



ICMGP 2024
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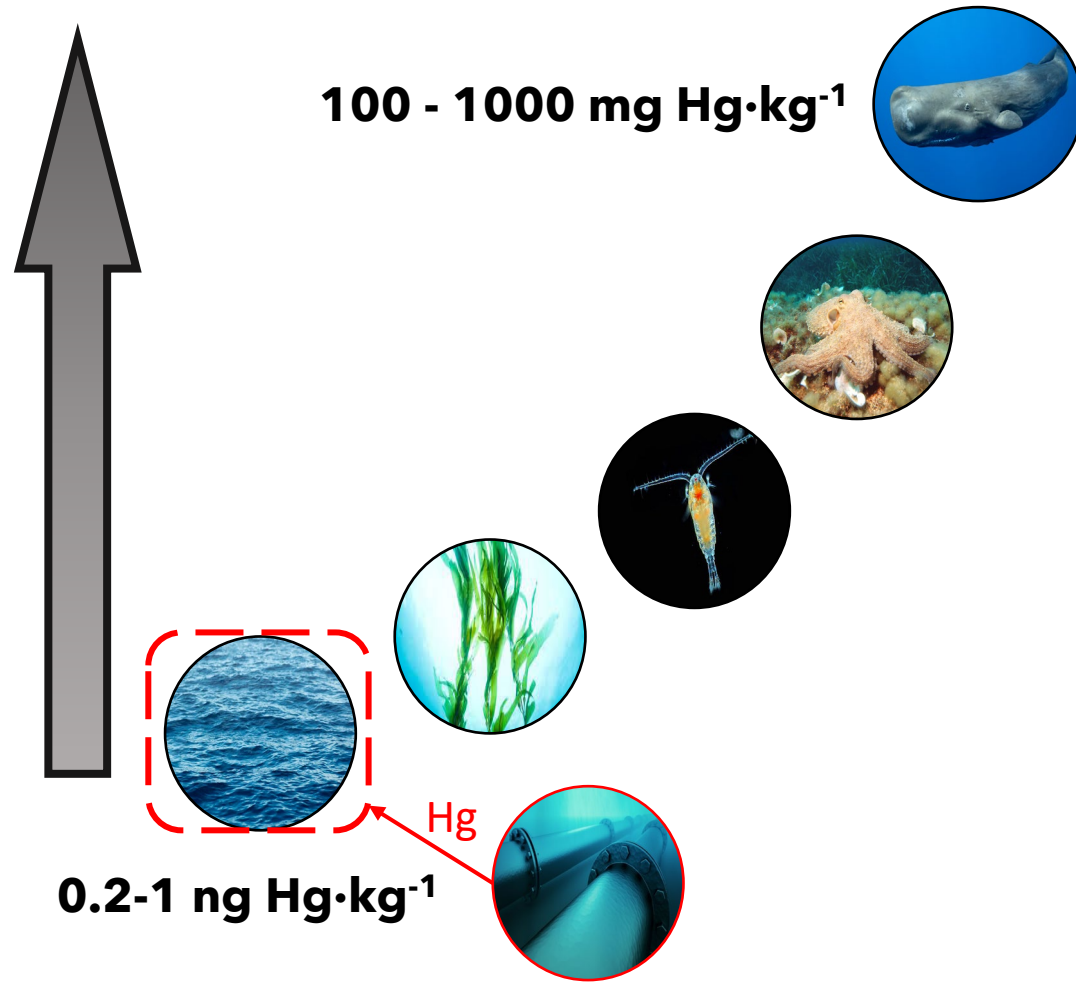
Are future oil and gas decommissioning sites potential sources for mercury contamination in the deep sea?

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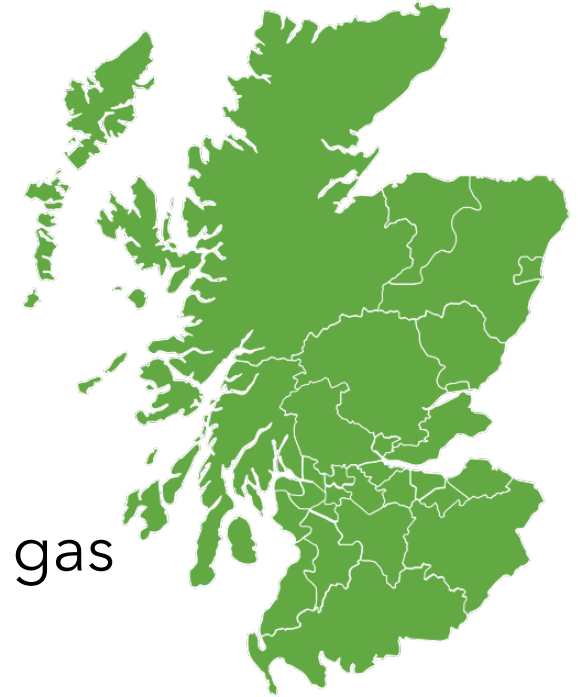


