Field testing of thin layer capping with AC and passive materials in Norway

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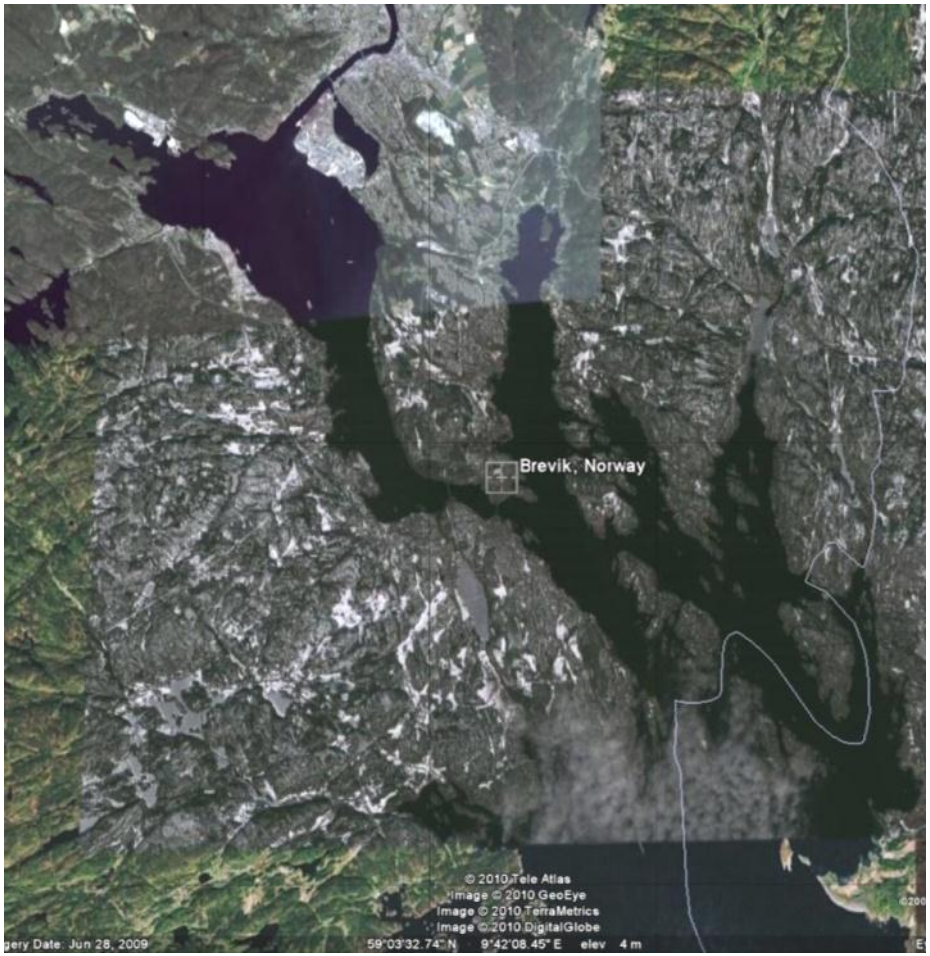
Content

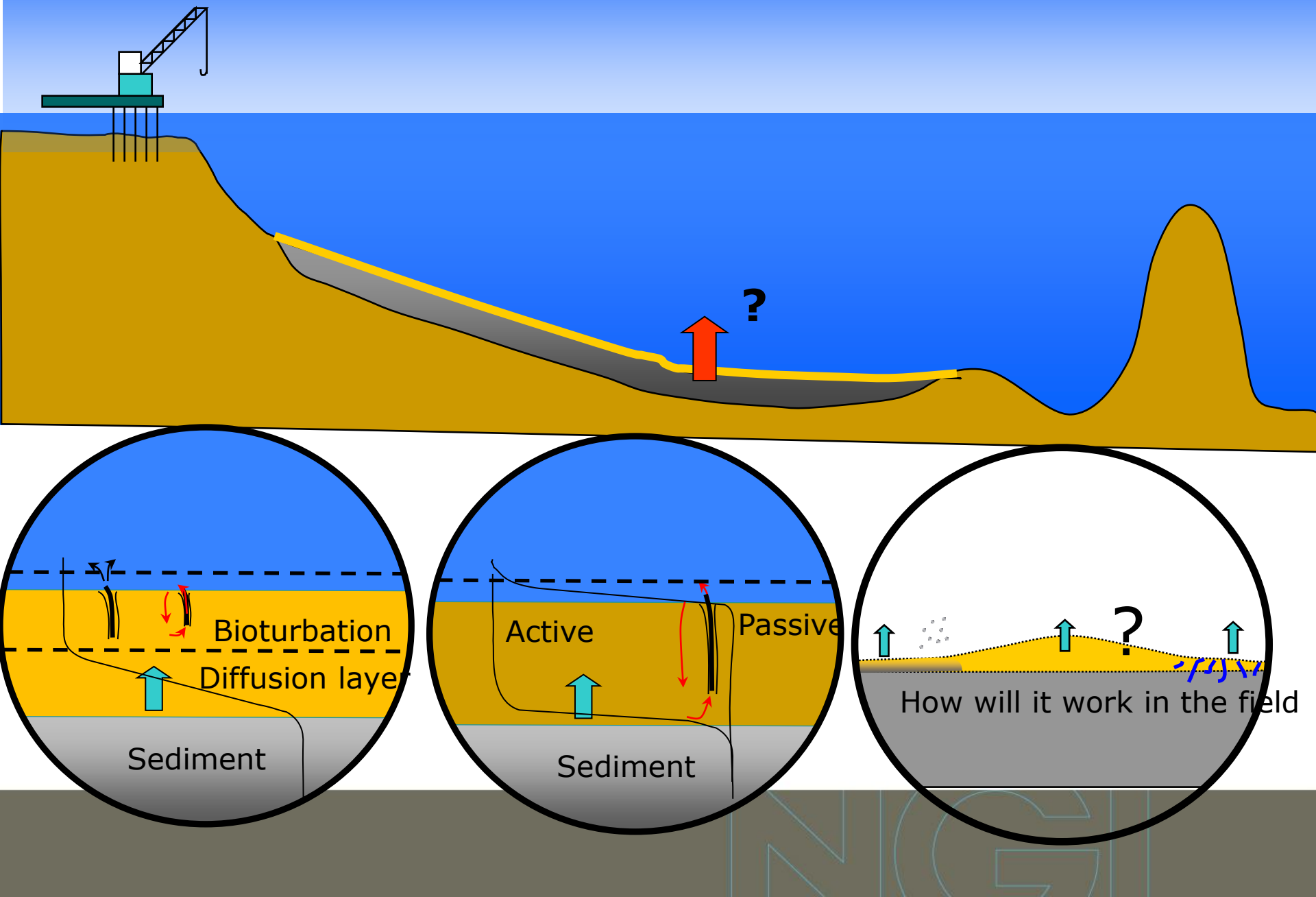
- Thin layer capping
- Methods used in the study of thin layer capping
- Effetiveness

Why thin layer capping?

