Possible leaching of pollutants from a deep-sea dumping of harbor sediments studied with passive sampling techniques.

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## Situation

### Polluted harbor sediment > 1 milj ton
- PCB
- PAH, R-PAH
- TBT
- Metals
- Etc
- Also analysed ecotoxicity, pesticides etc.

### Remediation
- Transport to dumping site and to 75 meter depth
- Pumping to bottom
  - Mixing
  - Adding salt
  - Powerful pumping to bottom in one foot tube
Question

- The task assigned was to investigate whether water dissolved chemicals are migrating from the dumped sediment to the surrounding environment outside the marked dumping area.
- The investigation was to start as soon as possible.
Sampling sites in Oslo Fjord during the two sampling periods ranging 30.10 – 12.12 2006.

- Source pattern
- Dumping area
- Background site
Deployment
Background information

- **SAMPLING PLAN**
  - Two times 3 week sampling
  - Sampling at one to four depth.

- **SAMPLING PROBE**
  (every foot sampling)
  - Water temperature
  - Salinity
  - Climate
  - Dumped amount during time periods
Variation of salinity at different depths during the study.
Variation of salinity at 25 meter from sea bottom.
Variation of salinity at 3 meter from sea bottom.
Analysis

- One membrane dialysis extract splitted into several portions for different targets.
- GC/MS Ion trap or GC/HRMS
- 8 PRC compounds + 1 CS (corruption compound)
  - PRC compounds all labeled.
- Full model for concentration calculations used.
- All data corrected for lab blank
- **Field control** samples for field problems and PRC calculations.
  - I do not like expression field blank. (not zero, dissipate)
## Labeled PRC analysis from FC

<table>
<thead>
<tr>
<th></th>
<th>µg/SPMD</th>
<th>Mean</th>
<th>STD</th>
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<tbody>
<tr>
<td><strong>Acenaften D10</strong></td>
<td>6.76</td>
<td>6.75</td>
<td>6.46</td>
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<tr>
<td><strong>Fluoren D10</strong></td>
<td>7.41</td>
<td>6.83</td>
<td>6.27</td>
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<td><strong>Fenantren D10</strong></td>
<td>10.5</td>
<td>9.68</td>
<td>9.56</td>
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<td><strong>Chrysen D12</strong></td>
<td>10.5</td>
<td>10.3</td>
<td>10.8</td>
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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>PCB3_C13</strong></td>
<td>39.2</td>
<td>41.3</td>
<td>37.3</td>
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<td><strong>PCB8_C13</strong></td>
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<td><strong>PCB37_C13</strong></td>
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<td><strong>PCB54_C13</strong></td>
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<td><strong>OCN</strong></td>
<td>783</td>
<td>766</td>
<td>802</td>
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</tbody>
</table>

**FLU 63 times**
**PCB3 2 times**

Pekka Bergqvist, 7th PSS, 2007, USA
Sum of PCBs period 1 (magnified), pg/L
Sum of congener groups of PCBs period 1, pg/L
Isomer pattern of tetra-CB from period 1, pg/L
PCB levels

- Levels highest at the bottom, but also 40 meter from bottom elevated levels compared to background site.
- Levels decrease with distance from dumping area.
- Distribution and levels confirmed with second sampling results.
**PCB “finger printing”**

- Principal component analysis (PCA)
- Normalized and centered data

In order to see the relationship between the different sampling sites PCA statistical method has been used.

By combining the results of the 79 different PCB congeners/“peaks” the similarities between the sampling sites can be tested.
Results Otto PCB 1c2 MA (PCA class 3)

[Scatter plot of all PCB data from the first sampling period.

Ellipses: Not ellipses to 0.55]

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Results: CSJ: PCB 102 MA (PCA-Class[1])

p(Comp. 1)p(Comp. 2)

p1/p2 Scatter plot of all PCB data from the first sampling period.

R2(1) = 0.96046  R2(2) = 0.260077

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PCB pattern

- PCB pattern established at dredging site.
- Similar PCB pattern at dredging site and dumping area.
- Closest similarity with sites nearby dumping area.
- “Diluting pattern” with distance from dumping area leading to the background pattern at site 16.
- Additional source at site 13 and maybe 12. Related to bottom source.
Metal sampled with DGT and water concentration calculated

- DGTs applied at same sites and depth as the SPMDs
- Results still to be evaluated.

Al, Ag, Ba, Ca, Cd, Ce, Co, Cr, Cu, Dy, Er, Eu, Fe, Gd, Ho, La, Lu, Mg, Mn, Nd, Ni, Pb, Pr, Sm, Sr, Tb, Tm, U, Yb, Zn
The investigation has so far shown that:

- Elevated levels of PCBs are found outside the dumping area.
- The levels decrease with the distance from the dumping area.
- Elevated levels of PCB are found from bottom up to 40 meters above sea bottom close to the dumping area.
- The PCB “fingerprint” close to dumping area resembles the pattern that was identified in Oslo harbor close to the excavating activities. Samples taken close to dumping area showed the closest agreement.

- This report is the first in a series describing different compounds spreading around the Malmøkalven dumping area.
Acknowledgement

- NGO Neptun for funding.
- Fishermen in the area for trying to guard the sampling equipment.
- Norwegian Oceanographic institute for sampling probe.
- Analysis by National lab for POP analysis in Ostrava, AnalyCen and Analytica.
- Ecovision nord for GIS-presentations.