Hg bioaccumulation: Part I

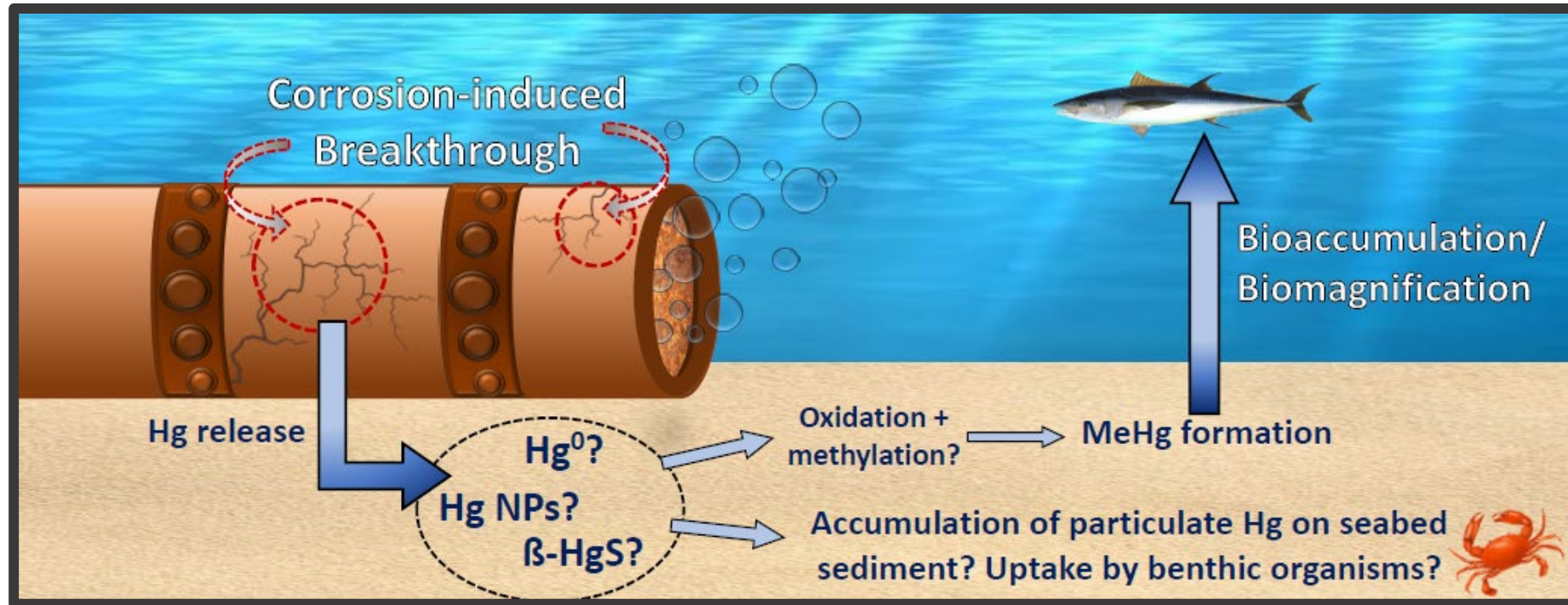


North Sea

- 27,000 km of gas pipelines
- What impact could pipelines left on the seabed have?



Hg accumulation



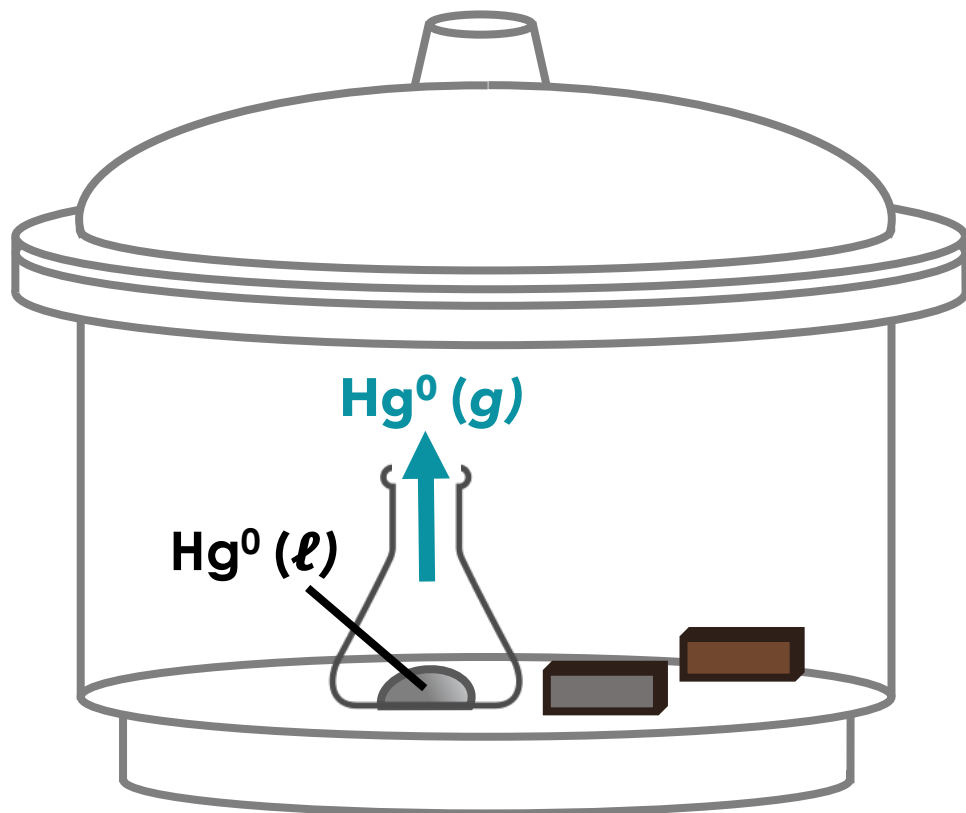
Key questions:

- Does Hg accumulate on subsea pipelines?
- Is this Hg mobile in the environment? Or is it all β -HgS?