- Remediation of large moderately contaminated areas
- Less use of non-renewable resources
- Less cost
- Less secondary effects on the environment where remediation is done



Working principle of passive and active caps



Partners in Opticap

Scientific:

NGI

Stockholm University

NIVA

Technical:

AGDER MARINE A/S
MUDRING OG MARINE OPERASJONER

SECORA

Materials:

NOAH
KOMPETANSE TIL Å OVERTA ANSVAR

Jacobi
THE CARBON COMPANY

OMYA Hustadmarmor

Financial:

HYDRO

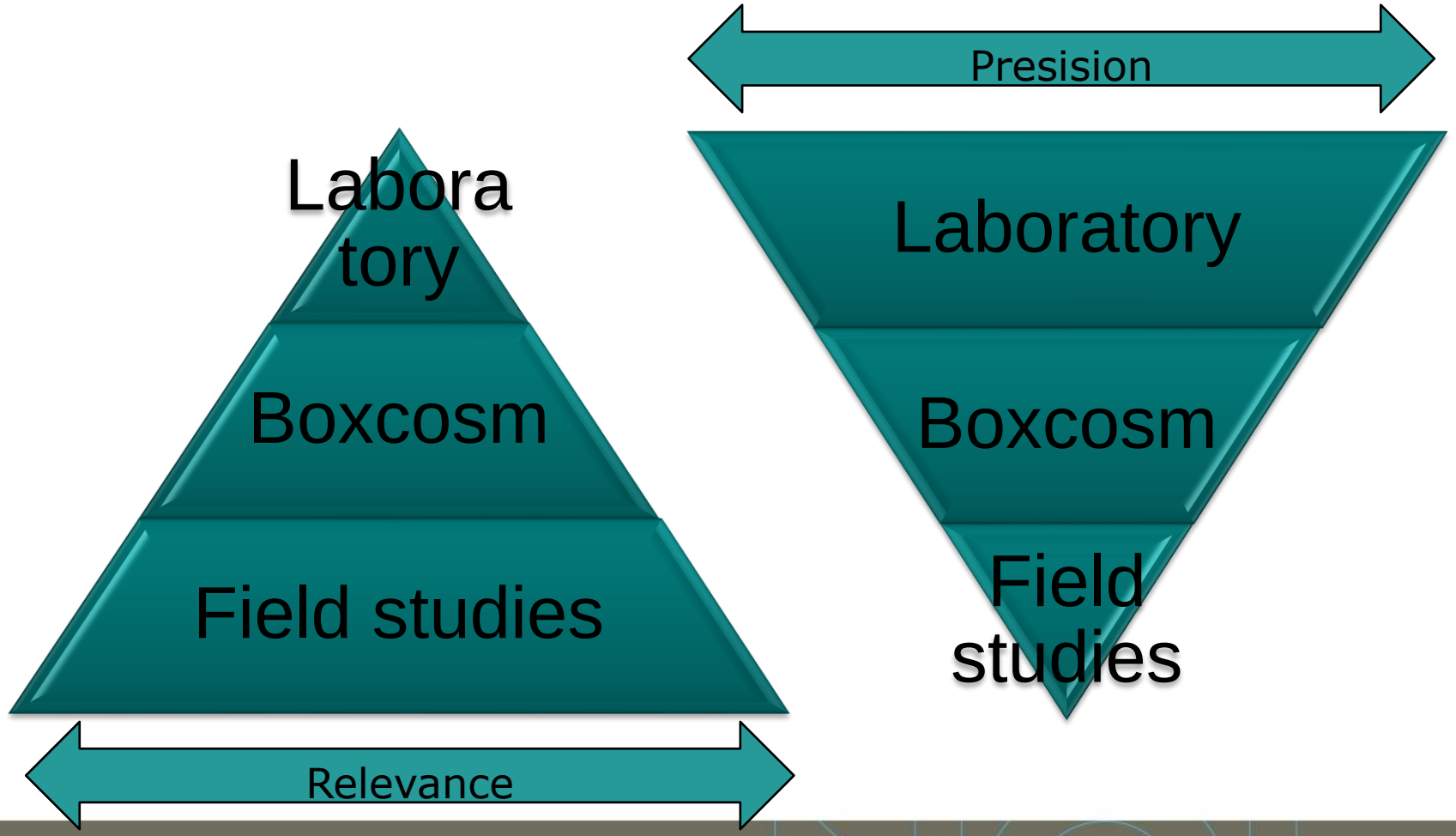
Forskningsrådet

KLIMA- OG FORURENSNINGS-DIREKTORATET

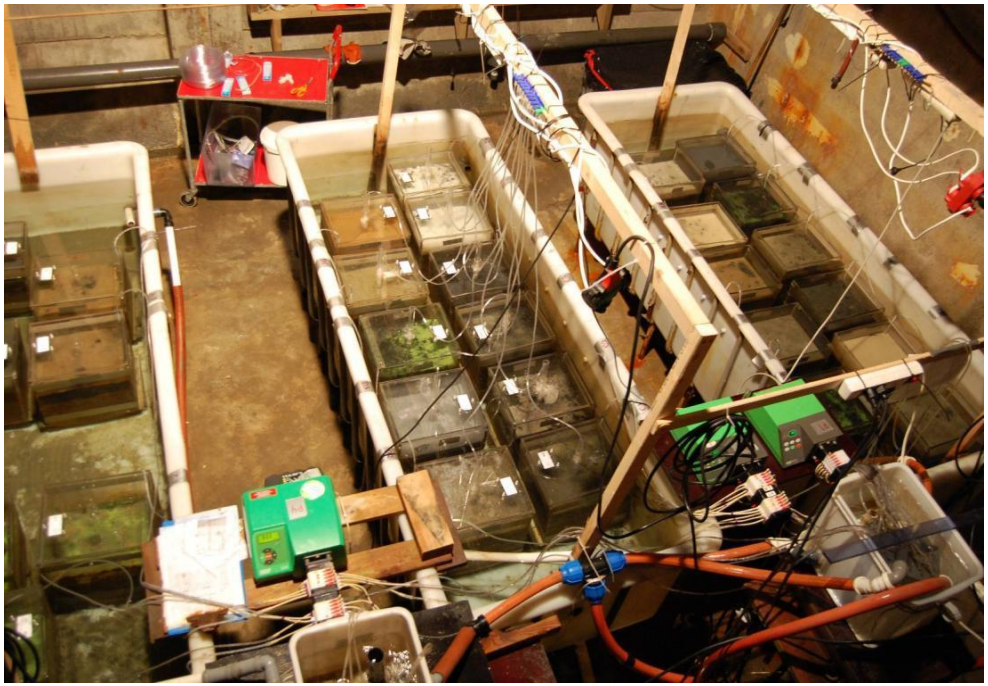
Methods used to study thin layer capping

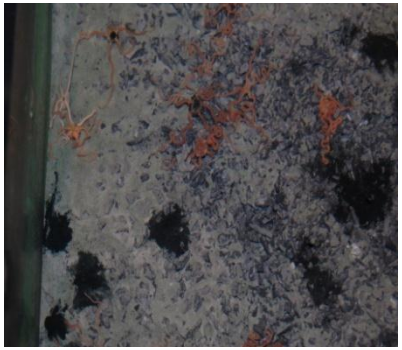
	Placement	Effectiveness	Secondary effects
Modeling	Placement from barge	Diffusion through cap layers	Life cycle assessment (LCA)
Laboratory tests Test of individual mechanisms	Material properties	Sorption and diffusion studies	Leaching from materials
