The corrosion rate of the toxic ammunition at the “Paardenmarkt”

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After WWI, a significant amount leftover German toxic ammunition was dumped on the “Paardenmarkt”, a silt bank close to the port of Zeebrugge. Recently, very small amounts of TNT and other toxic compounds have been measured in the water column off the Paardenmarkt, most probably released by leaking grenades. The objective of this project is to assess the physicochemical state of this munition after being buried partly and/or completely for more than a century. Because it is strictly forbidden to bring any of the grenades to the surface, this can only be done by using data from a pilot project and subsequent modelling, extrapolating the results to the appropriate time span of over 100 years. The experimental set up tries to simulate the conditions at the “Paardenmarkt” as closely as possible, taking into account that those conditions have changed since the dumping operations in 1919 - 1920. Relevant parameters are, among others, the historical variation in seawater temperature and salinity, the change in morphology of the seafloor due to expansion works at the port of Zeebrugge, the geophysical characteristics of the sea sand, a mixture of silt and sand, and the possibility of a freshwater influx leading to extra local variations in the salinity of the seawater. In the set-up brass, steel and zamak samples are exposed to soil and water in three different configurations, as well as galvanic coupling between brass and steel and zamak and steel, which were chosen to represent the materials that were most often used in construction of German WWI ammunition. Coupons were exposed to seawater (density 1.025), fresh water (density 1.000) and brackish water (density 1.012). One additional series of coupons was exposed with seawater with a weekly addition of sodium acetate to stimulate bacterial growth. Samples are being retrieved after 2, 6, 12, 24 and 36 months with each time point repeated eight times to obtain statistical significance. Weighing before and after the exposure time allows for the calculation of corrosion rates. If pitting corrosion is present, the depth of this localized corrosion will be assessed using a micrometer. Additionally, the upper layer of the sample will be analyzed by means of XRF, before and after the removal of the corrosion layers by means of citric acid. While the experiment only allows for shorter term submersion periods, the corrosion rates resulting from the weight loss method and the depth measurements will be used as an input to assess the current physicochemical state of the munition, with the corrosion rate of shipwrecks in the North Sea (De Baere *et al.*, 2020) serving as a measure for corrosion after longer submersion periods (up to 110 years). These short-term and long-term corrosion rates as well as the conditions at the Paardenmarkt will allow for the parametrization of Melchers’ model (Melchers, 2003) as well as for extrapolation to a submersion period of more than 100 years.

References

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