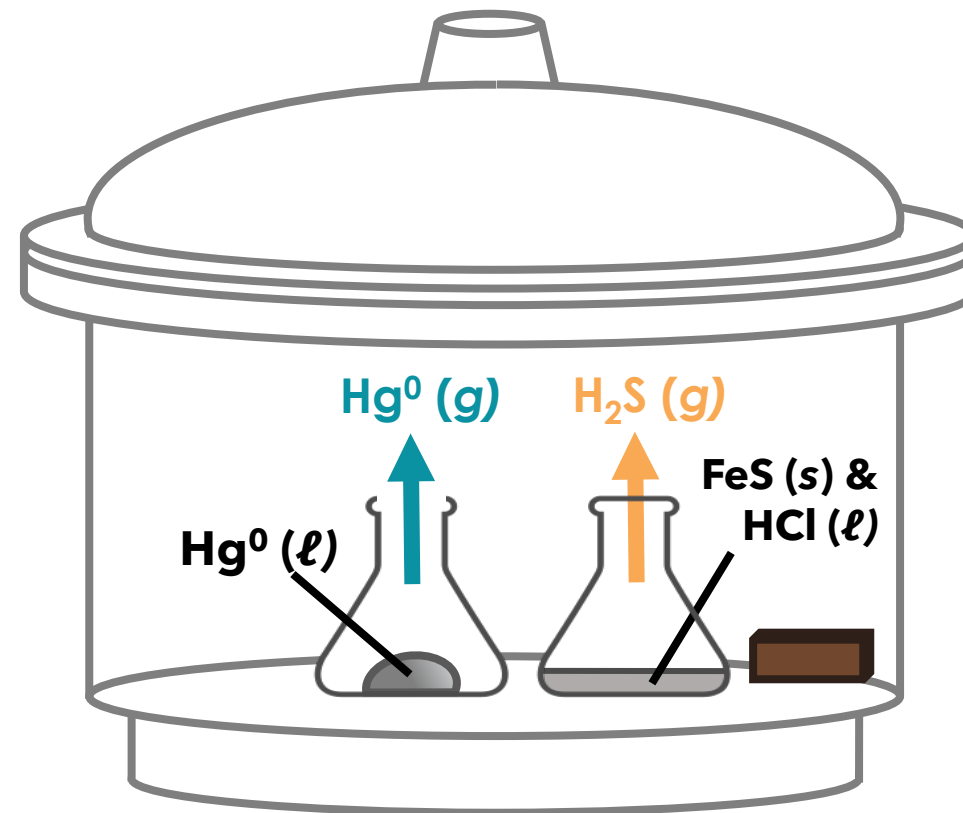


Experimental Design

System 1: Hg^0 exposure

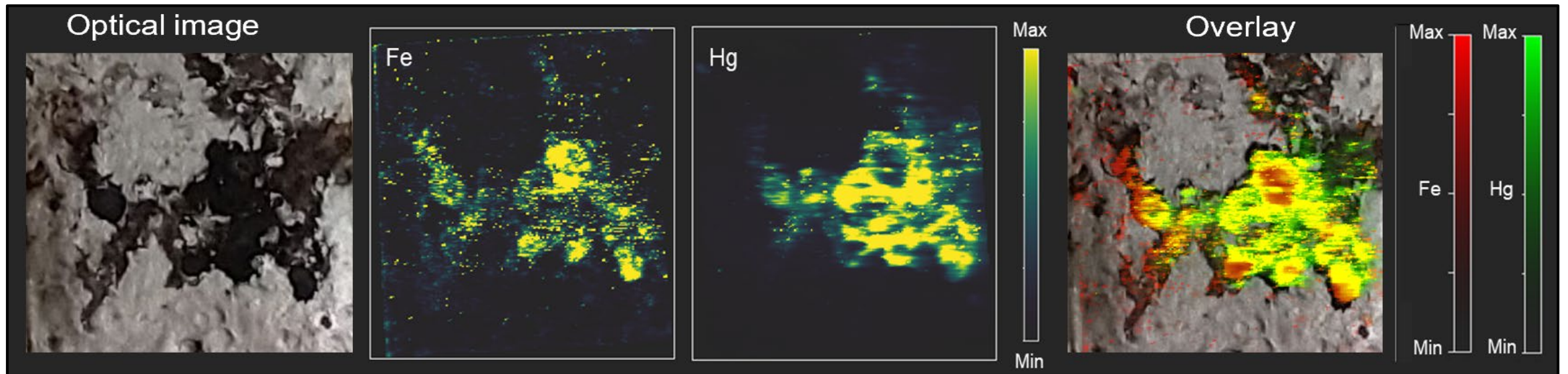


System 2: $\text{Hg}^0 + \text{H}_2\text{S}$ exposure

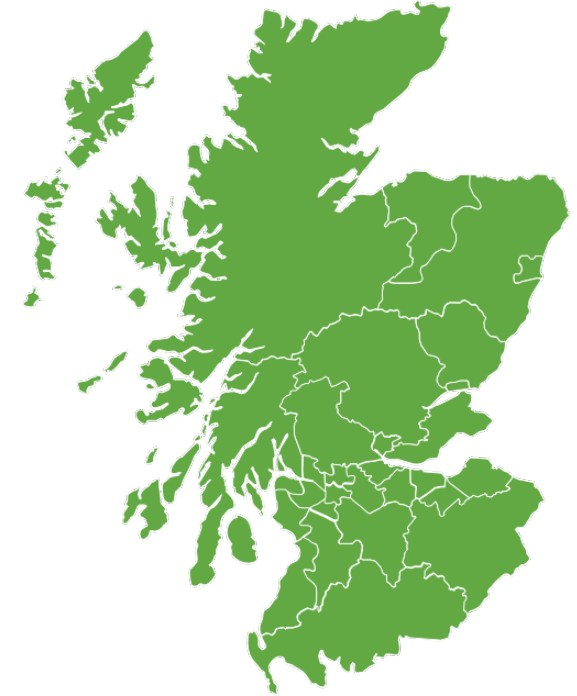
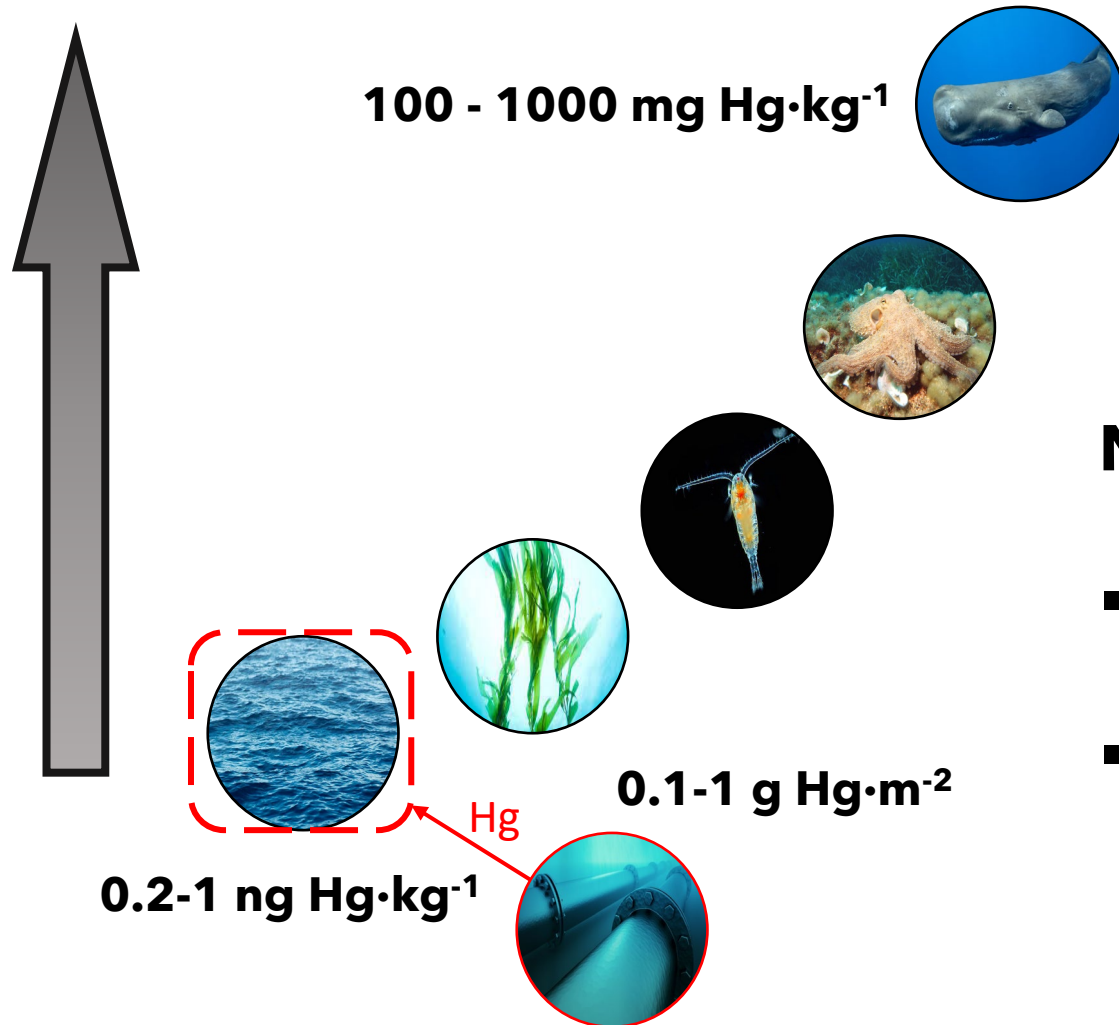


