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Bioremediation of oil contaminated environment

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Cedre
Interspill 2015

After the incident, main responses

At Sea

Mechanical recovery

Dispersion

In Situ Burning

On the Shoreline

First Cleanup

Manual cleaning

Sand screening

and Bioremediation

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Bioremediation ….

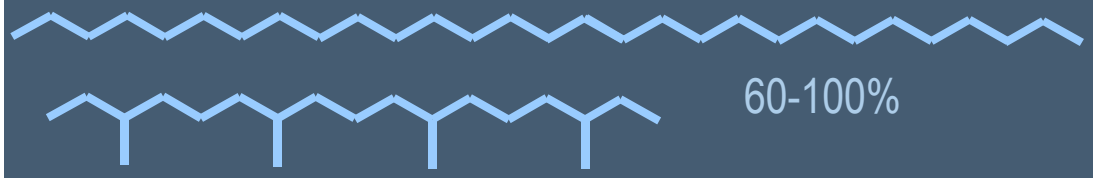
- Is considered as a « green » techniques compared to others

- Can be limited due to oil nature / concentration / physical state and environmental parameters (Temperature, Oxygen, Nutrients) => these parameters need to be assessed systematically before bioremediation deployment

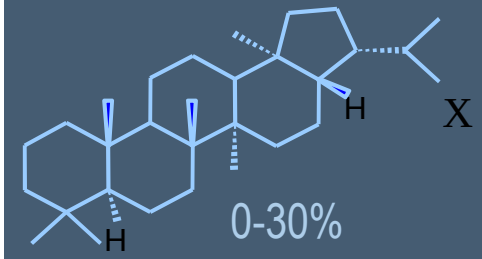
The bioremediation of a contaminated environment involves influencing environmental conditions to optimise the natural biodegradation of the contaminant.

Type of contamination

According to the chemical composition, the biodegradability of the oil will vary:

