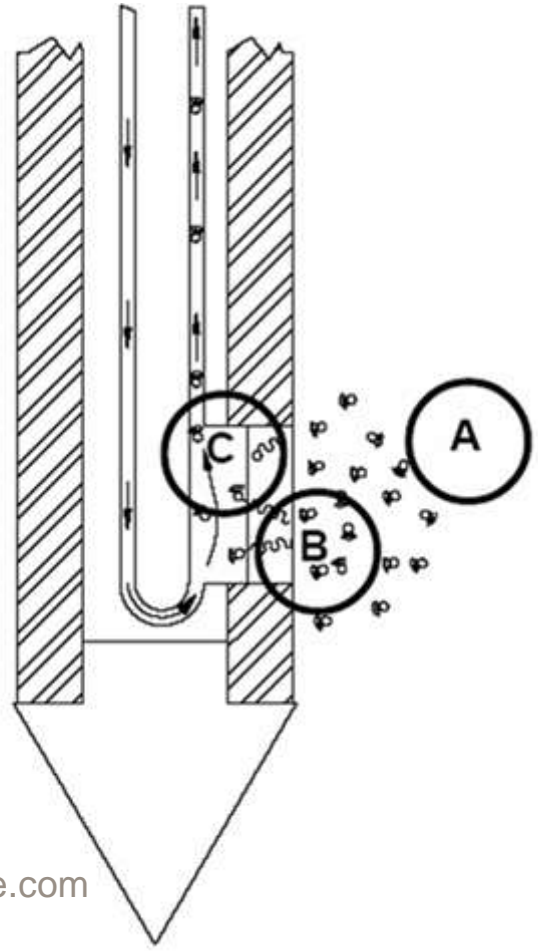
# Direct Push-Technologies

In situ measurements → EC-profiling

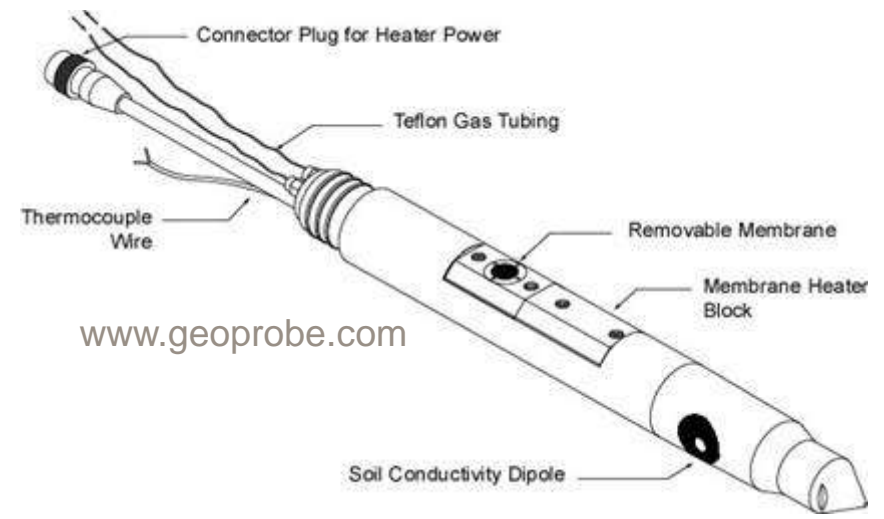


Butler et al., 2000

# MIP - Membrane Interface Probe



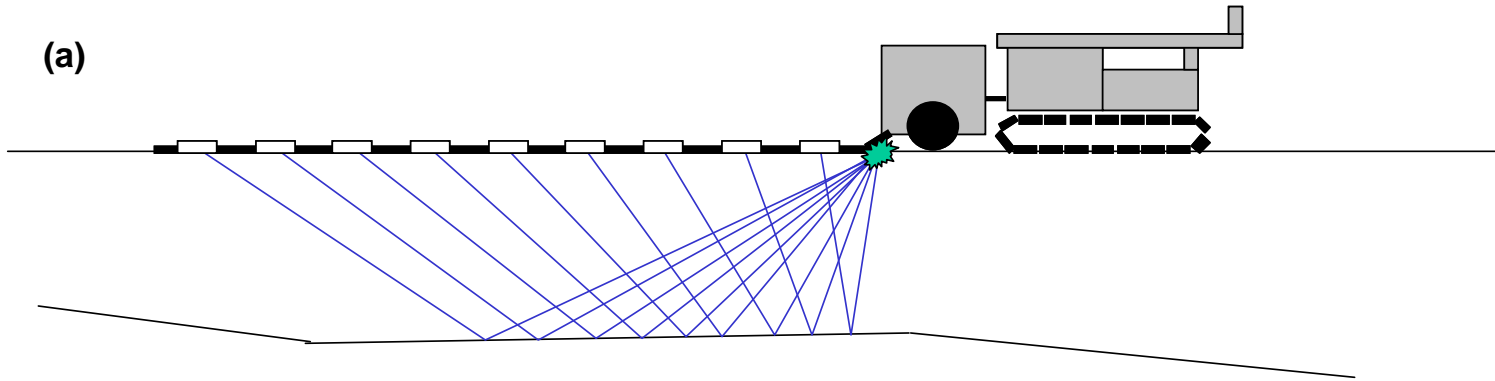
www.geoprobe.com