Hg on steel

- Corroded pipelines will accumulate 1000x as much Hg...
- Total Hg analysis (CV-AFS) = 0.1-1 g Hg·m⁻² of corroded steel



Hg bioaccumulation: Part II



North Sea

- 27,000 km of gas pipelines
- What impact could it have?
- **up to a 16 % increase!**



OPRED responds...



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Environment ▶ Climate crisis Wildlife Energy **Pollution**

Pollution

Abandoned pipelines could release poisons into North Sea, scientists warn

Researchers say toxic chemicals pose a pollution risk as oil and gas companies are allowed to leave pipelines to rot

Rachel Salvidge and Leana Hosea
Sat 24 Feb 2024 06:00 GMT

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OPRED: Offshore Petroleum Regulator for Environment and Decommissioning.

Regulators must be thrilled about our work, let's see...

Opred is a part of the Department for **Energy** Security and Net Zero (DESNZ). A spokesperson for the department said: “We do not recognise the conclusions drawn from this report which ignores the routine maintenance carried out on all oil and gas pipelines. Mercury and other harmful substances are kept to a minimum during the lifetime of oil and gas pipelines, with corrosion levels monitored regularly by operators.”

“Prior to the decommissioning of oil and gas fields, the contents of a pipeline are also flushed and filled with seawater to keep contaminants to a minimum.”

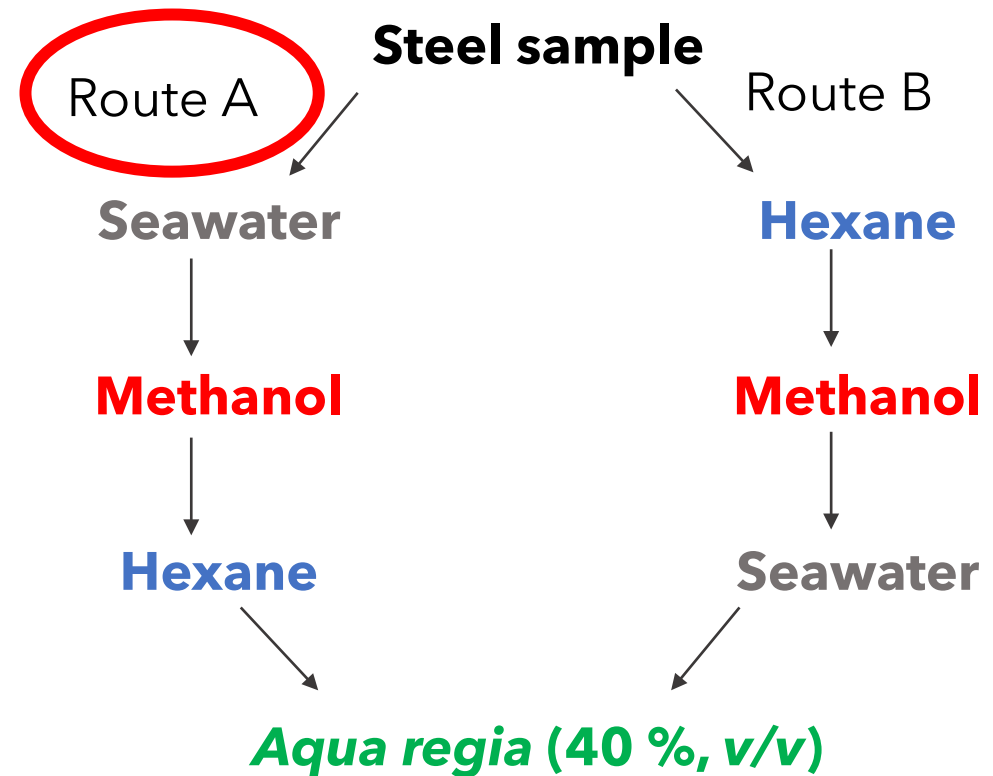
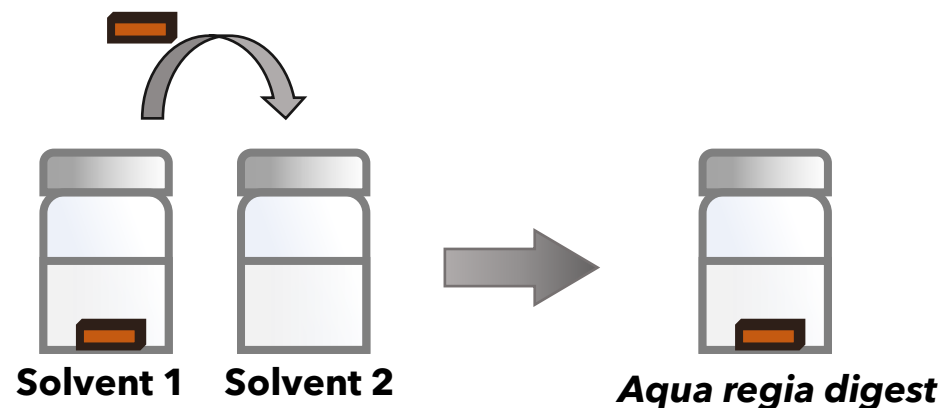


Hg fractionation

Aims:

- To determine the % of labile Hg species on the surface of contaminated steel.