Laboratory tests multiple mechanisms (Boxcosm)	Influence of Bioturbation on cap properties	Bio-accumulation and flux	Toxic effects of capping materials
Field tests	Cap thickness measured in situ	Flux in situ and accumulation in organims	Ecological status measured in testplots

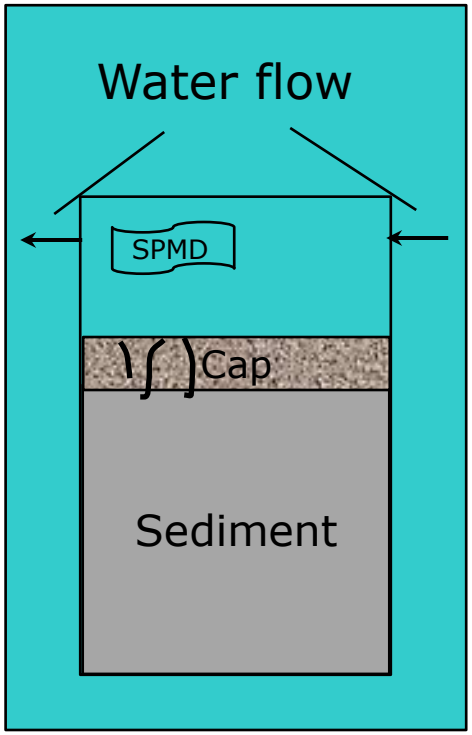
Relevance and presision in different methods



Boxcosm tests, NIVAs research station, Solbergstrand

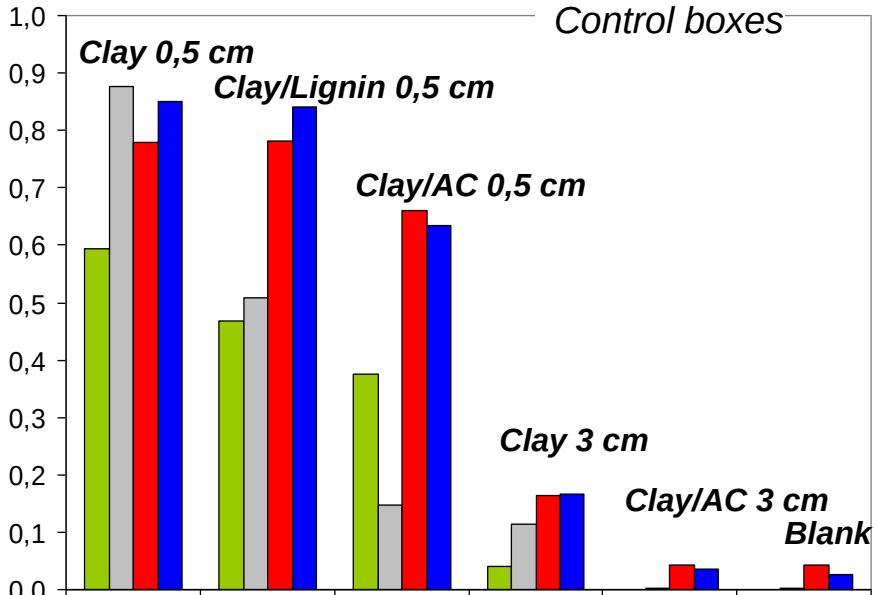






Effectiveness of thin layer capping
Flux in boxcosm

Reduced concentration of OCS, HCB and dioksines i pore water in bioturbation layer (0-3 cm)



	Cl-5	LI/Cl-5	AC/Cl-5	Cl-30	AC/Cl-30	LDPE-bl
OCS (73 950 pg)	59,5 %	46,8 %	37,6 %	3,9 %	0,1 %	0,0 %
HCBz (226 000 pg)	87,6 %	50,9 %	14,8 %	11,5 %	0,2 %	0,2 %
Sum PCDD/F (3002)	77,8 %	78,2 %	66,0 %	16,4 %	4,4 %	4,2 %
WHO-TEQ (276 pg)	85,1 %	84,1 %	63,4 %	16,7 %	3,6 %	2,7 %