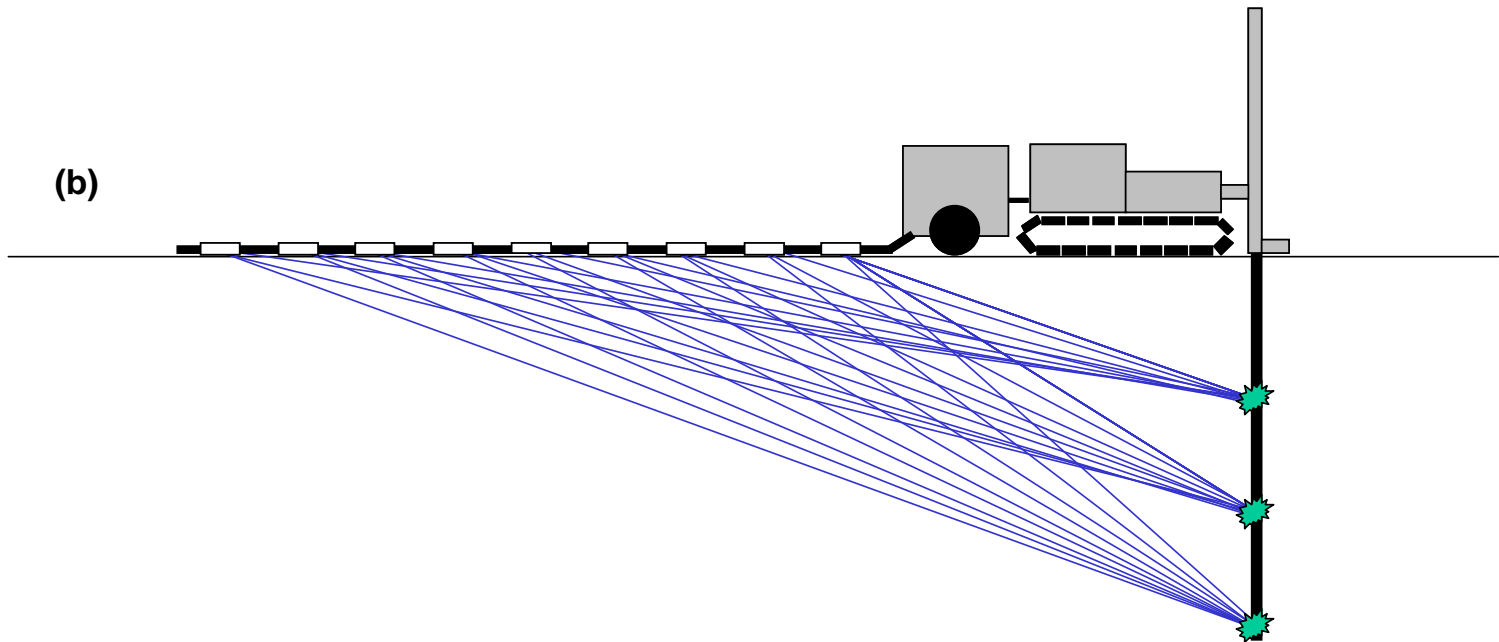
www.geoprobe.com



**(a)**



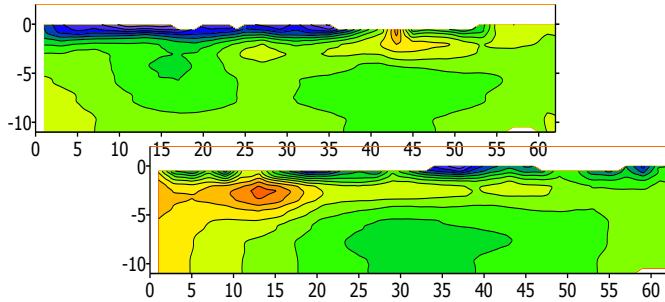
**(b)**



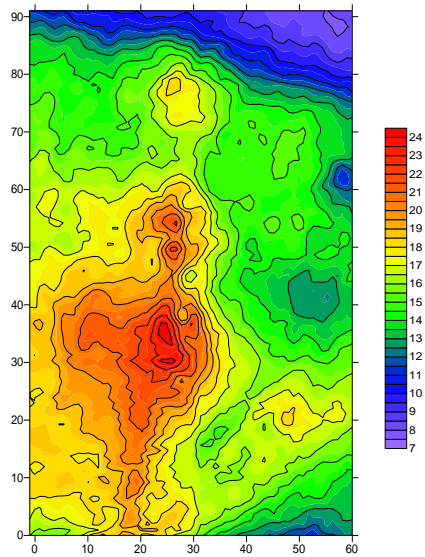


# WP 2+3: Geophysical imaging and data fusion

## Resistivity & Induced Polarisation



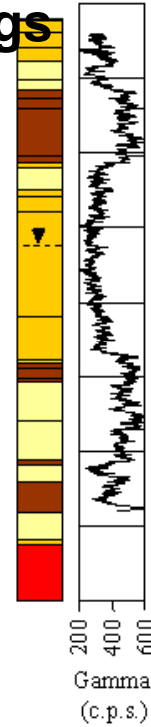