Sequential wash procedure



Fractionation results

OPRED:

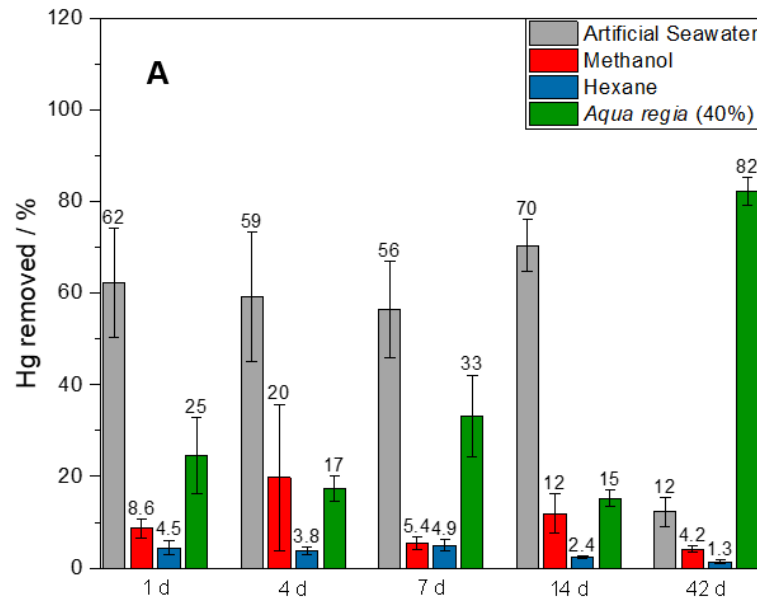
“Prior to the decommissioning of oil and gas fields, the contents of a pipeline are also flushed and filled with seawater to keep contaminants to a minimum.”

- Strategies which flush pipelines with seawater ?

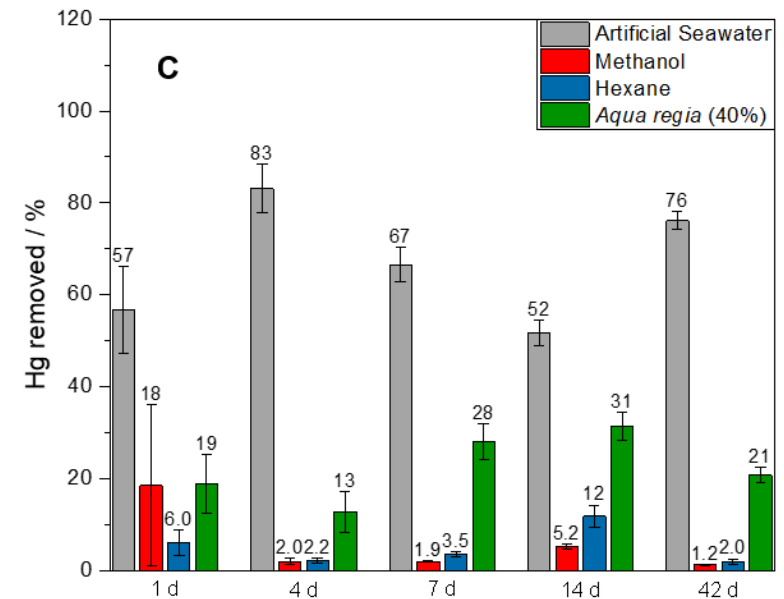
Species

- Seawater/MeOH = polar Hg
- Hexane = Hg^0
- What about the *aqua regia*?

