



COURSE PROJECT

Natural Attenuation

of Petroleum Hydrocarbons

at Upstream Oil and Gas Facilities

Kevin Biggar, U of A



The UofA
Geotechnical Centre





COURSE PROJECT SCOPE

- ◆ Natural Attenuation Evaluation at 2 upstream sites
 - ◆ Perform a typical investigation
 - ❖ see what the data tells us (site owner sponsored)
 - ◆ Perform a more detailed investigation
 - ❖ (more boreholes and analysis) and see if we get the same answer (COURSE sponsored)
 - ◆ Evaluate results for acceptable levels of investigation at future sites
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COURSE Participants

◆ University of Alberta

- ❖ Kevin Biggar [PI] (Geoenvironmental Engineering)
- ❖ Selma Guigard (Environmental Engineering)
- ❖ Julia Foght (Microbiology)
- ❖ Carl Mendoza (Hydrogeology)

◆ Industrial Partners/Advisors

- ❖ James Armstrong (Komex International)
- ❖ Lin Callow (Conoco)
- ❖ Lois Garrett (Devon)

◆ Government

- ❖ Ted Nason (Alberta Environment)
- ❖ Cathy Lareshen (AERI)
- ❖ Anne-Marie Thompson (Environment Canada)





COURSE Time Schedule

- ◆ Spring 01: Site investigation and installation of monitoring systems
- ◆ Spring 01 - Fall 02: Gather 2 yrs of data 3 times/yr
- ◆ Spring 03: Final report on findings.



2001-2002 Scope of Work

- ◆ Site characterization at two sites
 - ❖ Old flare pit site
 - ❖ Compressor-dehydrator lease
 - ◆ Installation and sampling of extra monitoring points
 - ◆ Utilized new monitoring tools
 - ◆ Performed alternative sampling methods to evaluate effect on geochemistry
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Additional Sampling

- ◆ Results at Flare Pit showed:
 - ❖ Highly variable nature of subsurface
 - ❖ Appears to be channeling into very narrow plume due to local geological heterogeneity





Additional Sampling (cont.)

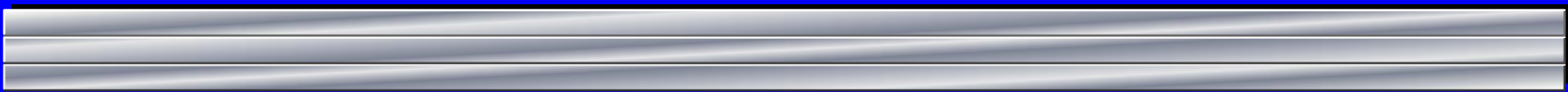
- ❖ Rapid decrease of contaminant concentration -
Plume Length <60m in sandy soil.
- ❖ Geochemical evidence of NA @ site
- ❖ No historical trends since only one monitoring
year in many of new wells





Novel Characterization Technologies

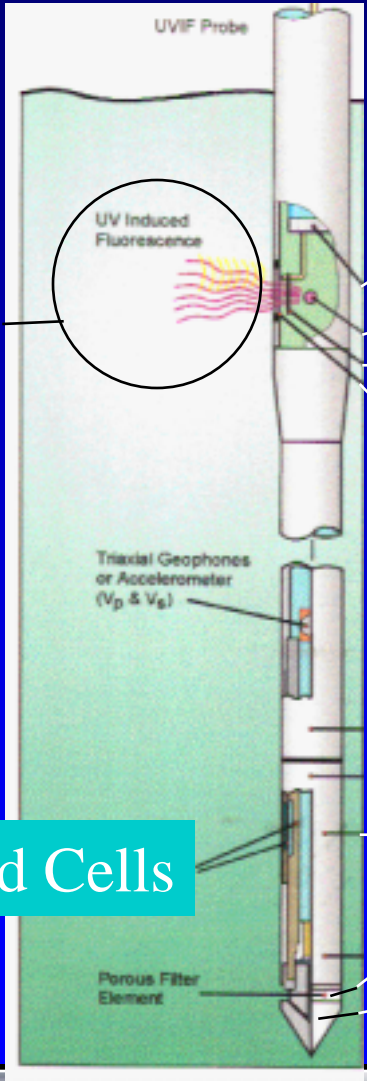
- ◆ Cone Penetration Test with Ultra Violet Induced Fluorescence (CPT-UVIF)
- ◆ Hydrogen gas sampling
- ◆ Diffusion sampling