## Ground Conductivity



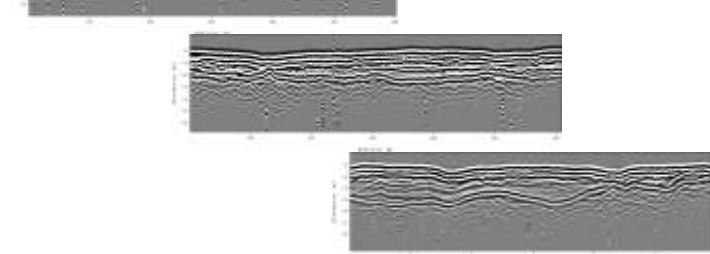
## Local sampling



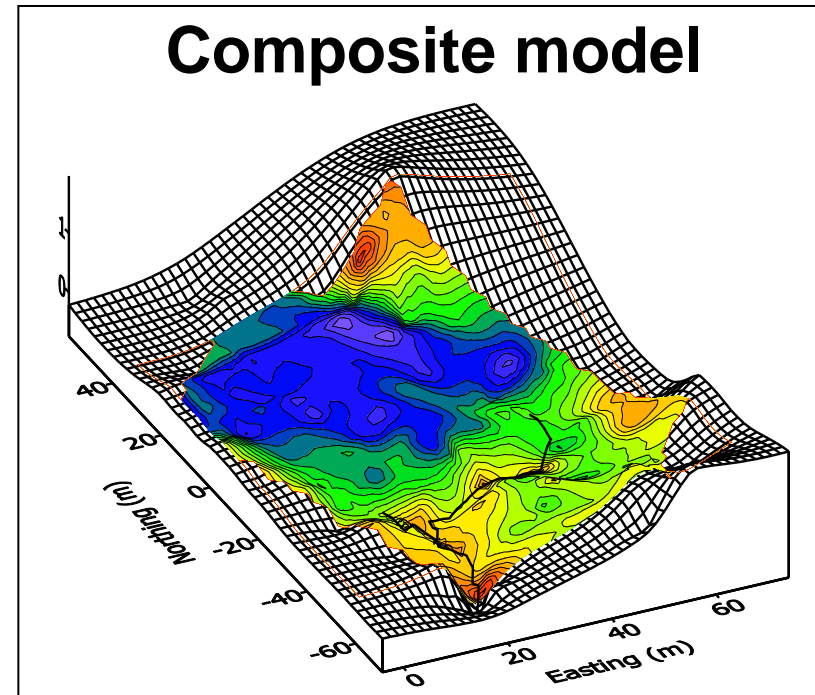
## Push rod logs



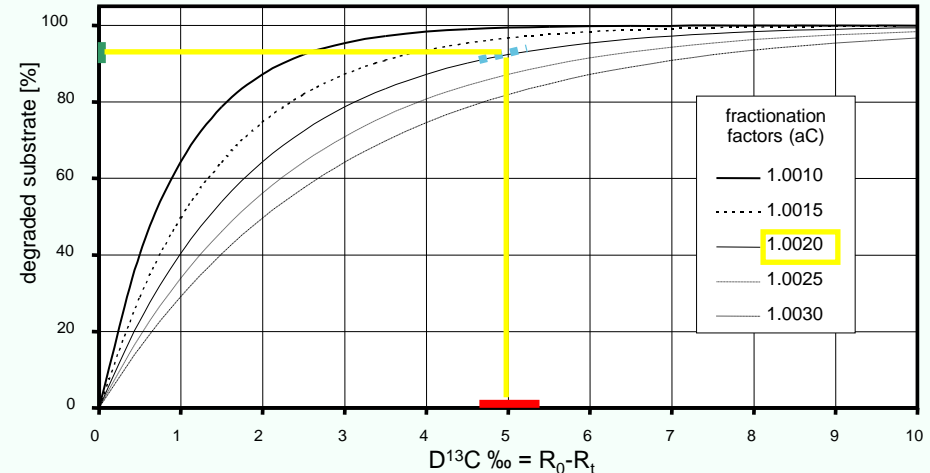
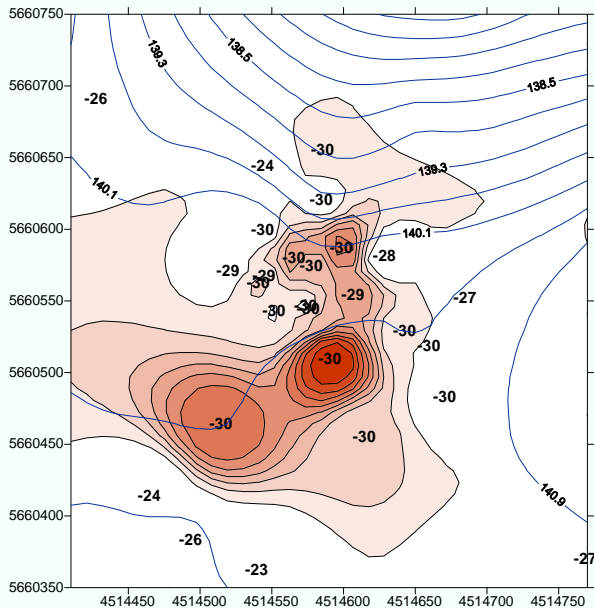
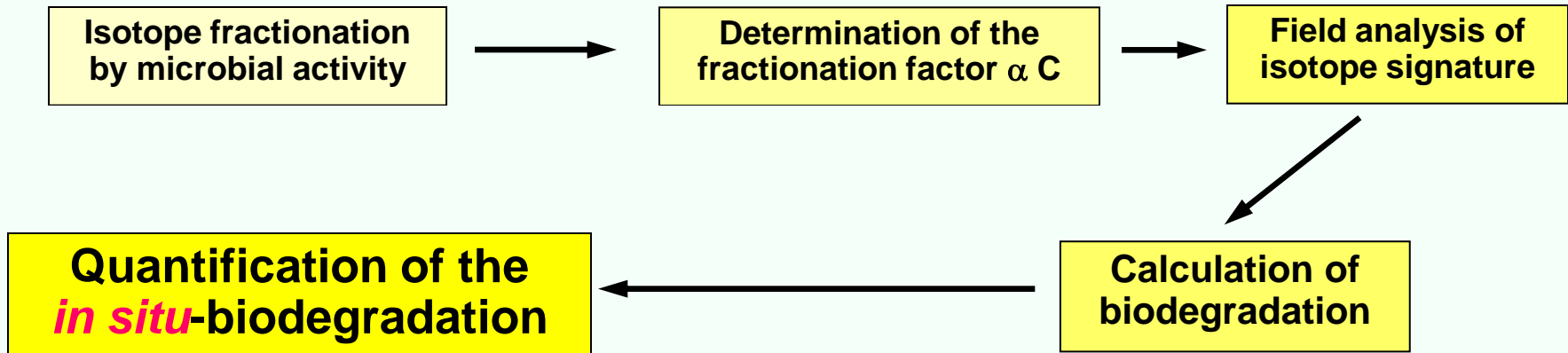
## GPR