Hg^0

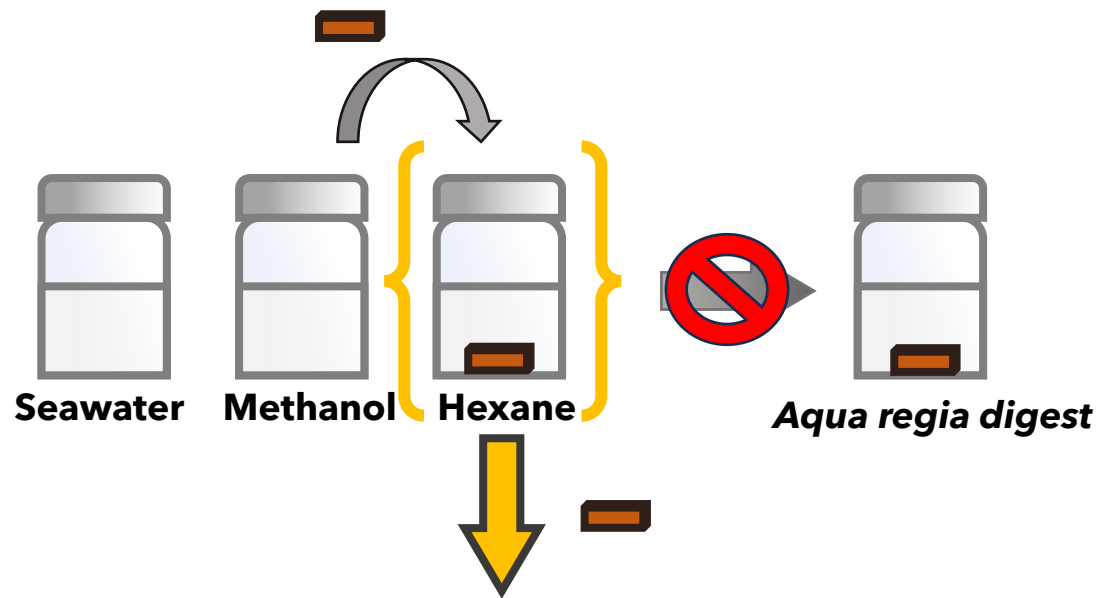


$\text{Hg}^0 + \text{H}_2\text{S}$



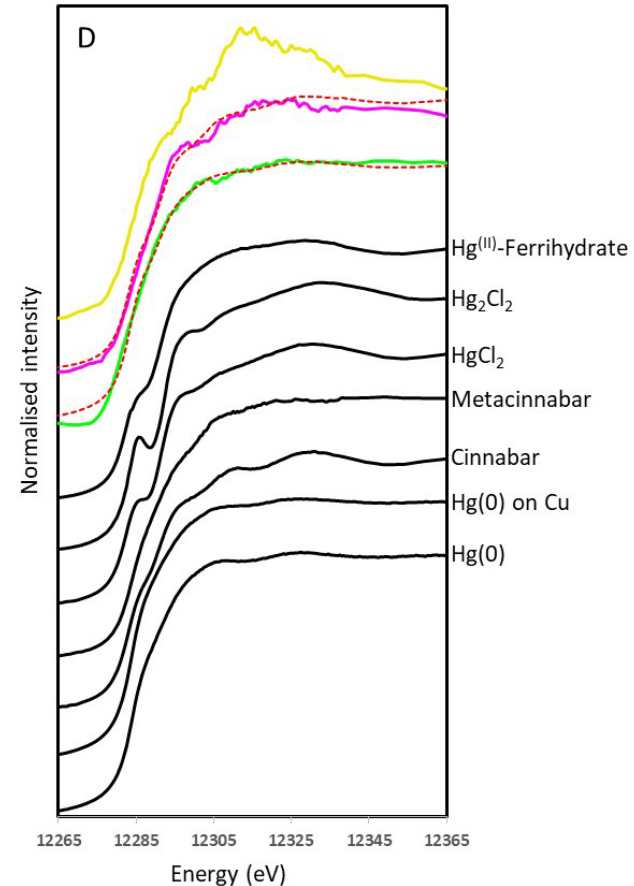
Surface analysis

Sequential wash



Surface analysis
(XFM, XANES, LA-ICP-TOFMS)

XANES



- Cu-Hg amalgam identified
- HgS present but not as a major species, why?

