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

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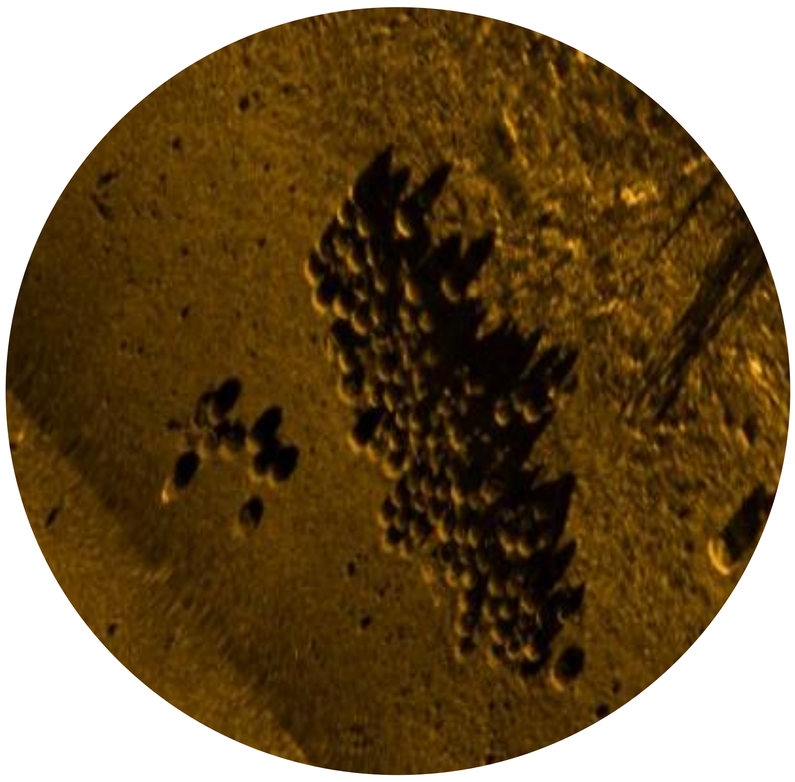

Figure 1 Dumped conventional weapon in the area of Kolberger Heide

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 Bełdowska, 2017; Bełdowska 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** emits more mercury than **chemical** weapon
- **Mercury contamination** follows a power curve **decrease from the source**

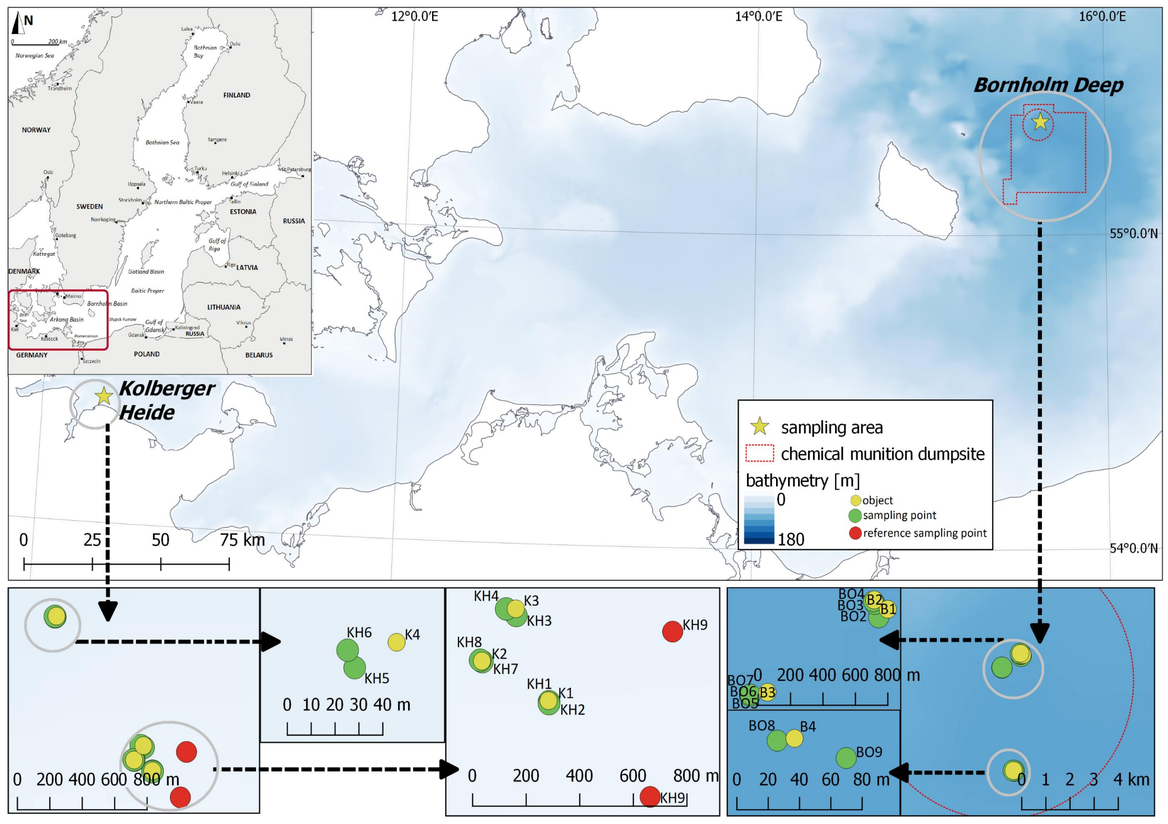

Figure 2 Locations of sampling sites in the southern Baltic Sea; 1A Kolberger Heide; 1B Bornholm Deep