## Composite model

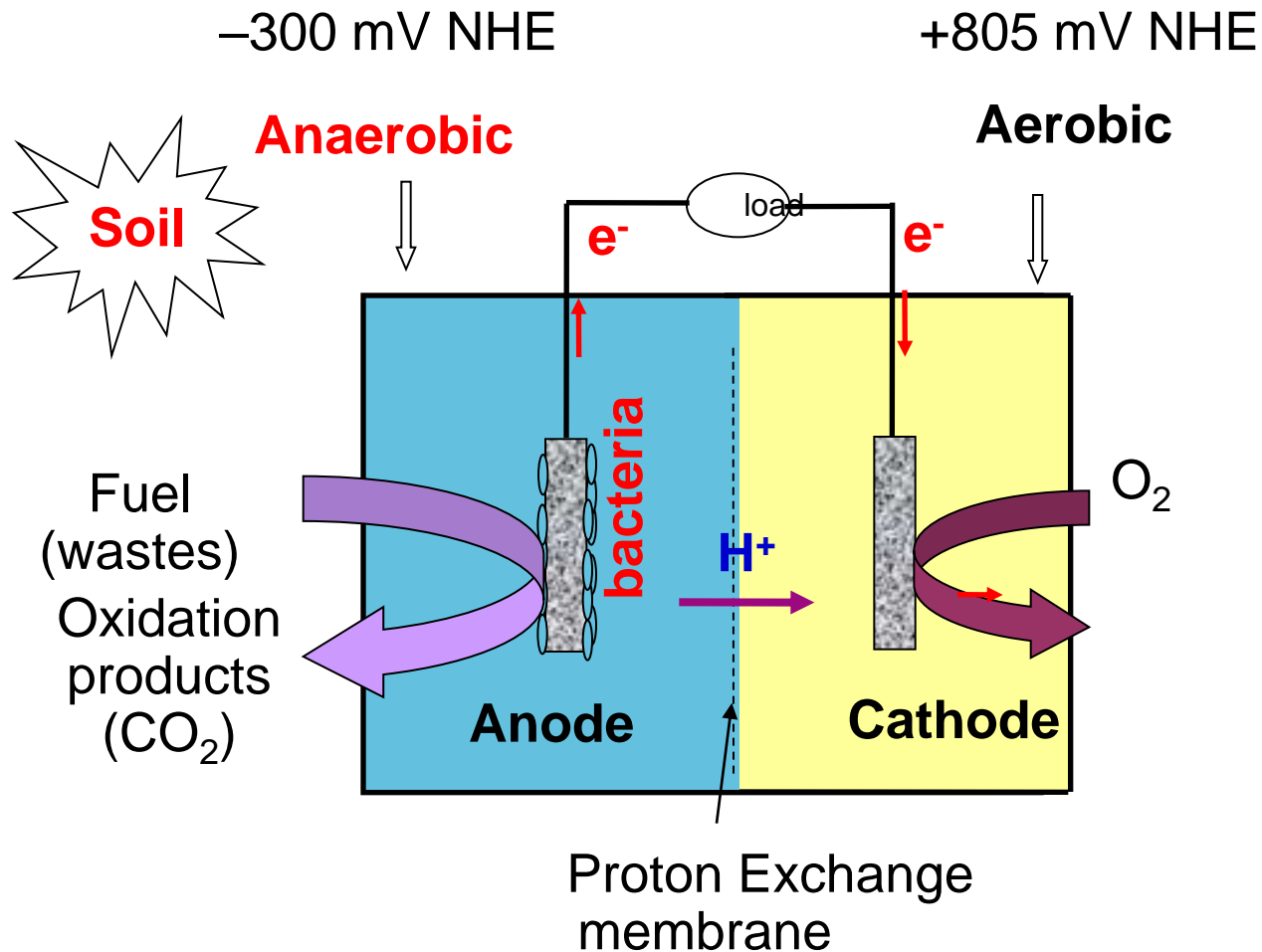


# WP 6: Microbial in situ activity + environmental forensics: compound specific stable isotope analysis



(Meckenstock et al. 1999, EM, 1; 409-414;  
Richnow et al. 2003, JCH, 65; 101-120;  
Meckenstock et al. 2004, JCH, 75; 215-255)

