Sea-dumped ammunition as a source of mercury to the Baltic Sea sediments

Jacek Biedowiski1, Marta Szubak1, Grzegorz Sindlewicz2, Ewa Korejwo2, Miłosz Grabowski2, Magdalena Biedowska2, Urszula Kawiagrzach2, Jacek Fabisiak2, Edyta Łońska1, Malgorzata Siała2, Janusz Pempkowiak2

1 Institute of Oceanology of the Polish Academy of Sciences, ul.Powstańców Warszawy 55, 81-712 Szczecin, Poland
2 Institute of Oceanography University of Gdańsk, ul.Piastowskiego 46, 81-378 Gdańsk, Poland

Email: hyron@ipan.gda.pl

Introduction

One of the anthropogenic sources of mercury in the marine environment is ammunition dumped in seas and oceans bottom. This holds especially true for the ammunition produced during World Wars I and II since mercury fulminate (II) (Hg(CON)2) was used widely as the ignition initiation material at this time. Mercury fulminate is one of the oldest explosive compounds. It reacts with most metals under various conditions, forming the metals fulminates and/or products of their decomposition and elemental mercury (also enhancing metal corrosion). Mercury fulminate is not stable in aqueous solution and its solubility is directly proportional to the water temperature. After World War II, as a part of Germany’s demilitarization, up to 385,000 tons of munition were sunk in the Baltic Sea. Objects containing various dangerous substances – Chemical Warfare Agents (CWA) - and explosives which can affect the marine environment. Some of those compounds can be an additional local source of mercury in the dumping areas. Unfortunately there is a lack of information on how dumped munition impacts the mercury levels in Baltic Sea sediments.

This study aimed to investigate if munitions from dumpsites can be considered as a point-sources of mercury in the Baltic Sea.

Methods

Sediment samples were collected during several research cruises conducted on board R/V Oceania to the munitions dumpsite areas. Iron, Manganese and Aluminium concentrations in the sediments were measured with the use of X-Ray Fluorescence Spectrometry (XRF) technique. Total mercury concentrations in the sediments were measured with the use of automatic mercury analyser AMA-254, which uses the Atomic Absorption Spectrometry technique. Samples for methylmercury analyzes were measured on automated methylmercury system MERX-M (Brooks Rand, USA) according to EPA Method 1630. The analysis of individual mercury forms was carried out on a DMA-80 analyzer (Milestone, Italy), according to the method of Hg compound thermo-desorption (Saniewska and Biedowska, 2017; Biedowska et al. 2018).

Conclusion

• Dumped ammunition may be a source of Mercury to the surrounding sediments
• Close to unexploded sea mines a thermal signature of Mercury fulminate can be observed
• Methyl mercury concentrations are elevated at dumpsites sediments
• Conventional munitions emit more mercury than chemical weapon
• Mercury contamination follows a power curve decrease from the source

Table 1. Characterisation of sediment samples in the Kolberger Heide (KH) and the Bornholm Deep (BO)

<table>
<thead>
<tr>
<th>study</th>
<th>No of analysed samples</th>
<th>Organic matter [%]</th>
<th>Hgtot (mg·g−1)</th>
<th>Fe (mg·g−1)</th>
<th>Al (mg·g−1)</th>
<th>Mud fraction contribution [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>KH</td>
<td>8</td>
<td>0.7 – 33.1 (6.8)</td>
<td>6.5 – 322.2 (90.4)</td>
<td>4.2 – 12.2 (7.3)</td>
<td>15.4 – 39.2 (23.3)</td>
<td>0.1 – 25.2 (10.22)</td>
</tr>
<tr>
<td>BO</td>
<td>11</td>
<td>16.7 – 21.2 (18.4)</td>
<td>34.0 – 91.7 (57.1)</td>
<td>40.5 – 46.0 (43.7)</td>
<td>–</td>
<td>43.4 – 51.8 (47.2)</td>
</tr>
</tbody>
</table>

Figure 2 Locations of sampling sites in the southern Baltic Sea; 1A: Kolberger Heide; 1B: Bornholm Deep

Figure 3 Mercury concentration in pairs of samples (farther and further from the object)—presented as a function of distance from the objects no. 1A, 1B, 2A and 2B

Figure 4 Mercury concentrations in sediments close to objects B1, B2, B3 and B4 at Bornholm

Figure 5 Concentration of Hg in sediments at Kolberger Heide sampling stations located close to munitions dumpsite and from reference points