

Management of metal
contaminated sediments in
Sørfjorden, West Norway
– an internationally known site

Jens Skei and Anders Ruus

NIVA

Outline

- The history of metal contamination in Sørfjorden
- Environmental implications
- Sediment remediation

Sørfjorden and the industrial town of Odda, West Norway



The history of metal contamination

- A zinc plant was established in Odda in 1929
- Prior to 1968 the solid waste discharged into a nearby shallow bay contained about 10% Zn and Pb
- After 1968 change in the process (jarosite) reduced the level of Zn and Pb in the residue to about 2-3% (discharged as a slurry at 20 m depth)
- Since 1986 the jarosite residue has been stored in underground tunnels
- Sørfjord was in the 70-ies considered as the world most metal contaminated marine location

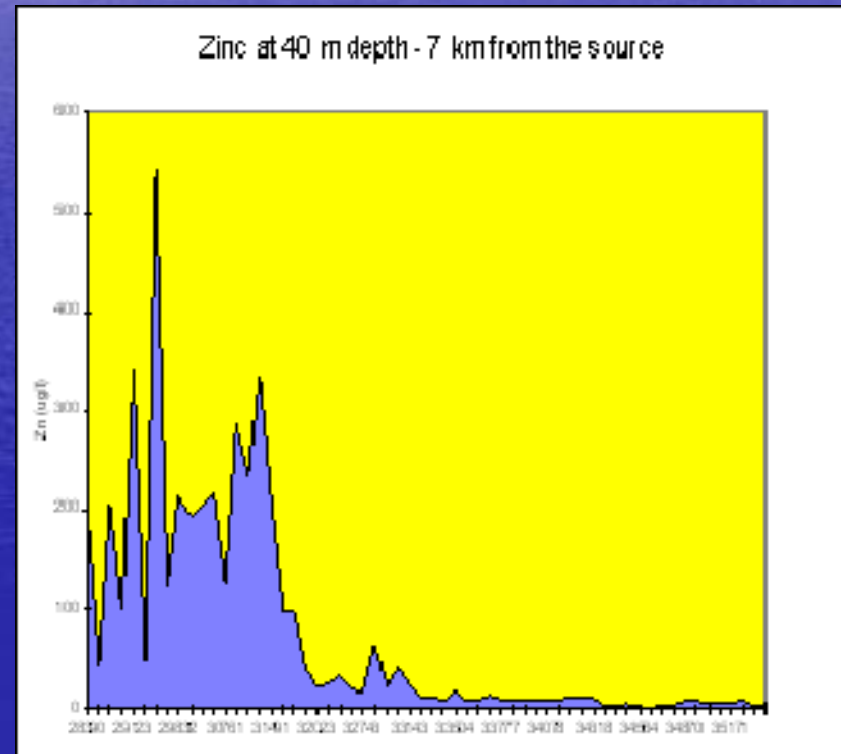
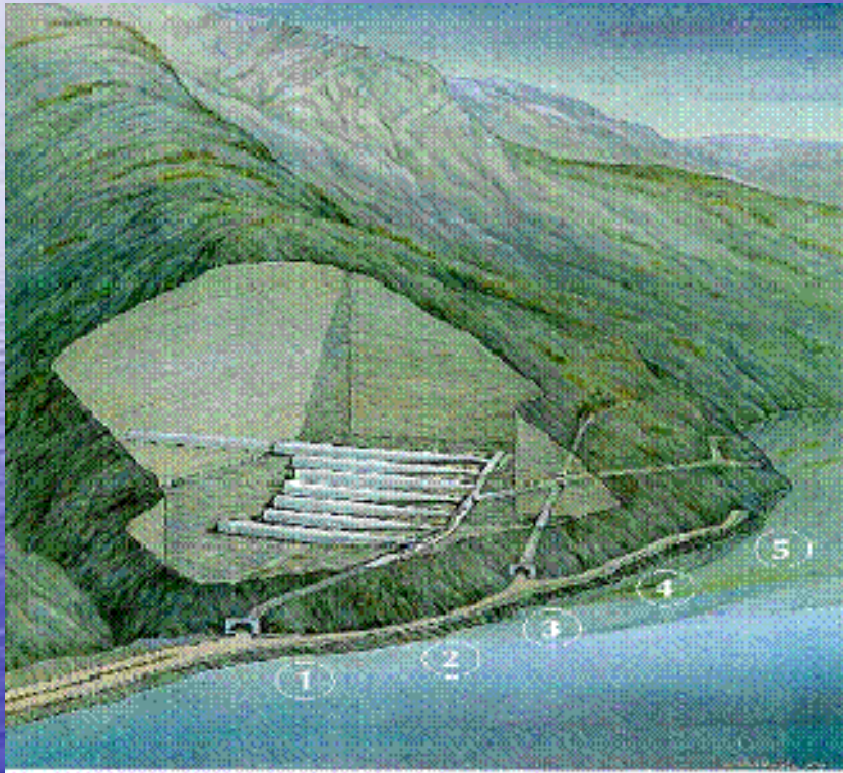
Eitrheimsvågen bay in the 60-ies