# Microbial fuel cells (MFC)



## Microbial activity

+  
**BOD/COD**



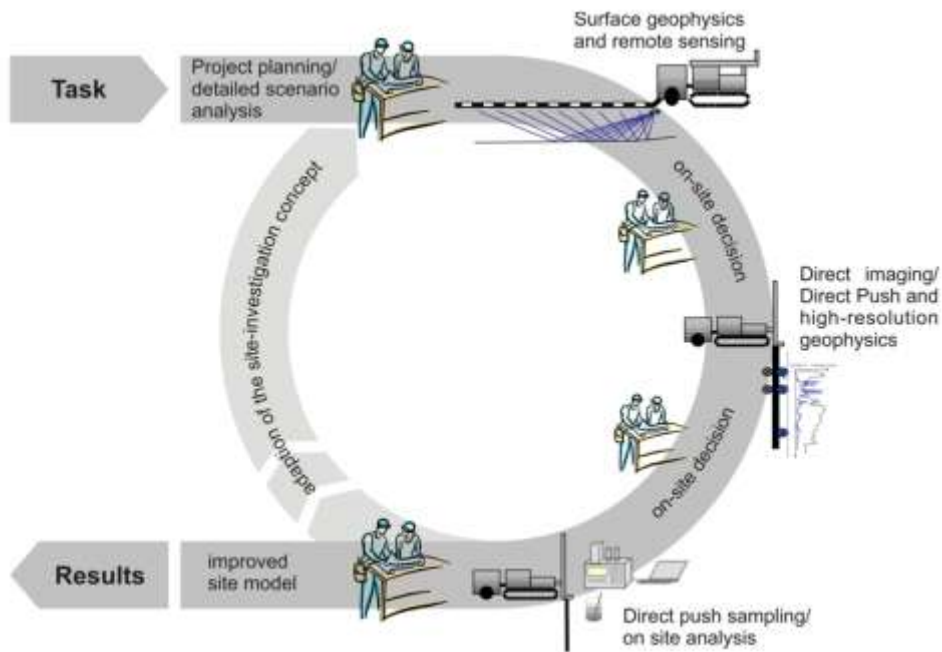
**Current**



**Biosensor**

# Handbook (A: Guideline)

## ModelPROBE approach



- (1) Site history, planning phase
- (2) Non-invasive geophysics
- (3) Tree core sampling
- (4) Data evaluation
- (5) Direct Push + geophysics
- (6) Data evaluation (field)
- (7) DP + bio-geo-chemical sampling
- (8) Data evaluation + modelling
- (9) Feedback → additional sampling
- (10) Adaptive site description
- (11) Site assessment

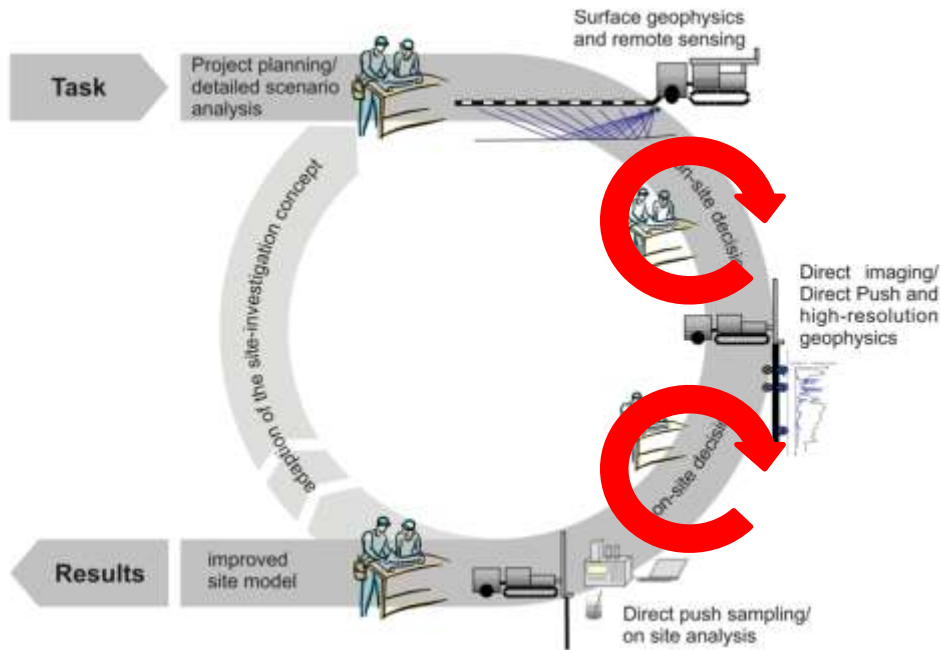


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# Handbook (A: Guideline)

ModelPROBE approach **revised**



- (1) Site history, planning phase
- (2) Non-invasive geophysics
- (3) Tree core sampling
- (4) Data evaluation
- (5) Direct Push + geophysics
- (6) Data evaluation (field)
- (7) DP + bio-geo-chemical sampling
- (8) Data evaluation + modelling
- (9) Feedback → additional sampling
- (10) Adaptive site description
- (11) Site assessment



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# ModelPROBE Dissemination System

## development status

**ModelPROBE Dissemination System** currently includes 2 types of artifacts:

- ✓ A Central Dissemination Platform, available online at [www.modelprobedisseminationsystem.com](http://www.modelprobedisseminationsystem.com)
- ✓ A number (currently 2) of distributable, lightweight e-learning packages, developed ad-hoc for each ModelPROBE training course

# ModelPROBE Dissemination System

## Central Dissemination Platform



**ModelPROBE**  
Dissemination System



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- [COMBINING CHEM & ECOTOX INFO](#)
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- [DATA ASSIMILATION](#)
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- [DNAPLS DYNAMICS](#)
- [EQUILIBRIUM SAMPLING](#)
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- [TREE CORE MONITORING](#)

### LOGIN

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## Home

The **ModelPROBE Dissemination System** is a cross-platform, web based system designed in order to distribute the results of the ModelPROBE project through the scientific community and more in general to stakeholder involved in the management of contaminated site.

You can enter the Dissemination System by a User-Friendly Interface which will guide you through the different technologies by a "Interactive Environment" or by an "Advanced List Interface" where you can directly access the different content.