Cap efficiency >95% for 3 cm clay/AC

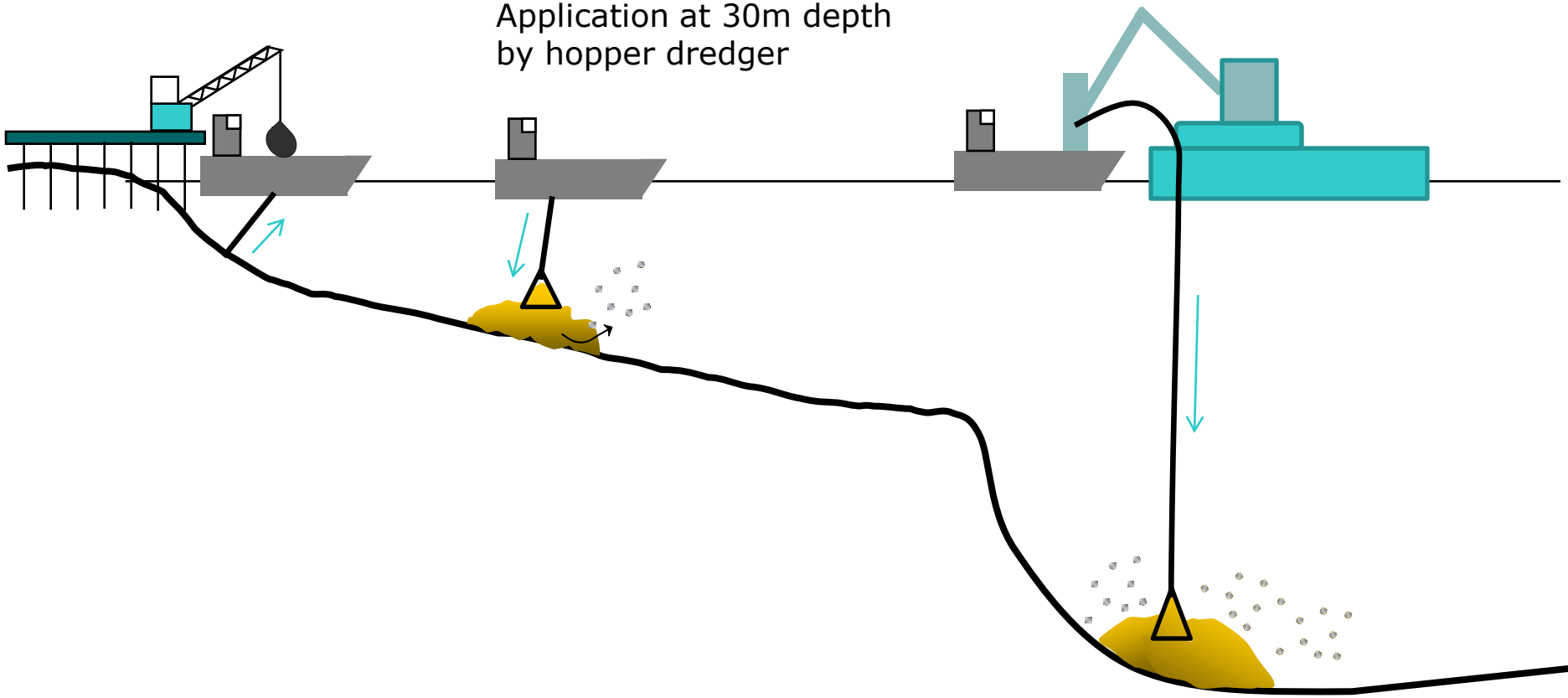
Model: $RE = e^{-b\sqrt{tykkelse}}$

Field testing of thin layer capping

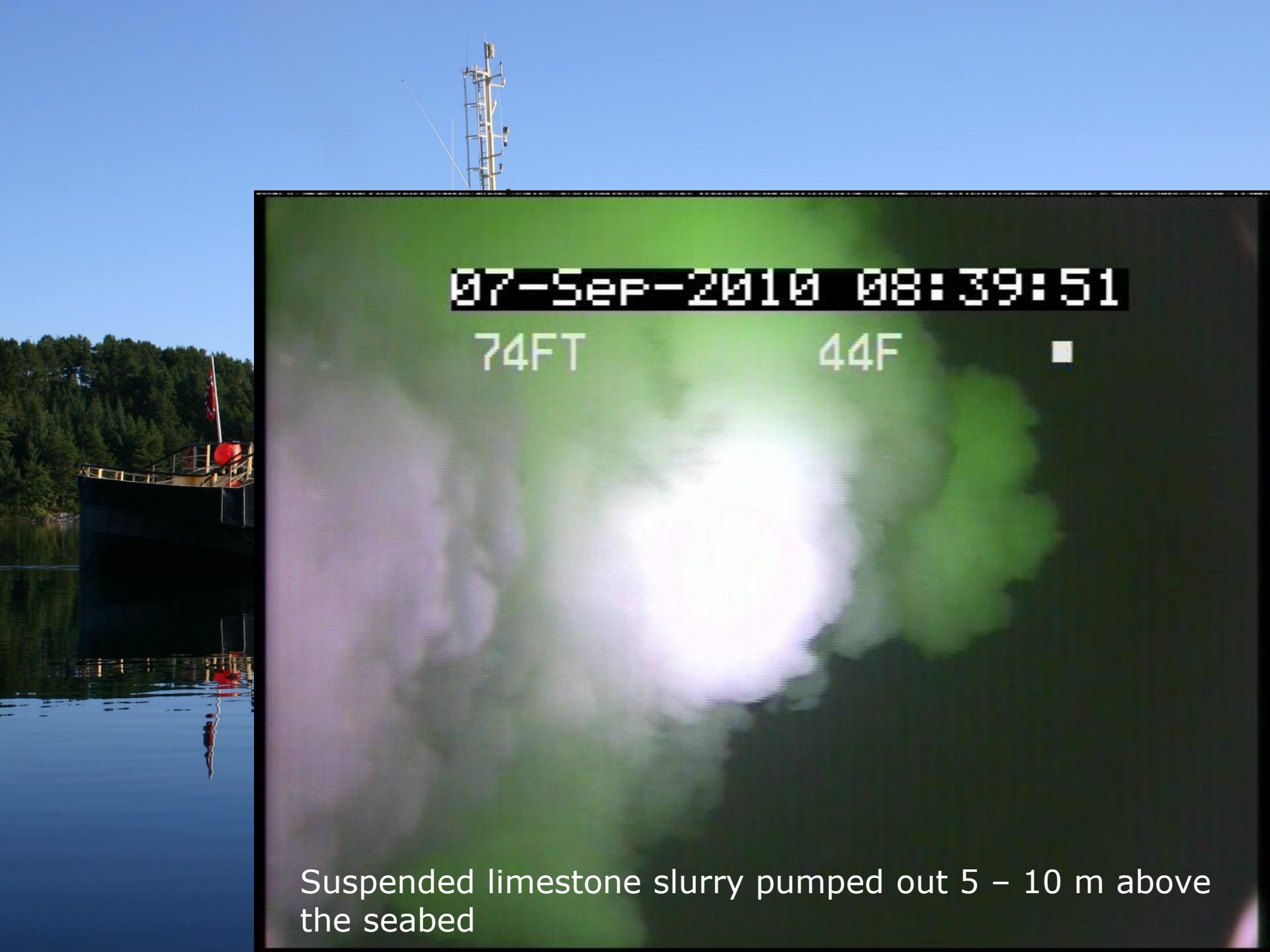
Dredging and mixing materials
in a hopper dredger