Eitrheimsvågen bay in the 70-ies



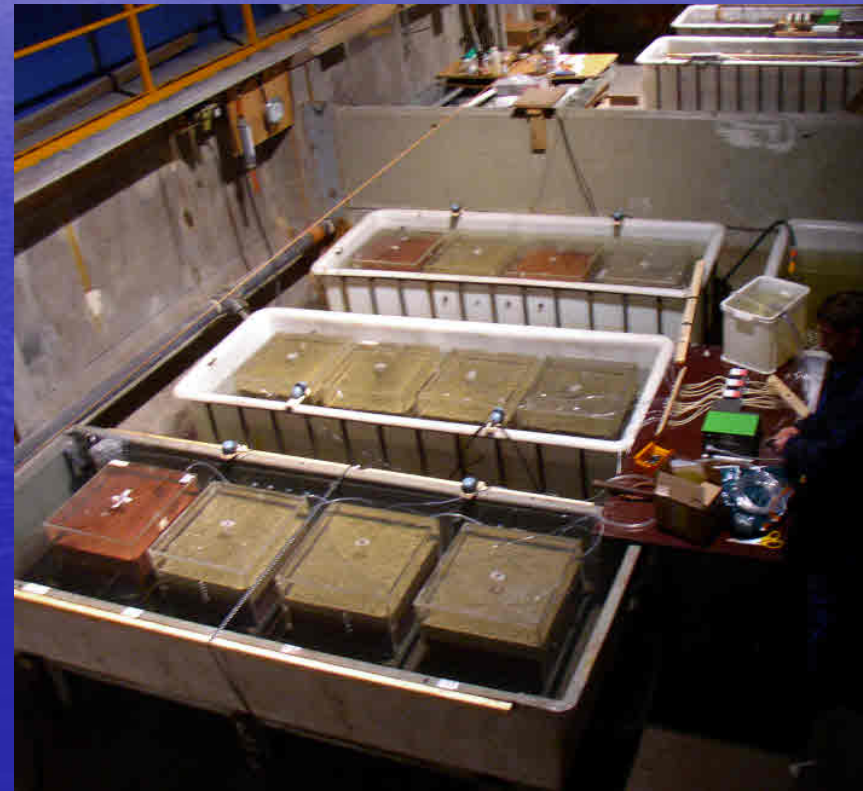
Storage of industrial waste in underground tunnels in 1986



Sediments as a secondary source

- Extreme levels of metals (including Cd and Hg) in the sediments of the shallow bay (< 15 m water depth) caused concern
- Experimental work was carried out on the sediments to measure fluxes and the effect of resuspension