*The ModelPROBE Dissemination System is developed by the University of Rome "La Sapienza" and funded through the ModelPROBE Project (European Commission, FP7 Contract No. 213161, deliverable 11.4).*



**SAPIENZA**  
UNIVERSITÀ DI ROMA

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# ModelPROBE Dissemination System

## E-Learning Packages

E-learning packages typically provide:

- ✓ A tiny overview of the Central Dissemination Platform, typically limited to technologies' factsheets

**ModelPROBE Dissemination System**

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**OVERVIEW**

Advanced List View  
Impactive Environment

**TECHNOLOGIES**

BIOSASSAYS FOR ECOTOX. ASSESS  
BIOELECTROCHEMICAL SENSOR  
CLASSICAL BACTRAPS  
COMBING CHEM & ECOTOX INFO  
CSIA  
DATA ASSIMILATION  
DIRECT FISH  
EIT & SIP  
ELECTROMAG. INDUCTION MAP  
EQUILIBRIUM SAMPLING  
FISH & CARD-FISH  
GROUND PENETRATING RADAR  
MICROBIAL FUEL CELL  
MULTI-PHASE MICROBIAL  
SELF POTENTIAL  
TRIS CORE MONITORING

**Technologies Overview (Advanced List View)**

 Biosays for Ecotox. Asses	 BioElectrochemical Sensor	 Classical Bactraps
 Combining Chem & Ecotox Info	 Contaminant Trap	 CSIA
 Data Assimilation	 Direct Fish	 EIT & SIP
 Electromag. Induction Map	 Equilibrium Sampling	 Fish & Card-Fish
 Ground Penetrating Radar	 Microbial Fuel Cell	 Multi-Phase Microbial
 Self Potential	 Tris Core Monitoring	 Tris Core Monitoring

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  - CLASSICAL BACTRAPS
  - COMBING CHEM & ECOTOX INFO
  - CONTAMINANT TRAP
  - CSIA
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  - DINFLS DYNAMICS
  - EQUILIBRIUM SAMPLING
  - FISH & CARD-FISH
  - GEOPHYSICAL METHODS
  - MICROBIAL FUEL CELL SENSOR
  - TRIS CORE MONITORING

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### Bioassays for Ecotoxicity Assessment Overview

**MAIN OBJECTIVES**

- Detection of toxic effects caused by contamination;
- Contaminant plume characterisation in groundwater using aquatic short-term bioassays;
- Risk assessment (i.e. based assessment and risk management).

**BRIEF DESCRIPTION**

**Main Principle**

The major aim of ecotoxicity assessment is the provision of tests such as bioassays for the detection of effects from contamination. Complete chemical analytical data (i.e. that chemical exposure is typically not directly linked to biological effects, while biological responses in the presence of goods such as toxicologically acceptable raw water for human consumption, excluding exceptional services. Such bioassays might prove useful, since different organisms may respond with varying sensitivity on different chemicals. It is common to apply complementary. Different ecotoxicological assays such as the luminescent bacteria, the fish egg toxicity, and the phytoecology assay are exposure against organic groundwater pollutants.

**Main Results**

Given a standardised test protocol and sufficient controls to exclude confounding factors, results depend only on the contaminant or bioassays are typically presented as impairment of the observed biological property vary between 0% (no effect) and 100% that effect on chemical information on organisms present and biological effects (provided thereof can be established if concentration effect results information (Klostermeyer et al., 2004).