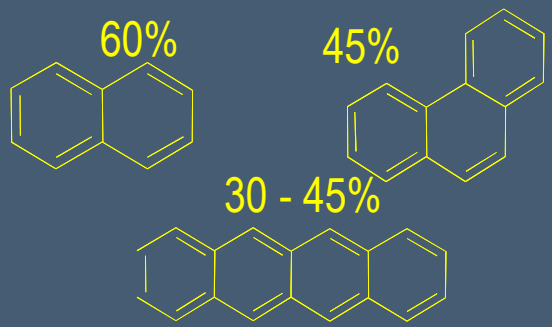


60-100%

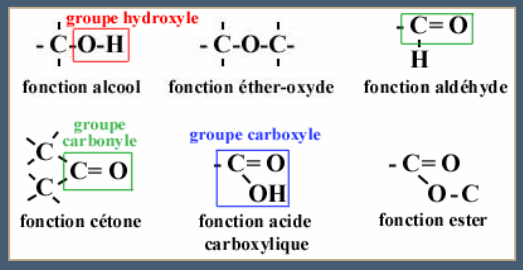


0-30%

Alkanes

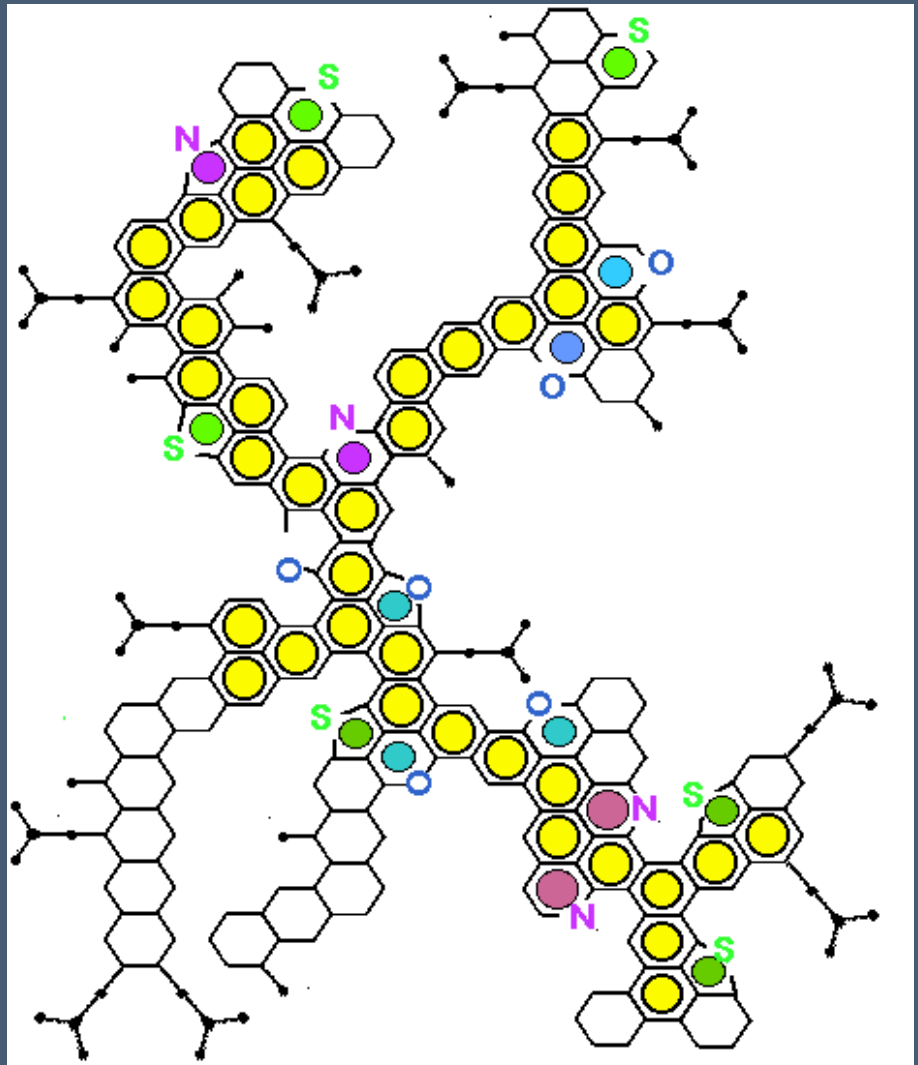


Aromatics



Resins

10 - 30%



Asphaltenes

0 – 10%

The bioremediation of a contaminated environment involves influencing environmental conditions to optimise the natural biodegradation of the contaminant.

⇩

Type of contamination

According to the chemical composition, the biodegradability of the oil will vary:

Type of oil	Biodegradability (%)
Petrol	> 90%
Kerosene	> 80%
Diesel	60 – 80%
Lubricants	< 50%
Crude oil (variable)	30 – 70%
Heavy fuel oil	10 - 20%
Bitumen	negligible

Bioremediation ….

- Is considered as a « green » techniques compared to others

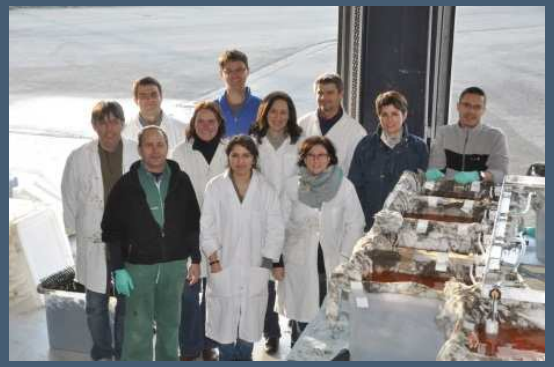
- Can be limited due to oil nature / concentration and environmental parameters (Temperature, Oxygen, Nutrients) => these parameters need to be assessed systematically before bioremediation deployment

- Implies that commercial products are used to increase oil biodegradation / bioavailaibility through the addition of nutrients (biostimulation), bacteria (bioaugmentation), surfactant