Application at 30m depth
by hopper dredger

Application at 100m depth
using a separate pump on
transport platform

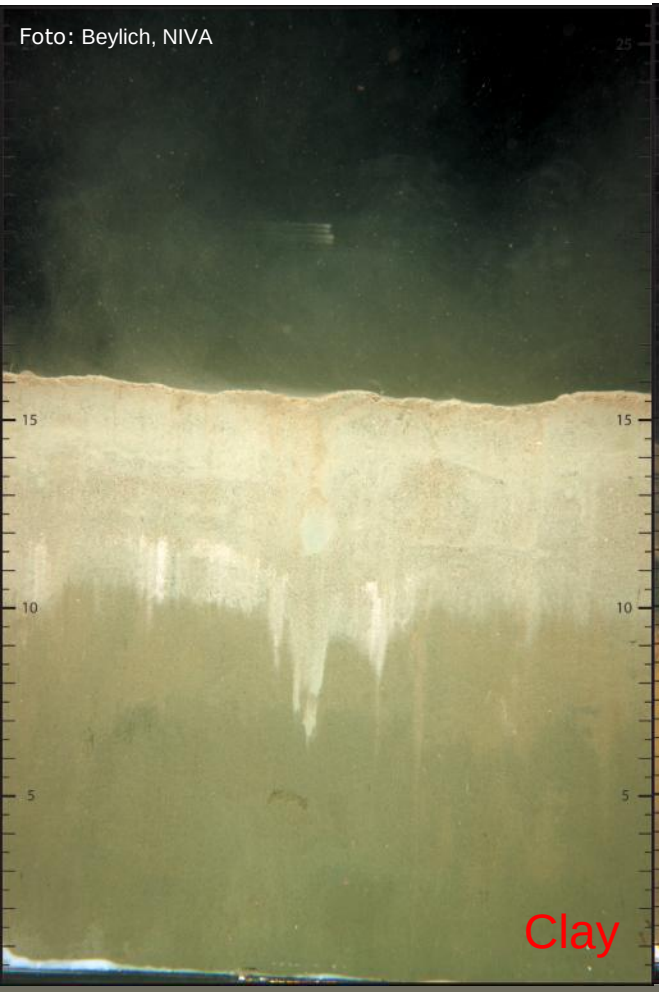


Material mixing in hopper dredger



Suspended limestone slurry pumped out 5 – 10 m above the seabed

Grenlandfjord (30 m depth)



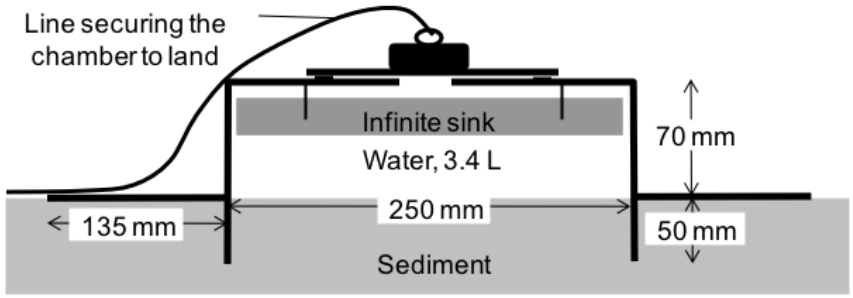
Monitoring of effectiveness of the thin layer capping in the field