Experimental work at NIVA

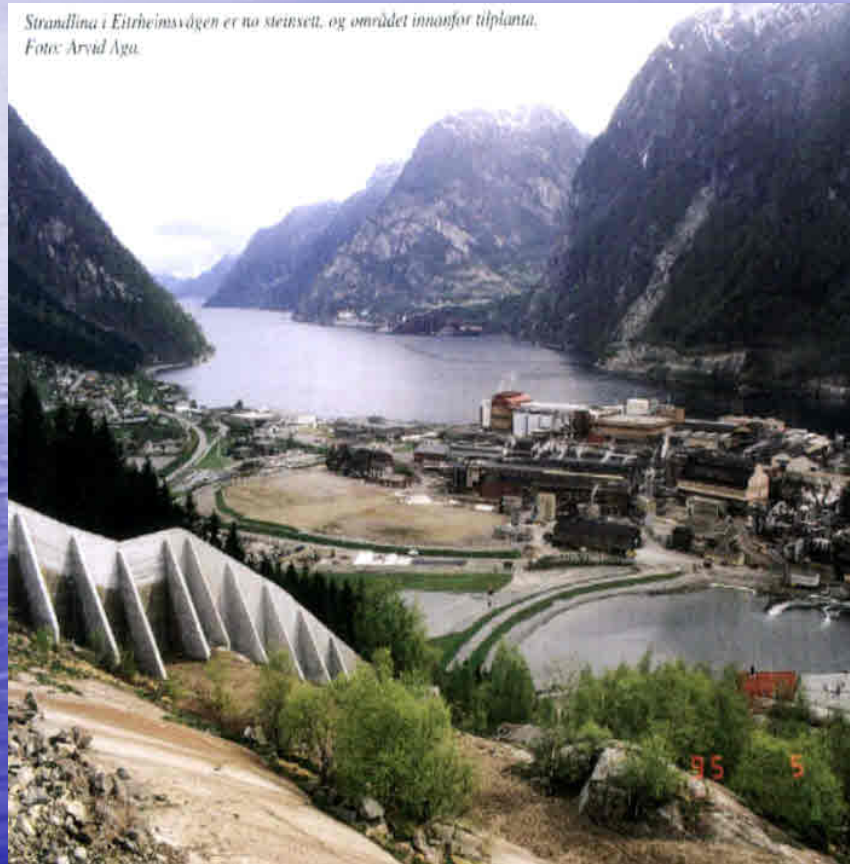


Conclusive results

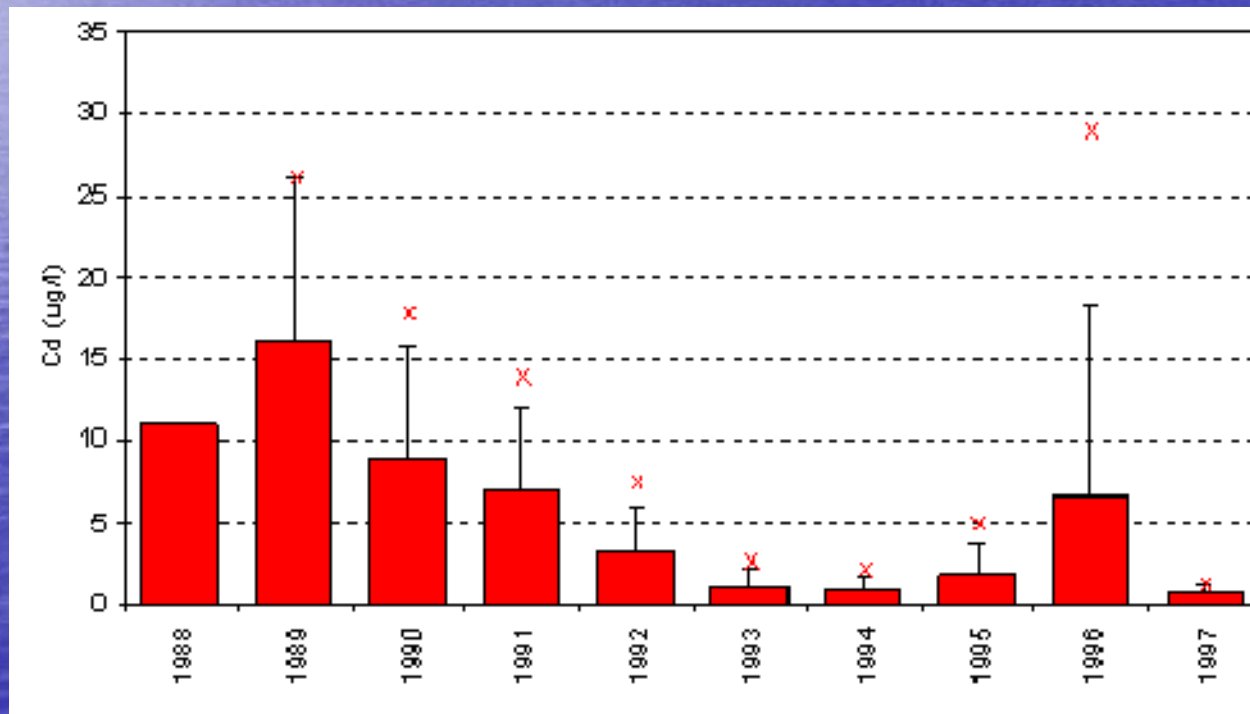
- Flux measurements carried out in 1987 showed a significant release of metals , particularly during resuspension events
- Based on this it was decided to cap the shallow bay (90.000 m²) with a geotextile and 30 cm of sand
- The capping was finalised in 1992