Recent activities …

Oil degradation in coastal muddy areas and anoxic ecosystems

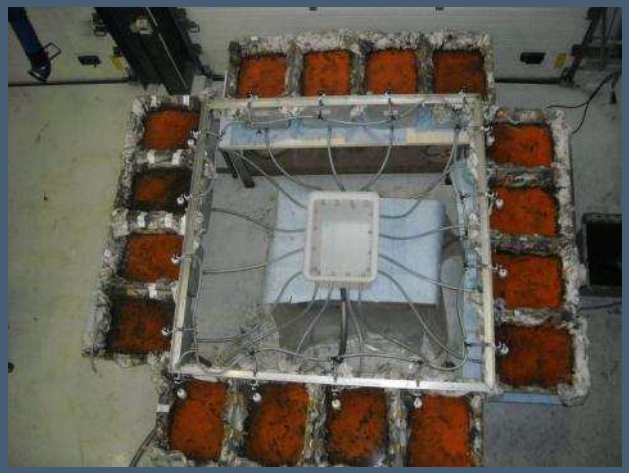
*In **DE**pth characterization of HC-degradation **CAPA**cities of marine sediment microbial communities: adaptation, metabolic processes and influence of oxy**GE**nation regimes*



- University of Toulouse
- University of Pau (2 laboratories)
- University of Marseille
- *Cedre*

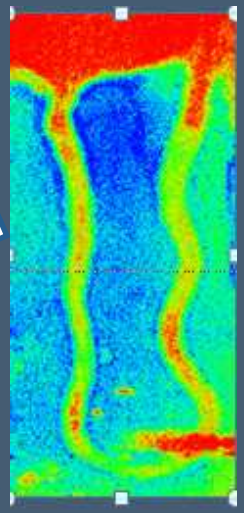
Recent activities …

- To better understand how biodegradation works in coastal ecosystems :
  - Influence of macrofauna (burrowing) in mudflats: very low [O_2]
  - Effect of oxic / anoxic oscillations conditions on the ecology of microorganisms

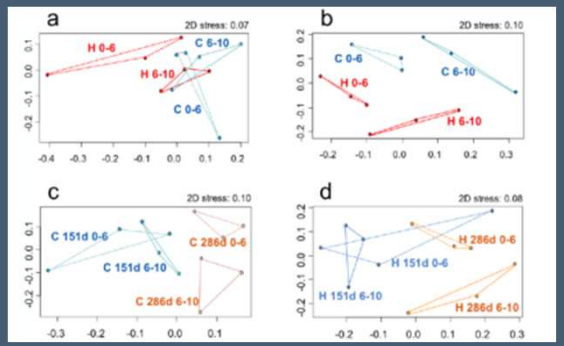


DECAPAGE experiment: *simulation of oil spill in mudflats during 10 months*

Addition of *H. diversicolor* in contaminated sediment

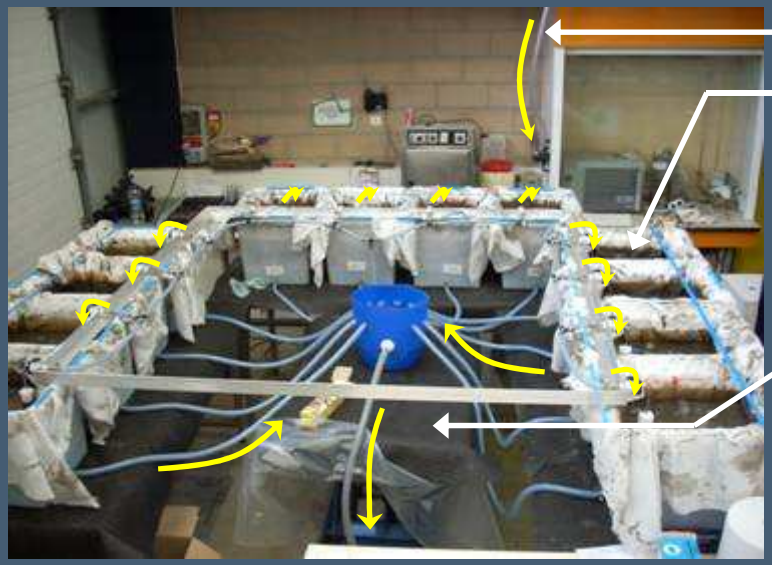


Oxygen diffusion in H. diversicolor *burrow*



Comparison of bacterial community structures by non-metric multidimensional scaling (NMDS) analyses based on T-RFLP 16S rRNA gene patterns.