Flux chambers with

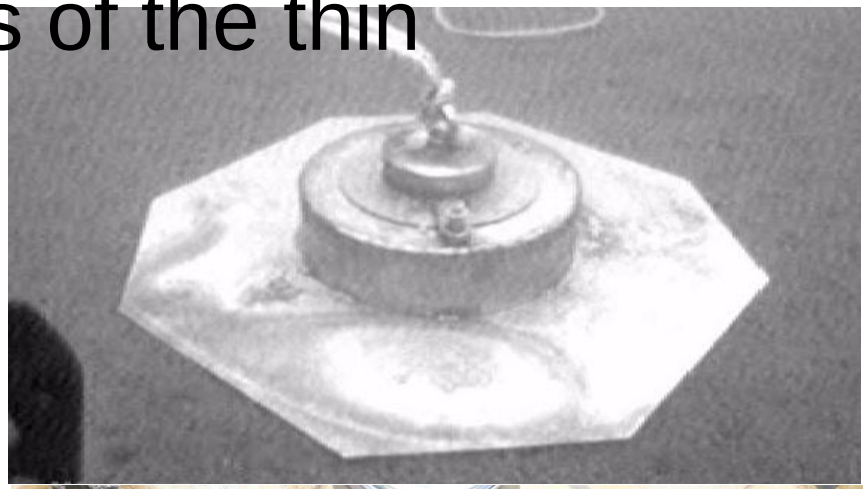
infinite sink passive samplers

Exposed in 2 – 24 weeks

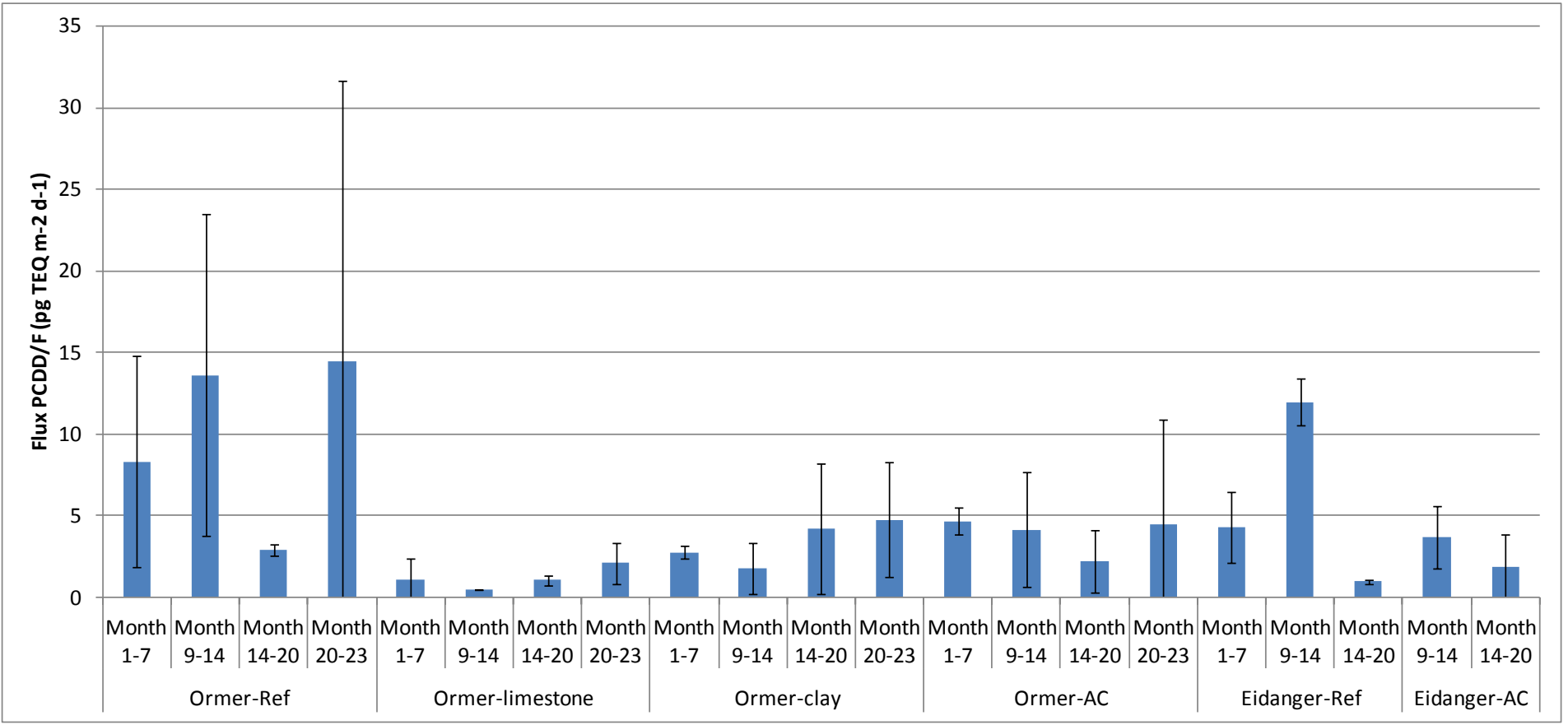
- Flux of TBT, PAHs, PCBs and dioxins from the seabed



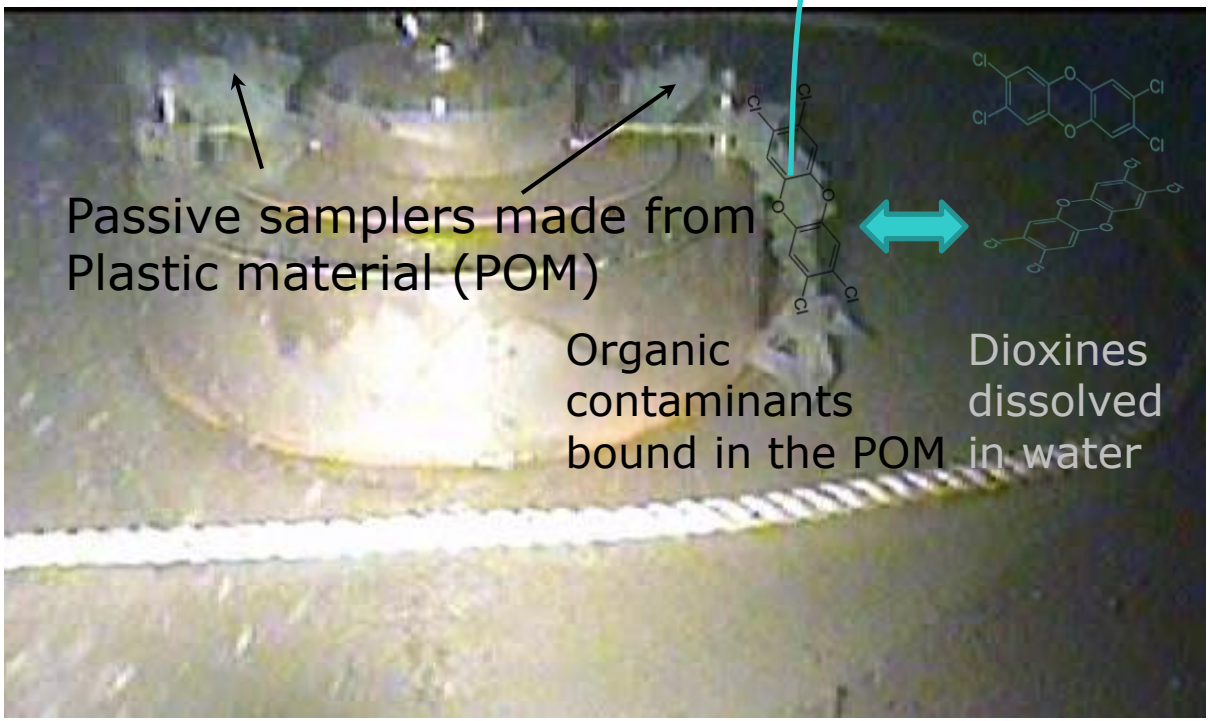
Eek et al., Environmental Science & Technology 2010