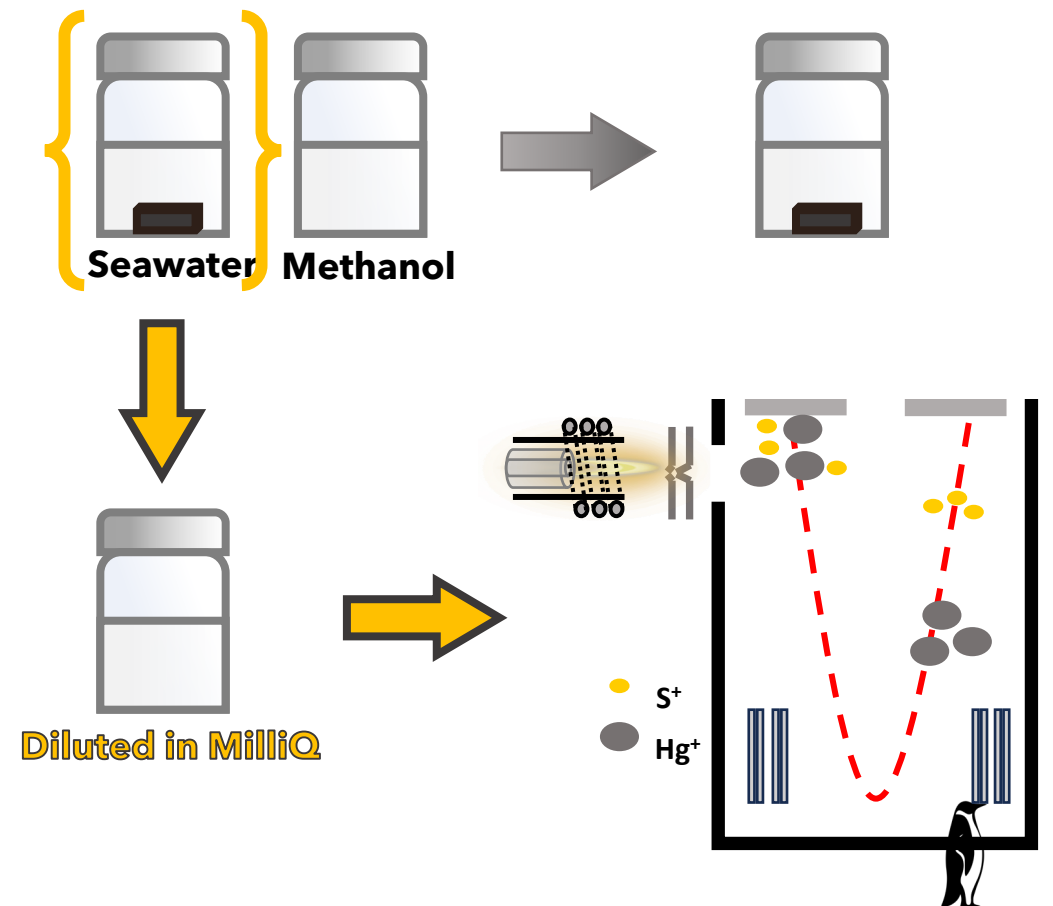


Hg-containing nanoparticles

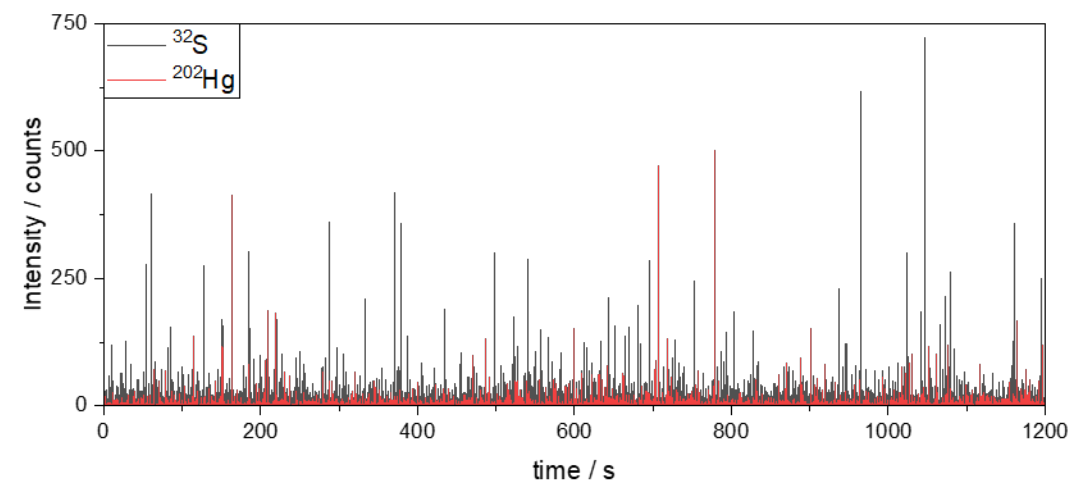
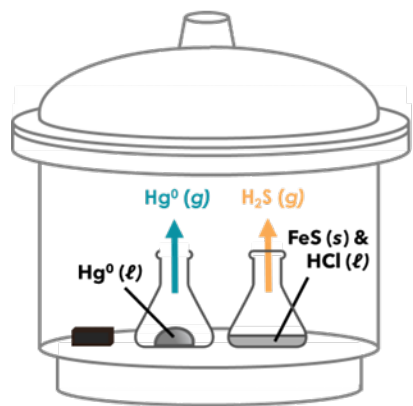
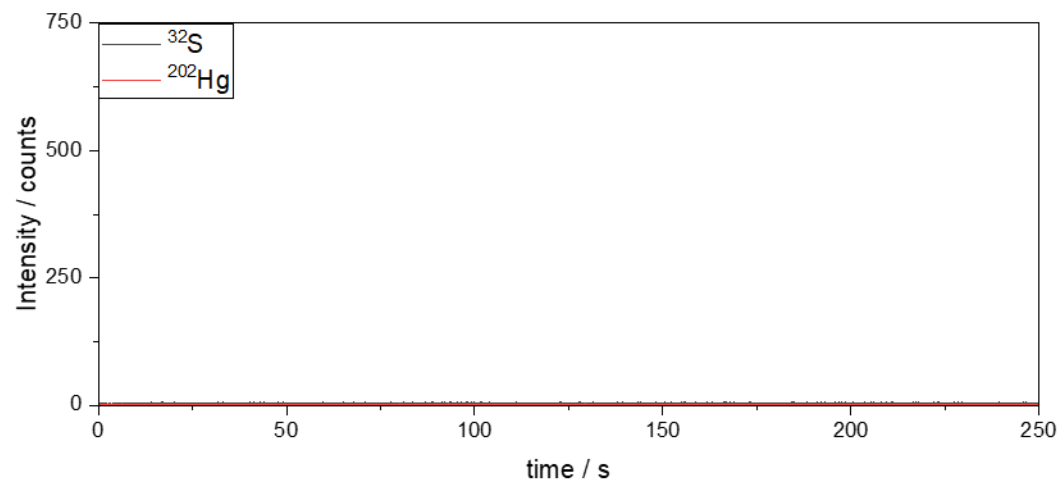
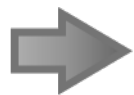
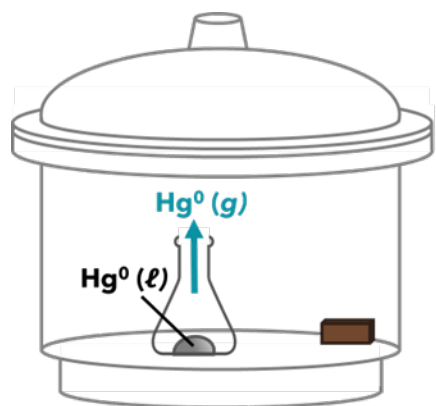
Context.

- Liu et. al. and Zhang et. al. highlighted risks associated with HgS NPs
- Increased methylation potential in HgS NP
- **Question:** can decommissioned pipelines be a source of Hg NPs in the deep sea?

Approach.



Hg/S nanoparticles

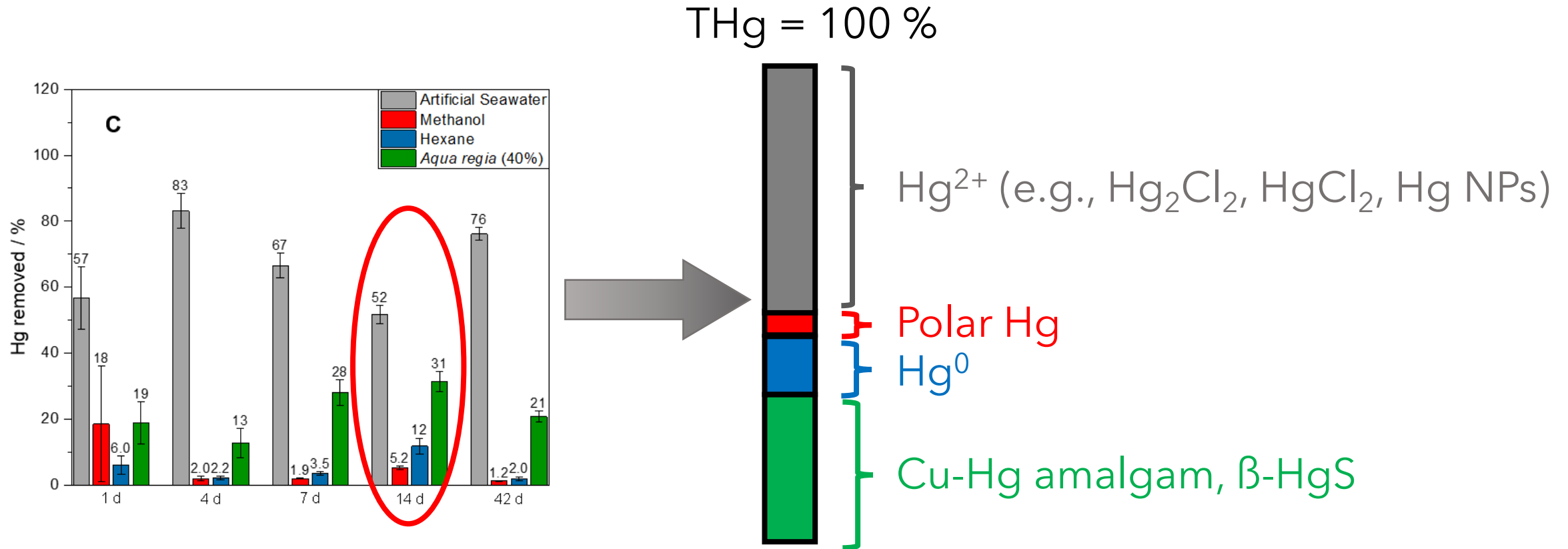


Outcomes:

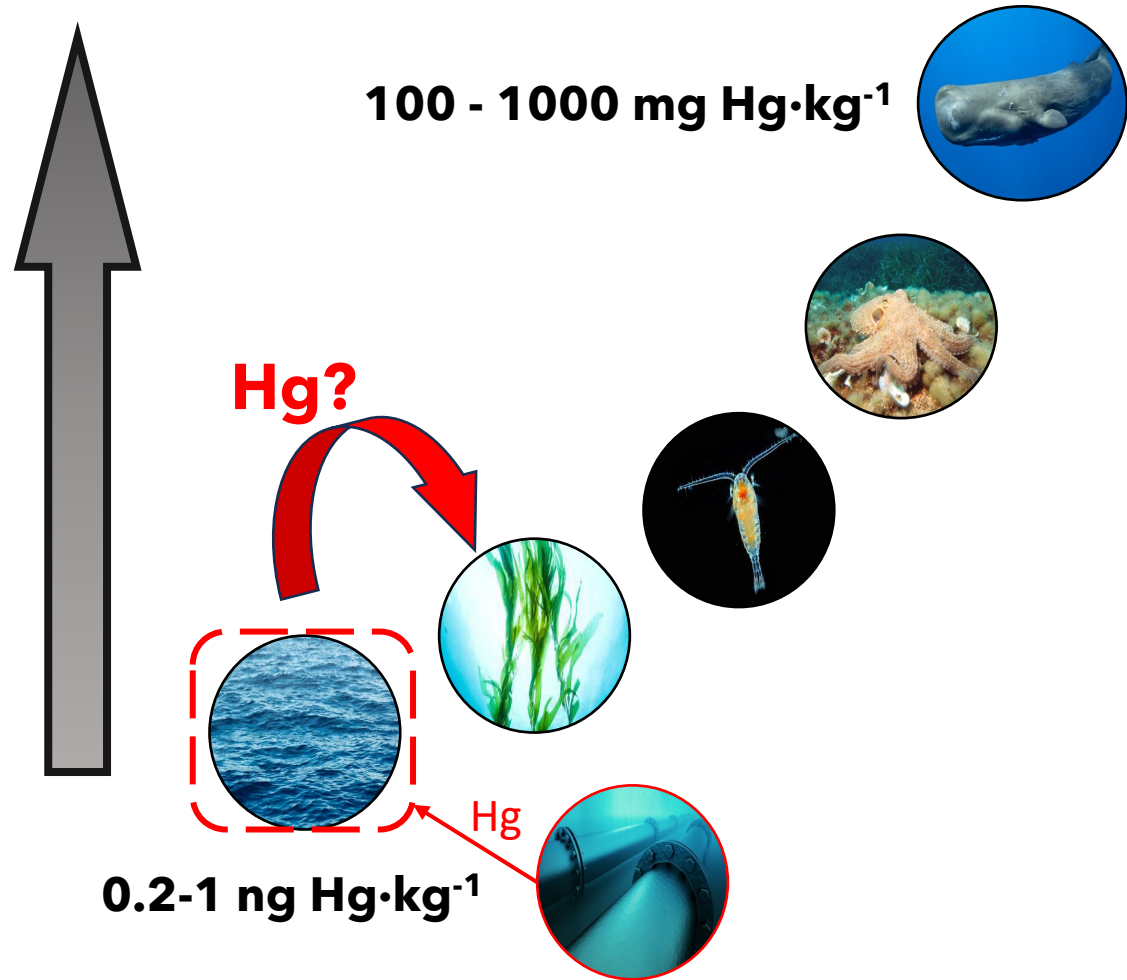
- PNC = 7×10^{10} Hg particles \cdot mL $^{-1}$ -> **1 % of THg**
- Mean particle size = **31 nm**
- Hg particles -> only with H₂S
- HgS formed in pipelines may not be as inert as first thought.



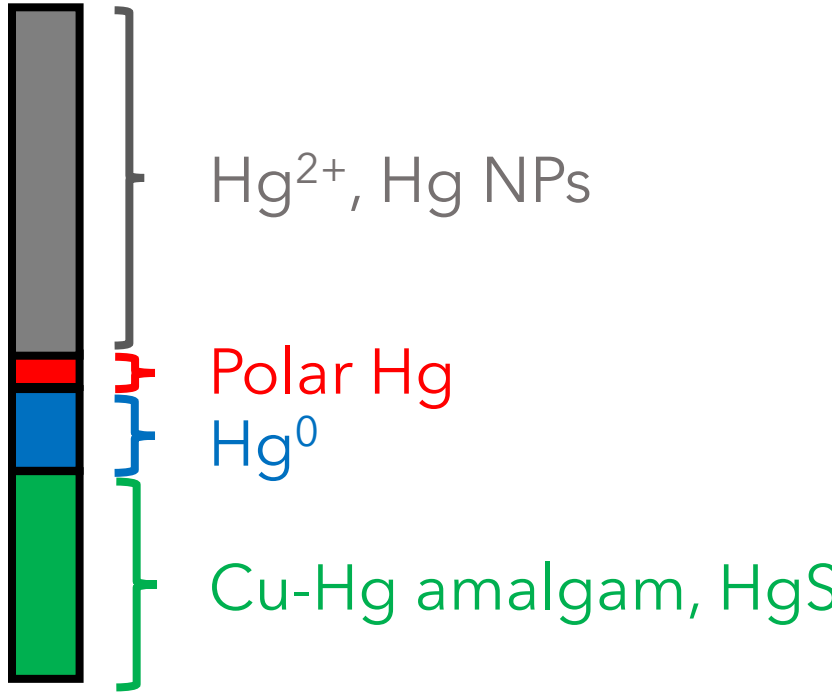
Hg species on steel: summary



Bioaccumulation: Part III

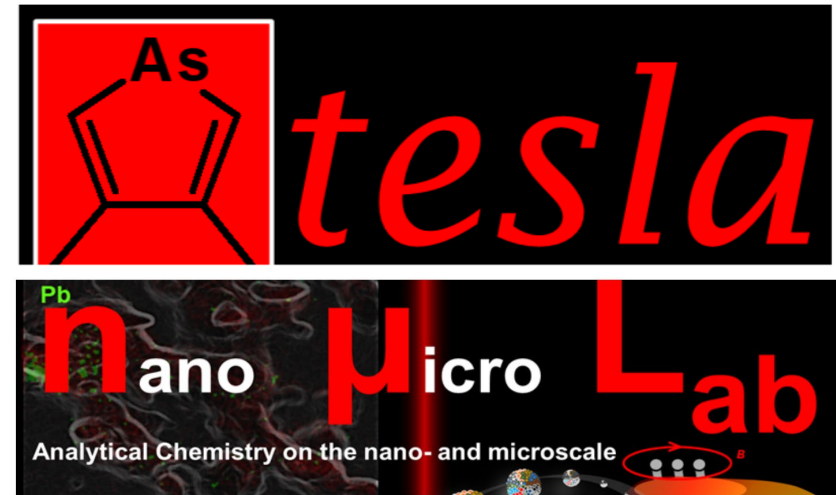


$THg = 0.1-1 \text{ g}\cdot\text{m}^{-2} = 100 \%$



Thank you for listening,
any questions?

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