After cleanup of the bay in 1992

*Strandlina i Eitheimsvågen er nå steinsett, og området innøst for tilplanta.
Foto: Arvid Aaga.*



Cadmium in seawater near the capped site in Sørfjorden



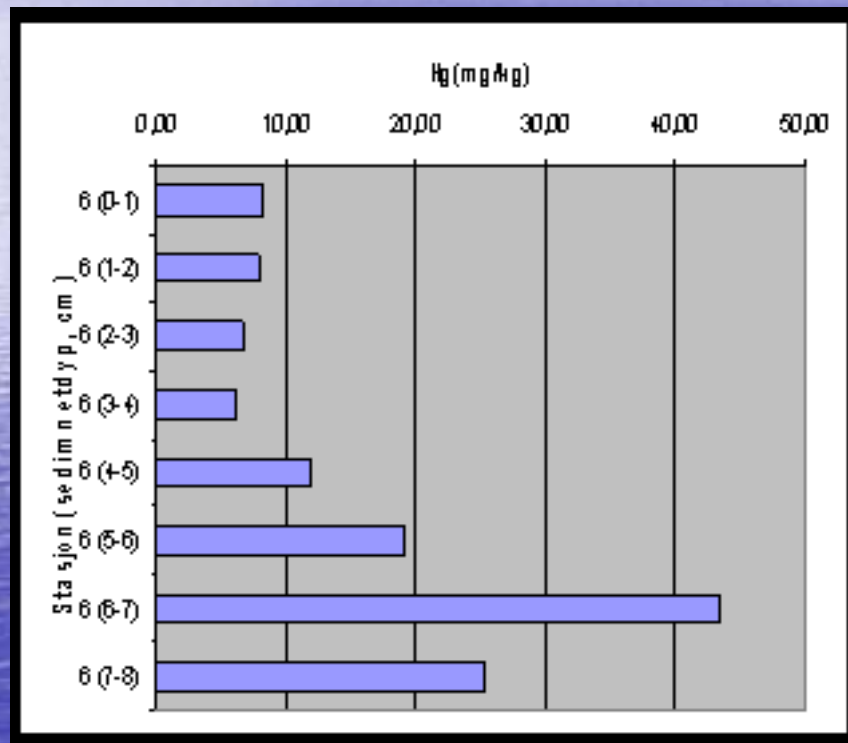
Lack of source control

- Several incidents of accidental spills have contaminated the cap
- Actions have been taken by the industry to obtain source control
- Additional capping of the shallow bay has been recommended

What is the present situation in Sørfjord?