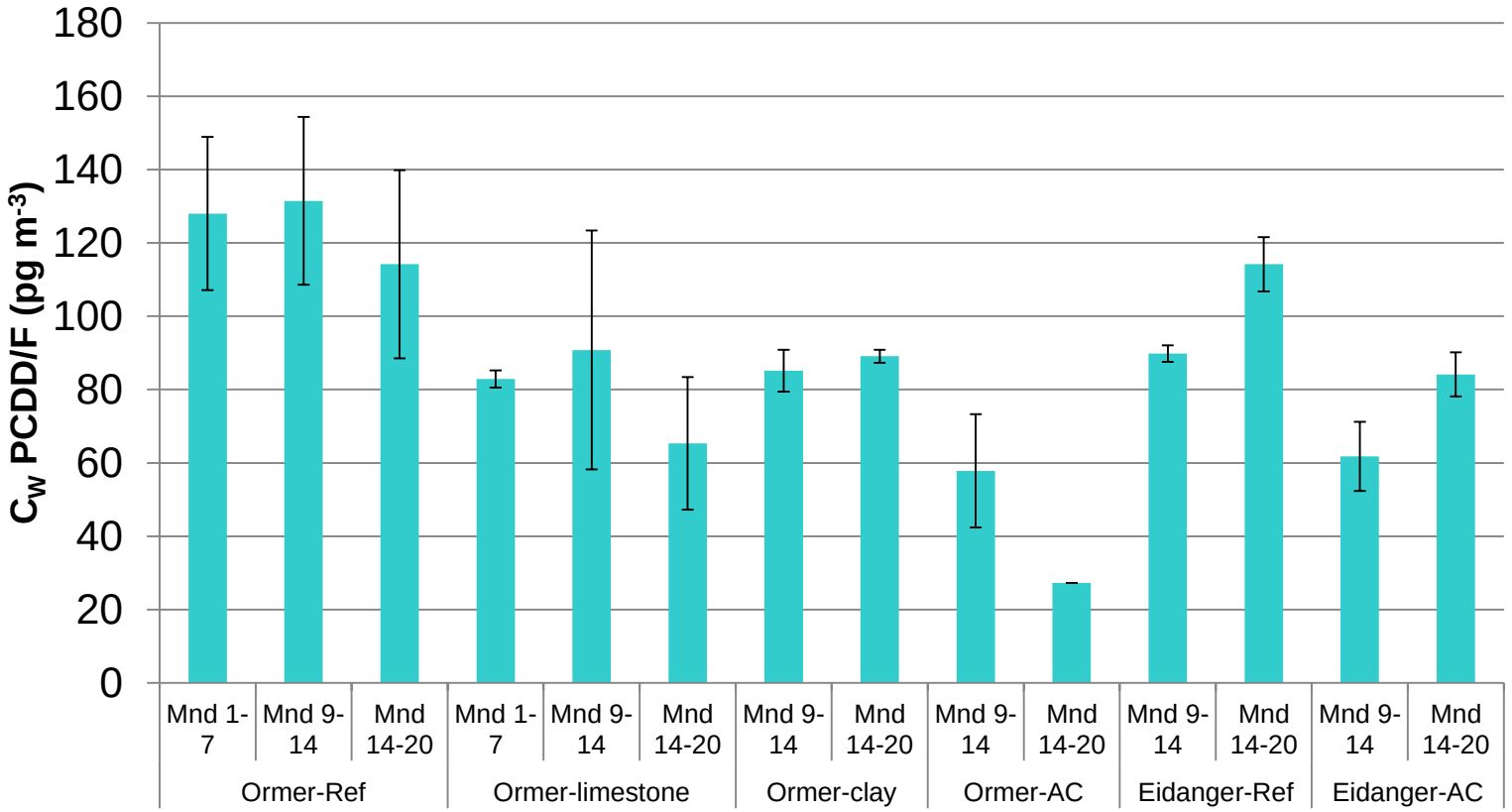
Release of dioxins/furanes in flux chambers from Grenlandfjord test plots



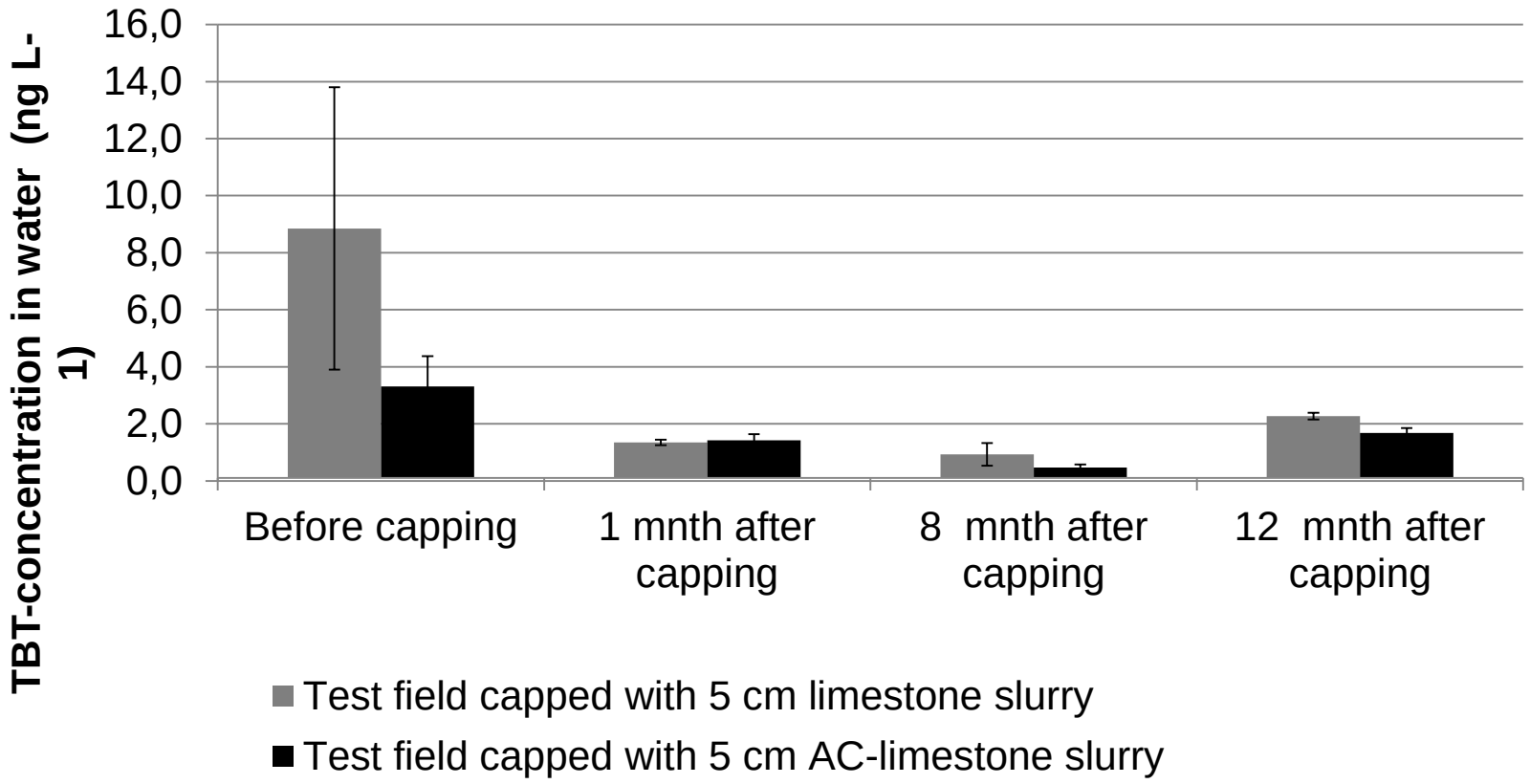
Freely dissolved organic contaminants in overlying water