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.

study		No of analysed samples	Organic matter [%]	Hgtot [ng·g-1]	Fe [mg·g-1]	Al [mg·g-1]	Mud fraction contribution [%]
area	site		min-max (average)				
KH	**Kolberger Heide**	8	0.7 – 33.1 (6.8)	6.5 – 322.2 (90.4)	4.2 – 12.2 (7.3)	15.4 – 39.2 (23.3)	0.1 – 25.2 (10.22)
BO	**Bornholm Deep**	11	16.7 – 21.2 (18.4)	34.0 – 91.7 (57.1)	40.5 – 46.0 (43.7)	-	43.4 – 51.8 (47.2)

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

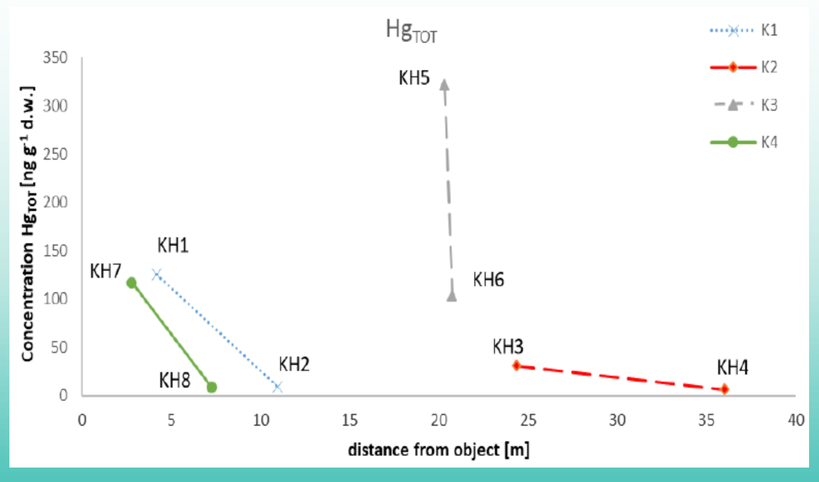

Figure 3 Mercury concentration in pairs of samples (closer and further from the object)— presented as a function of distance from the objects nos. K1, K2, K3 and K4

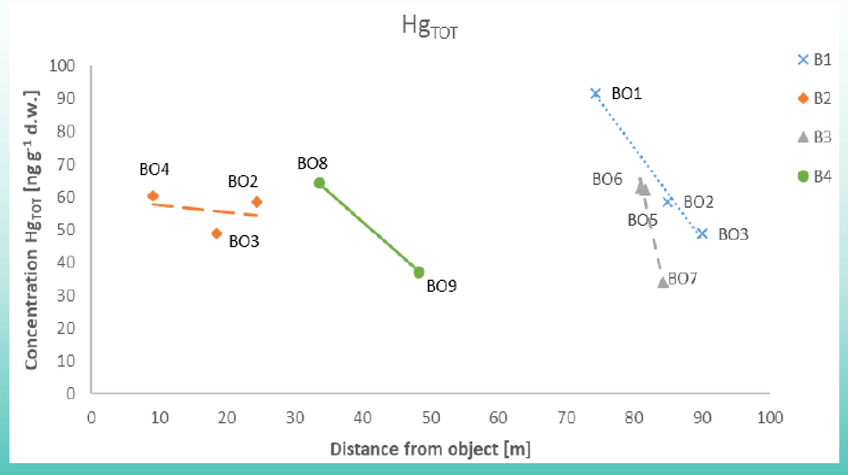

Figure 4 Mercury concentrations in sediments close to objects B1, B2, B3 and B4 at Bornholm dumpsite vs distance from objects

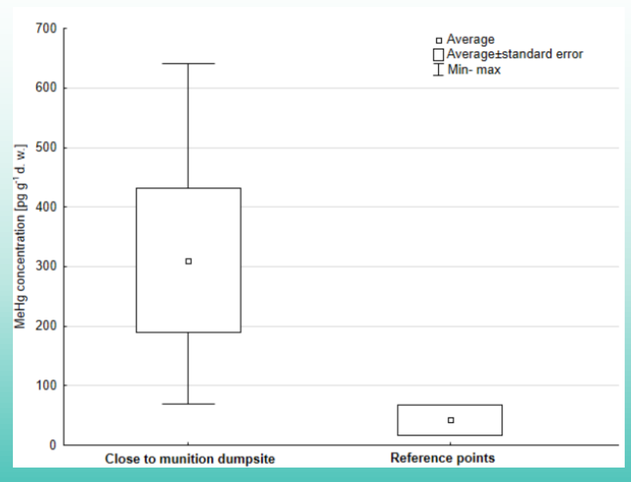

Figure 5 Concentration of MeHg in sediments at Kolbeger Heide sampling stations located close to munitions dumpsite and from reference points

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