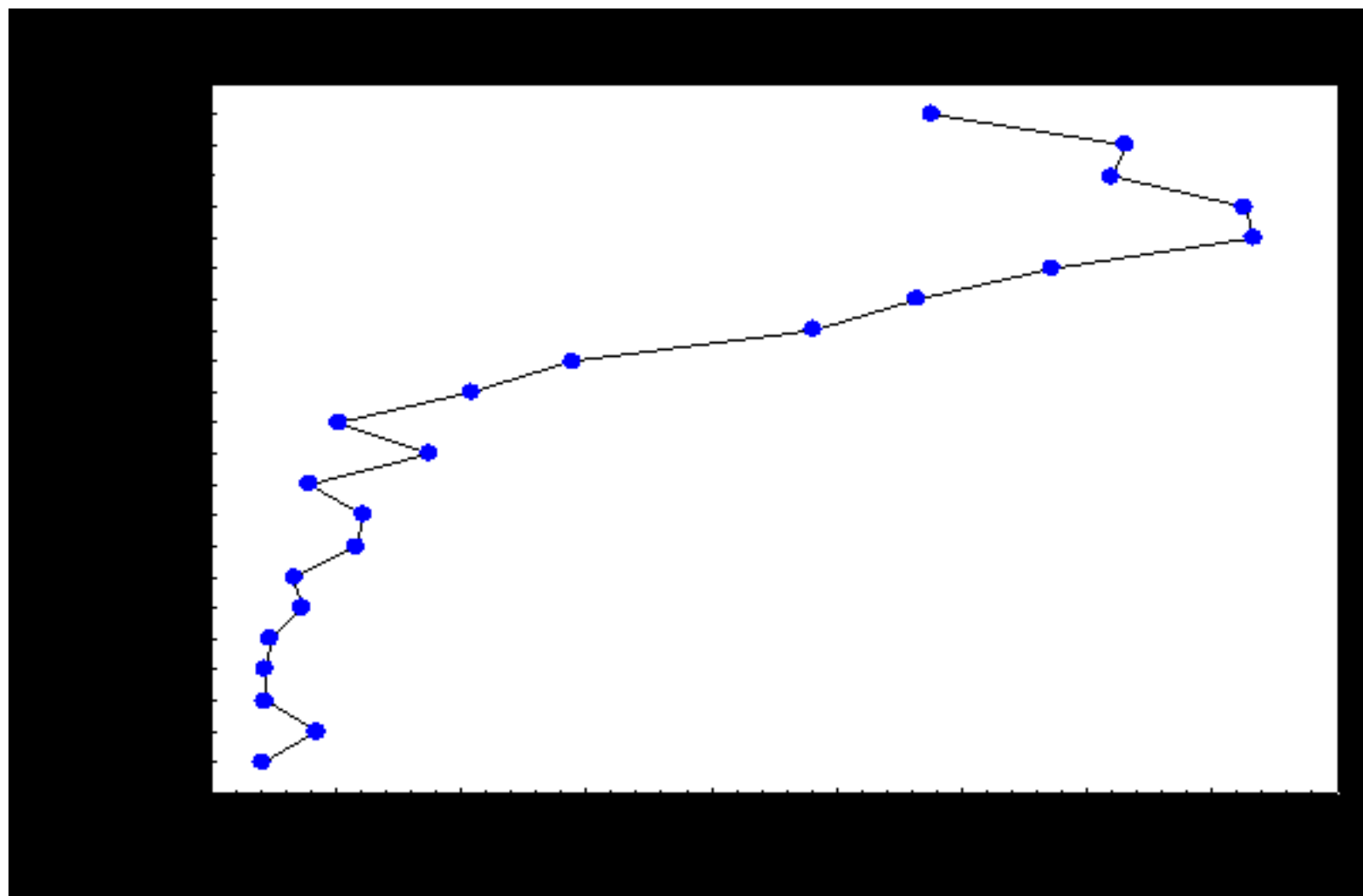
- The level of Hg in cod is still exceeding recommended levels for human consumption
- A new sediment survey in 2007 documents improvement in the surface sediments
- Sediments in the inner part of the fjord may still be considered as a major secondary source of metals and a sediment remediation plan is discussed

Mercury in sediment core (2007)