CPT-UVIF Principles

UV Induced
Fluorescence
of free phase
HCs



UVIF Detector
UVIF Source
Filter
Sapphire Window


Load Cells

Friction Sleeve
Pore pressure sensor
Cone Tip





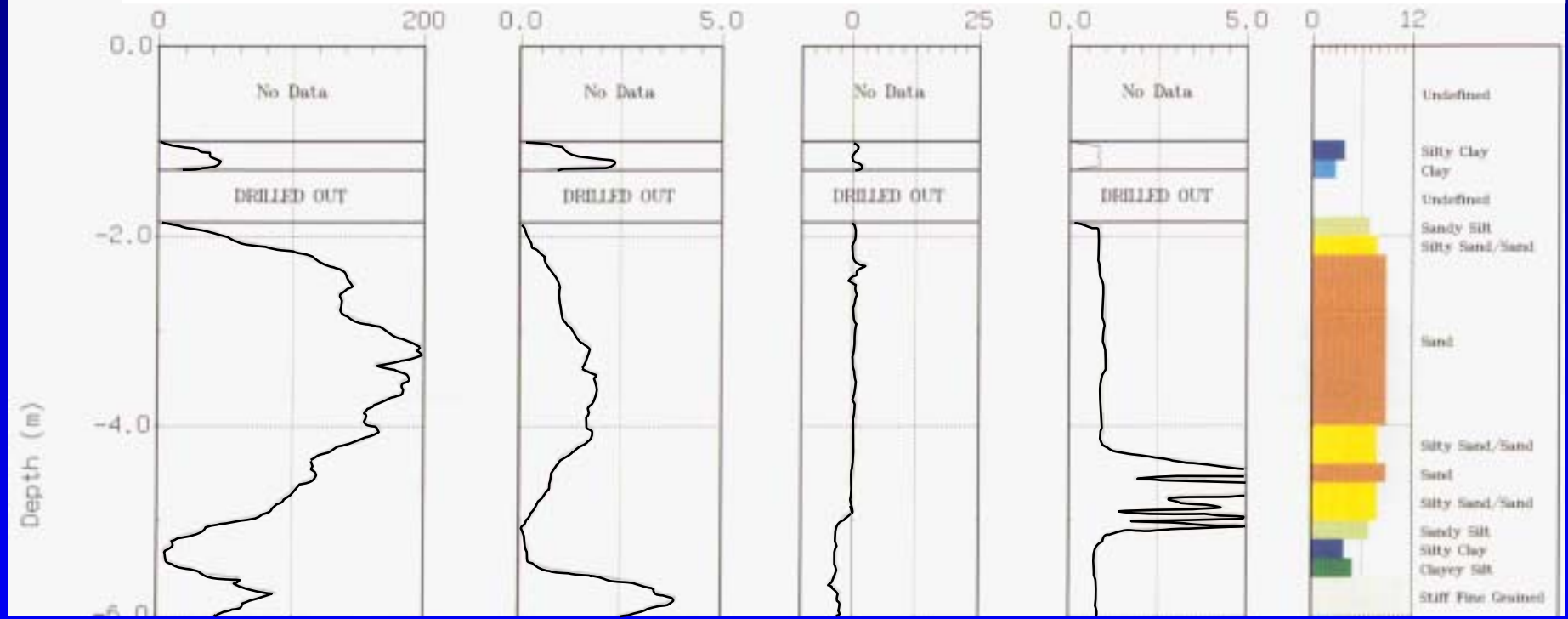
CPT-UVIF Performance

- ◆ Worked well until bedrock contact- refusal
 - ◆ Despite concerns about hitting large stones in till, good penetration
 - ◆ UVIF provided rapid indication of contamination near flare pit
 - ◆ Non-detect in areas with no FP despite elevated TPH, TEH
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CPT UVIF Results

Tip Resistance Friction ratio Water press. Fluorescence Soil Type





Hydrogen Gas Sampling

- ◆ Used Field Portable Gas Chromatograph with Reduction Gas Detector (GC/RGD) and Bubble Strip Method
- ◆ Long times required for H₂ gas to stabilize (30-40 minutes)
- ◆ Finicky to perform in the field
- ◆ Ongoing study