**Sketch of measuring principle or concept**

Effect assessment is based on risk management

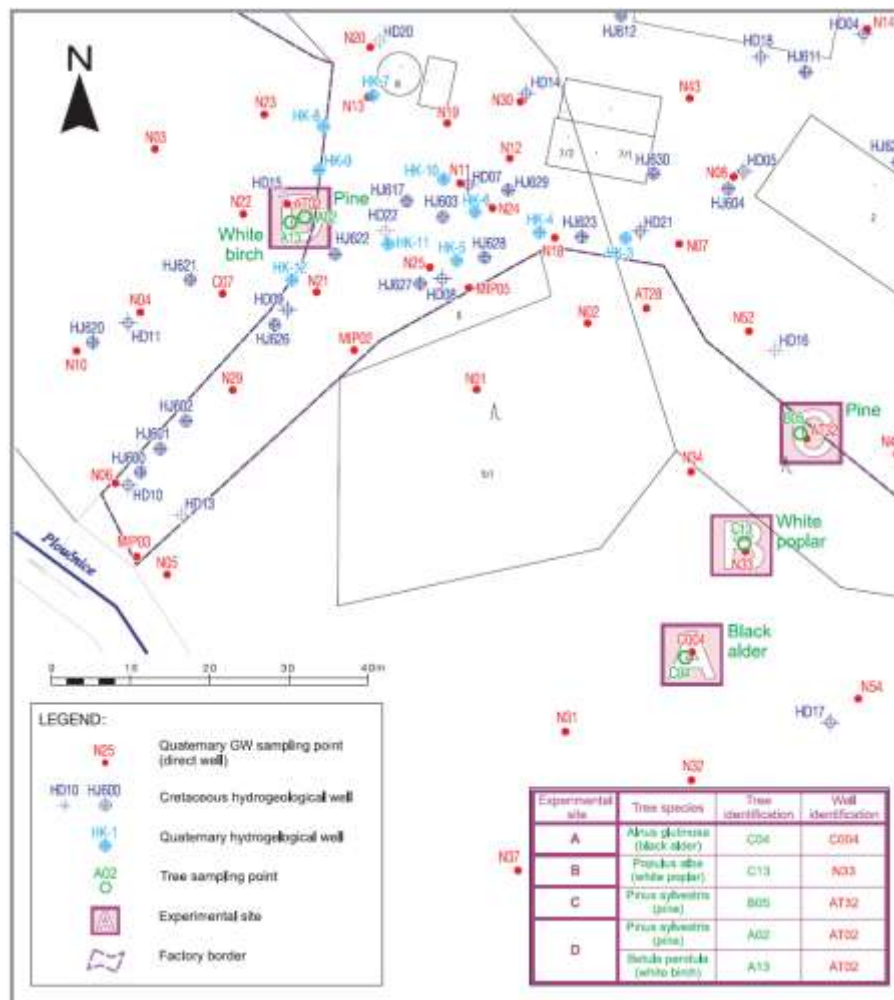
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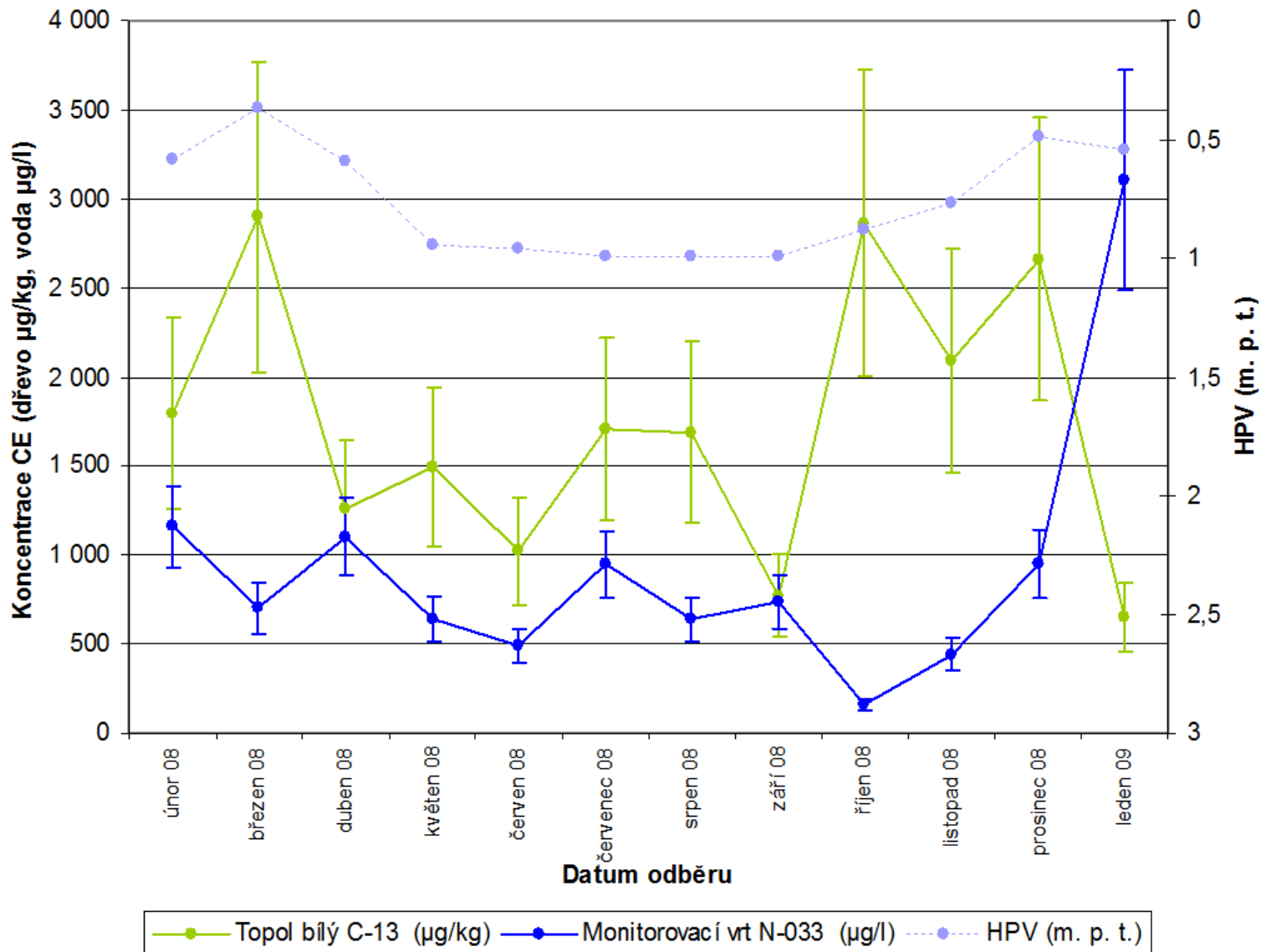