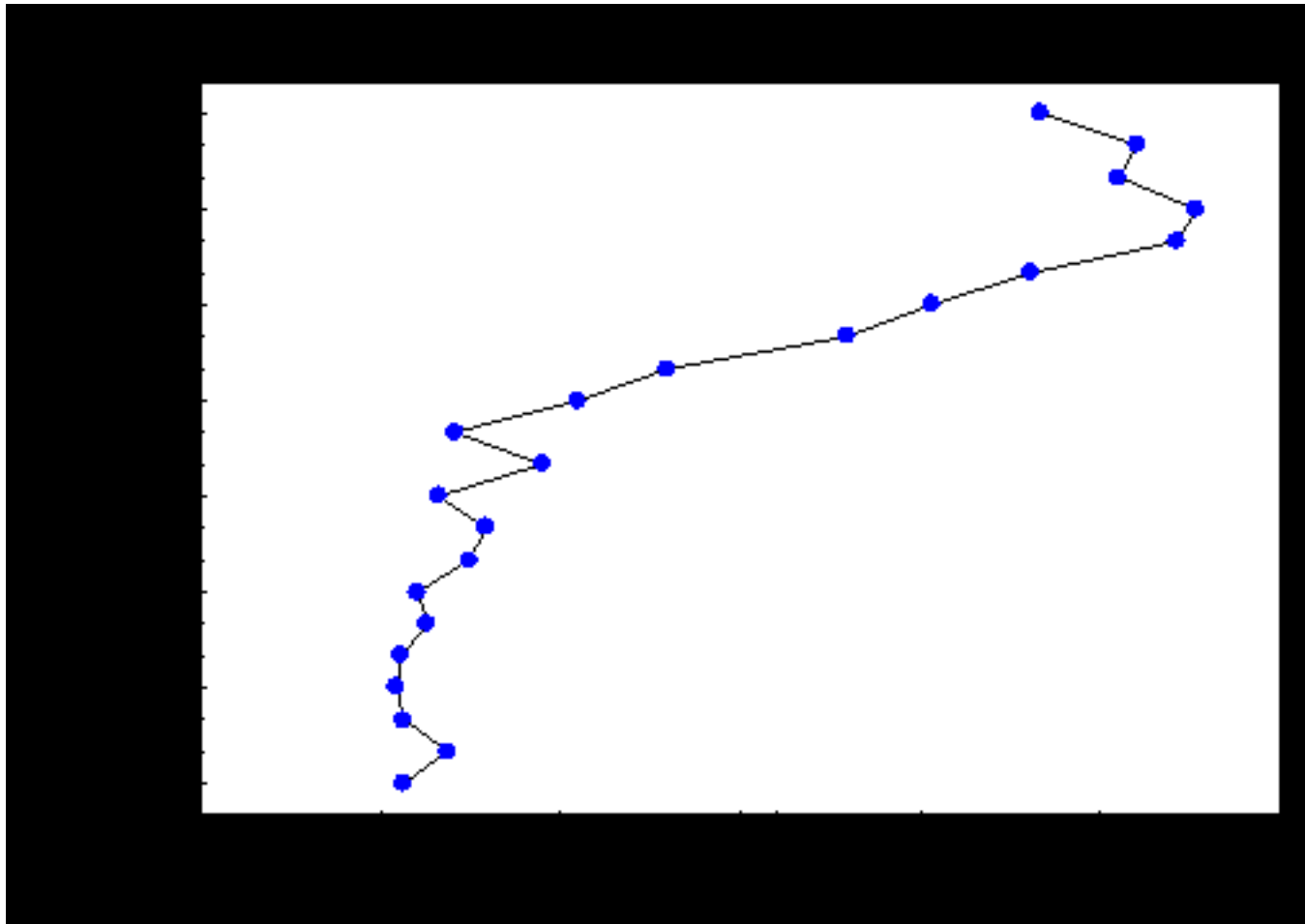




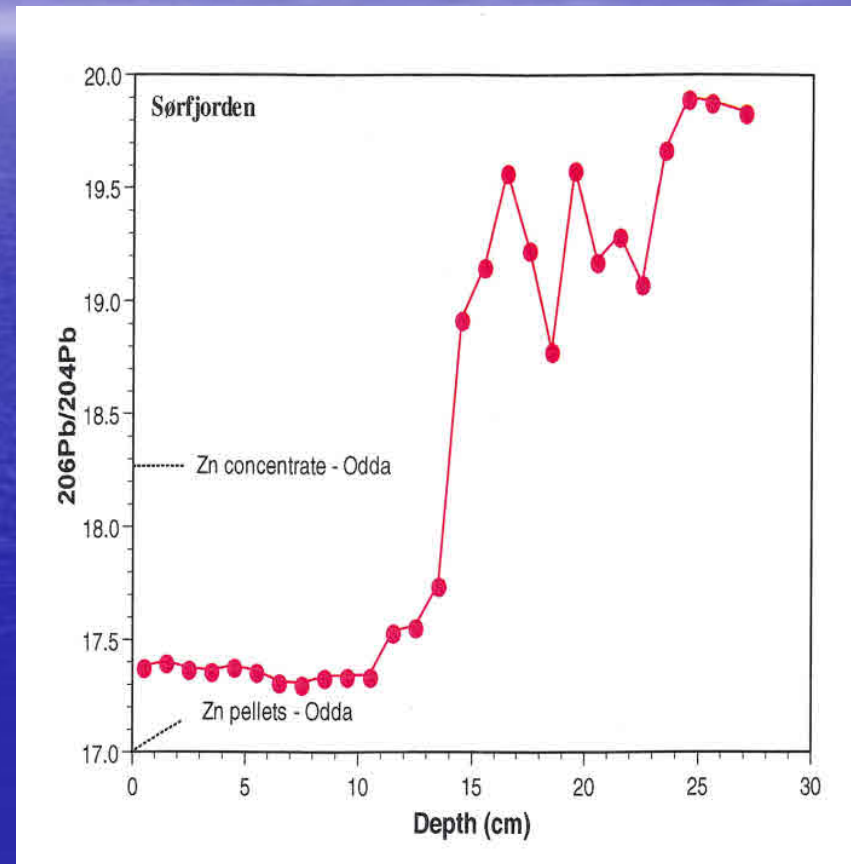
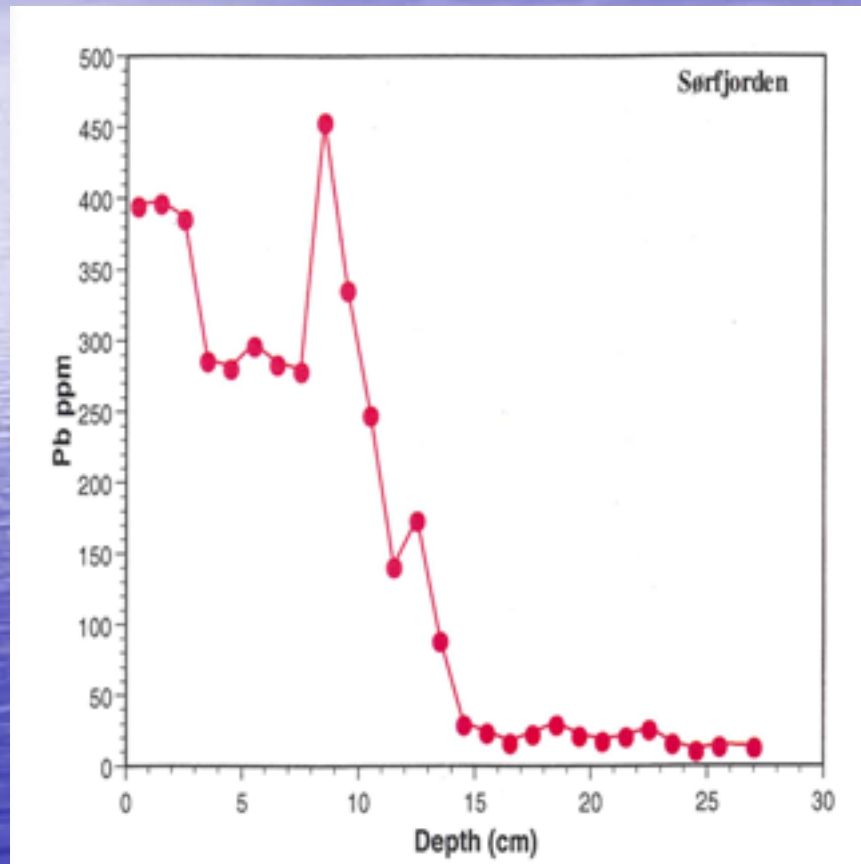
Vertical distribution of Pb – 40 km from the smelter



Vertical distribution of Zn – 40 km from the smelter



Change in Pb^{206}/Pb^{204} - ratios



Conclusions

- Sediment remediation may be required near the source
- Dredging is out of the question
- The success of capping will depend on source control
- Thin layer capping may accelerate natural recovery