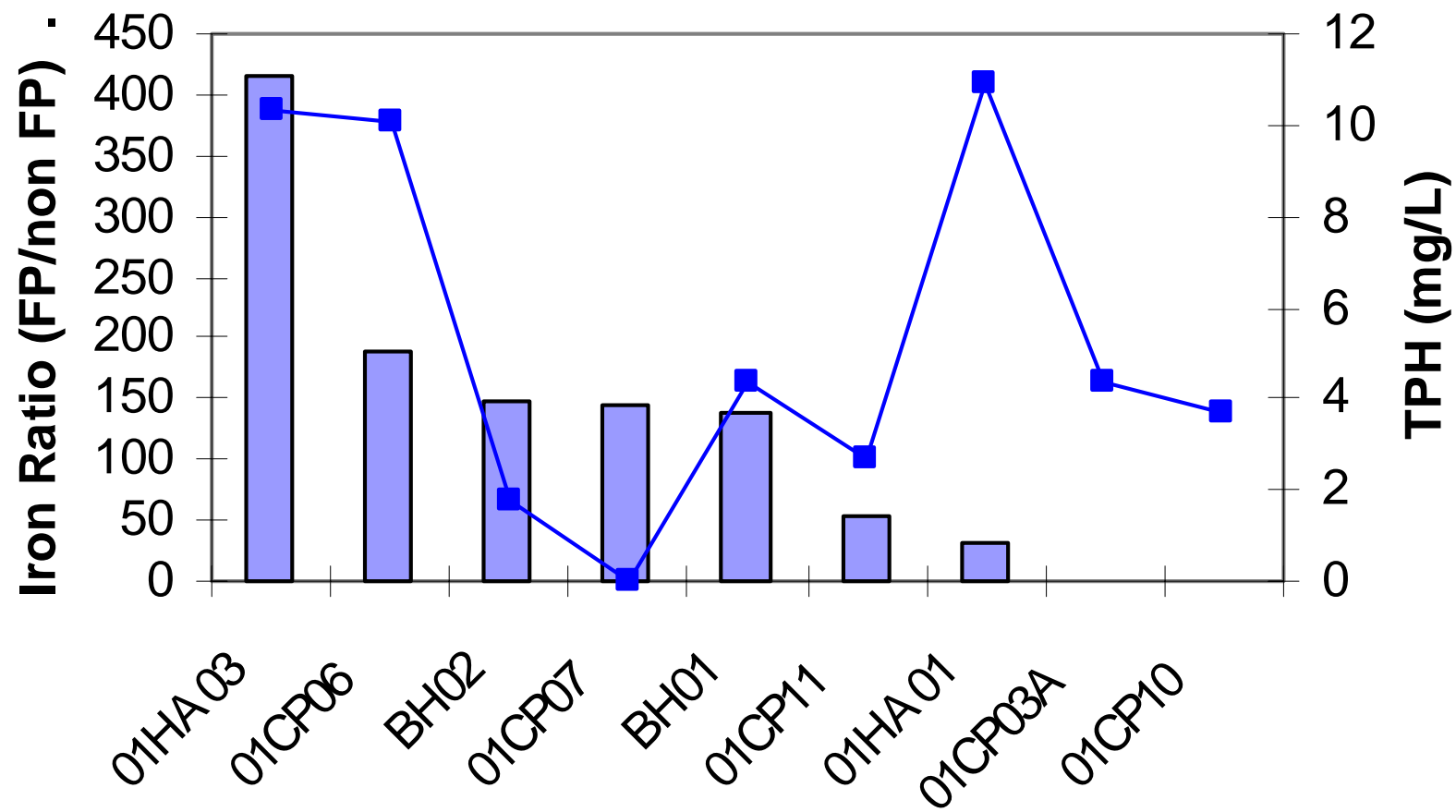
Alternative Sampling Methods

- ◆ Important with respect to geochemistry
- ◆ Dissolved iron in particular as TEA
- ◆ When samples filtered and preserved concentrations increased dramatically





Effect of Filtering and Preservation on Iron






Diffusion Test Method

- ◆ U of C initiative with Komex participation
- ◆ Prototype was tested and work is ongoing
- ◆ Results are still being evaluated as the design is modified.





CORONA Funding

- ◆ Conoco and Devon are funding significant cash and in-kind
 - ◆ CAPP has provided financial support
 - ◆ Komex has contributed significant in-kind
 - ◆ Funds provided by COURSE, AB Env, and Env Canada, though contributions are not matchable by NSERC
 - ◆ NSERC funding pending
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Additional CORONA Participants

◆ Confirmed

- ❖ U of C
(Diffusion Sampling,
Bioassays)
- ❖ NWRI Burlington
(Sulfate Reduction)

◆ Tentative

- ❖ Universities in Leipzig
and Tübingen in Germany
- ❖ U of S
(Sampling Technologies)