Freely dissolved Dioxins in overlying water at Grenlandfjord test plots



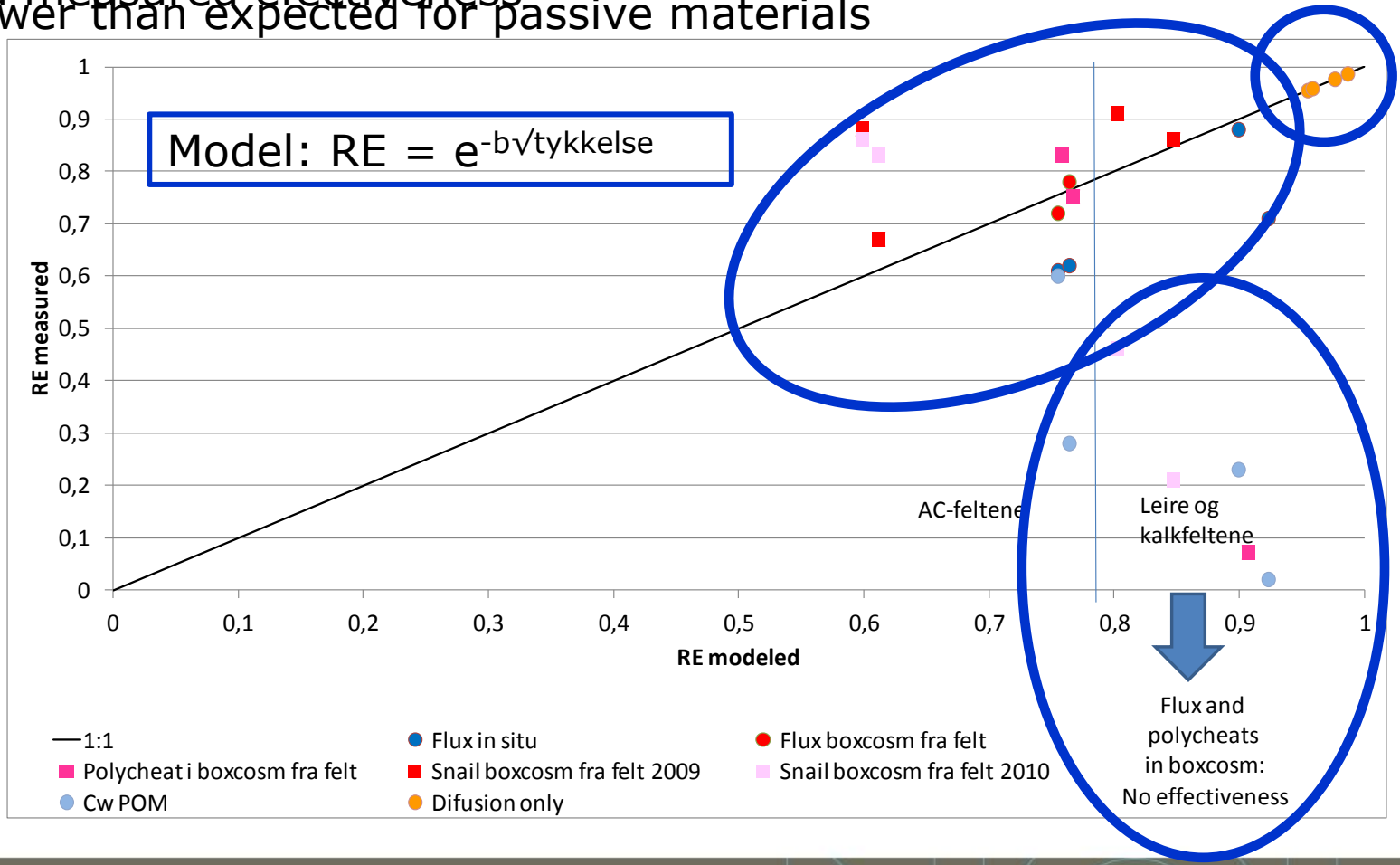
Freely dissolved TBT in overlying water



Modelled vs measured Remediation effectiveness (RE)

Generally good agreement found between modeled and measured efectiveness

The theoretical diffusion controlled Effectiveness measured in boxcosms was lower than expected for passive materials



Conclusions

Placement of AC-mixed with clay resulted in well defined AC-layers

Important parameters like pore water concentrations sediment to water release and overlying water concentrations can be monitored *in situ*

Thin layer capping with or without AC can reduce the availability with 50 – 95 %

Both cap thickness and active material content are important

Thanks !