Mesoscale Experimentation (Jan. - Nov. 2012 / Jan 13 – Nov 13)
Microcosms of a mud type ecosystem



Seawater supply

16 microcosms (30L of mud each) equipped of :

- *geotextile membrane*
- *ball cock*
- *evacuation pipes of tides water*

Lifting table with collector of tides water

Conditions :

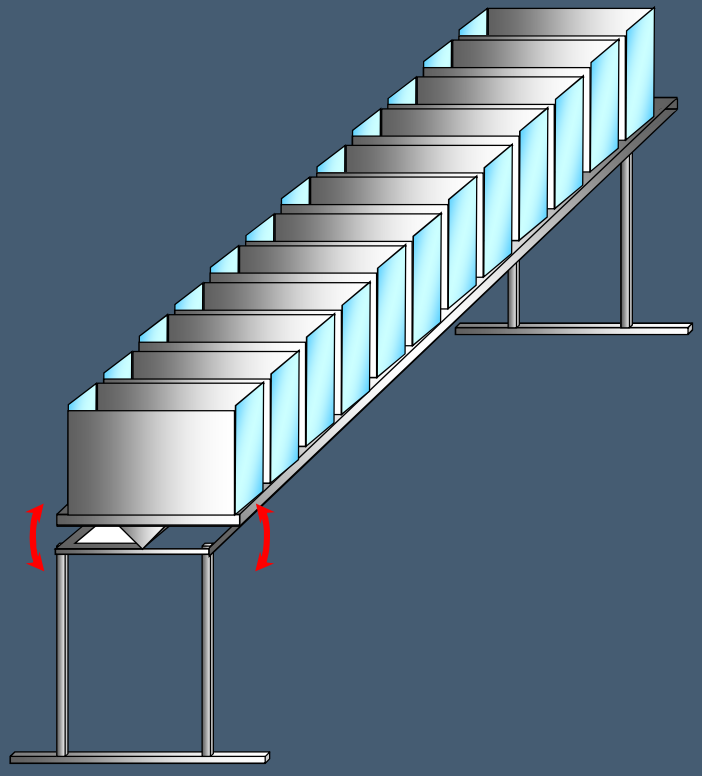
- *negative control (only sediments)*
- *sediments with oil pollution*
- *sediments with Hediste diversicolor (bioturbation)*
- *sediments with oil pollution + bioturbation*
- *sediment with dispersed oil with or without Hediste.*

10 sampling rounds of sediment cores (10 x 3 cm) were dispatched to the different laboratories during the 10 months of experiment.

Recent activities …

Development of an efficiency test for bioremediation agents

Objective: to simulate a contaminated shoreline treated with a bioremediation agent including continuous dilution due to tidal cycle.



12 tanks
(L = 40cm; l = 20 cm; h = 30 cm)

Oscillating table
(L = 4,80m ; l = 20 cm)

Development of an efficiency test for bioremediation agents

Objective: to simulate a contaminated shoreline treated with a bioremediation agent including continuous dilution due to tidal cycle.

- shaker table with 12 tanks
- seawater tank
- programmable lifting table whose upward and downward movements control the emptying (low tide) or filling (high tide) of the tanks

Need of experimental studies …

- To define a new protocol for comparison of bioremediation agent efficiencies including continuous natural dilution with fresh water to simulate tidal cycle (not the case in most of the existing test)

Sintef column system including a water reservoir

Cedre "shoreline bench" including water reservoir and agitation

Need of experimental studies …

- To assess and define bioremediation agent use: multiple application ? time of the 2nd application?

- To assess the biodegradation kinetics and biodegradability of dispersed oil in water column: need of standardized laboratory protocol including:
    - Oil concentrations ? Temperature ?
    - autochtonous bacteria or bioaugmentation ? ,
    - which chemical analyses : n-alcanes / PAHs degradation or global analyses of oil (HTGC, GC2D)
    - which microbial analyses: MPN, PCR, TRFLP, … ?

- To assess / improve biodegradability of refractive compounds (high molecular weight compounds)

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THANK YOU