# Výzkum AECOM/ČZU – závislost koncentrací CE v podzemní vodě a dřevní hmotě

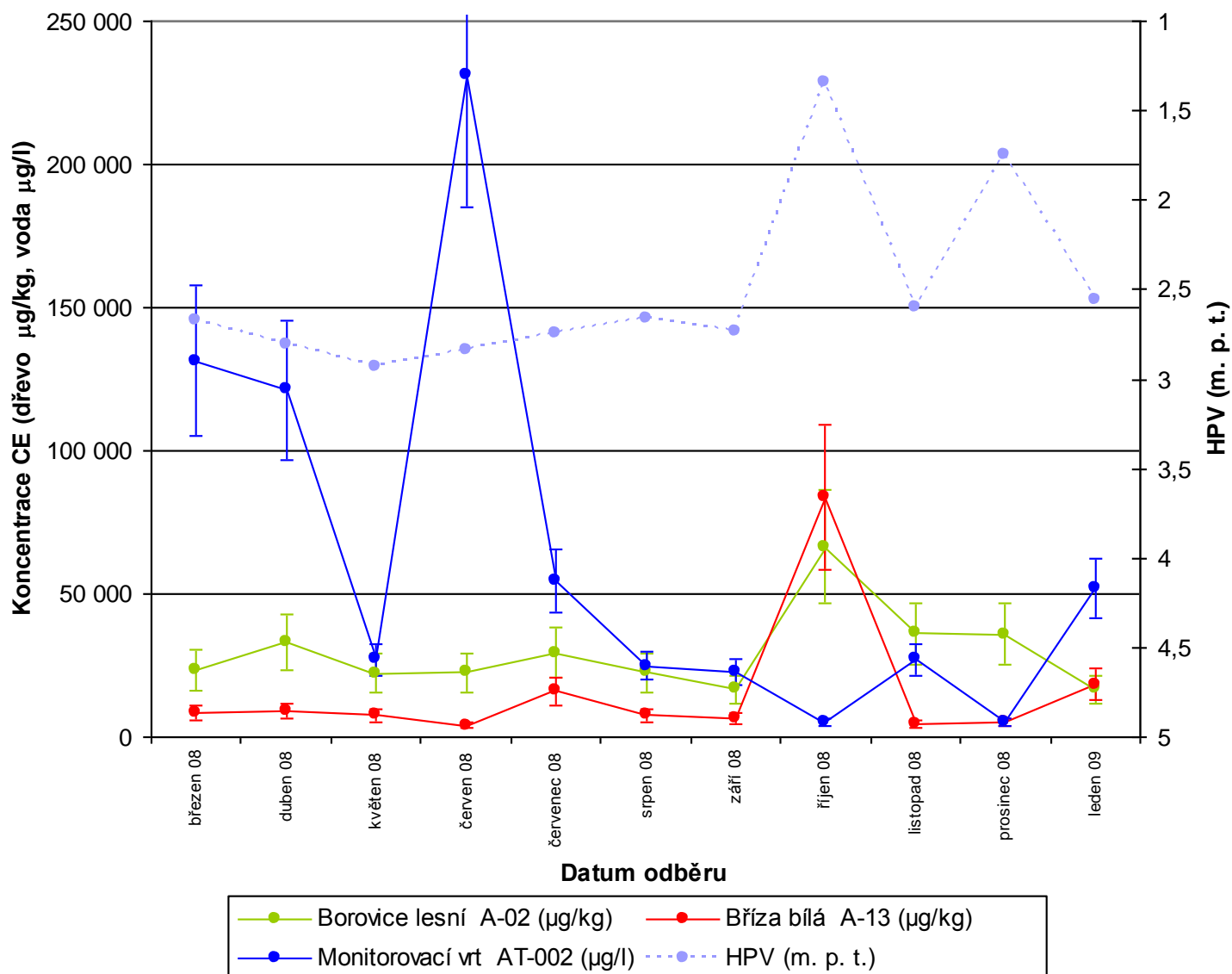
- 1 rok sledování koncentrací na čtyřech dílčích lokalitách na lokalitě SAP Mimoň (měsíční interval)



# Hladina podzemní vody, koncentrace CE ve vzorcích podzemní vody a dřevní hmoty během jednotlivých odběrů – lokalita B



# Hladina podzemní vody, koncentrace CE ve vzorcích podzemní vody a dřevní hmoty během jednotlivých odběrů – lokalita D



Lokalita	Druh stromu / věk	Kód dřeviny	Kód vrtu		
		průměrná koncentrace CE v dřevní hmotě (µg/kg)	průměrná koncentrace CE v podzemní vodě (µg/l)	koeficient determinace (%)	Bio koncentrační
		stupeň degradace - dřevo (% nižších CE v sumě)	stupeň degradace - voda (% nižších CE v sumě)	koeficient korelace	faktor
A	Olše lepkavá / 15 let	C-04	C-004	5%	
		3 387	8 000	0,22	42%
		8%	30%		
B	Topol bílý / 20 - 25 let	C-13	N-033	25%	
		1 741	923	-0,5	189%
		29%	16%		
C	Borovice lesní / 74 let	B-05	AT-032		
		632	2 904	13%	22%
		68%	55%	-0,36	
D	Borovice lesní / 26 let	A-02	AT-002	6%	
		28 925	58 738	-0,25	49%
		5%	1%		
	Bříza bradavičnatá / 20 let	A-13	AT-002	15%	
		22 687	58 738	-0,38	39%
		1%	1%		

# Závěr

- kontaminace vzorků dřevní hmoty, získaných ze dřevin rostoucích v oblastech s kontaminací podzemní vody CE korespondovaly s obsahy kontaminatů v podzemní vodě
- při hodnocení výsledků je však nutno zohlednit celou řadu faktorů, které mohou ovlivnit koncentraci CE ve vzorcích dřevní hmoty.
- v rámci experimentu pozorované hlavní vlivy byly úroveň HPV, druh stromu a intenzita transpirace
- byla pozorována velmi rychlá odezva na zapojení sanační technologie, u borovice a topolu byl pozorován i možný fytoimediační vliv transpirace
- při využití vzorkování dřevního jádra pro hodnocení podpovrchové kontaminace je proto vhodné vyhodnotit i dendrologické charakteristiky vzorkovaných stromů a transpirační aktivitu a pokud je to možno, zopakovat vzorkování v různých obdobích vegetační sezóny

[www.isosoil.eu](http://www.isosoil.eu)

[www.modelprobe.ufz.de](http://www.modelprobe.ufz.de)

[www.modelprobedisseminationsystem.com](http://www.modelprobedisseminationsystem.com)

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