Marine bioremediation of port sediment: investigation of tributyltin degradation using Active Nautical Depth

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1 Introduction:

Active Nautical Depth (AND) is a promising method to fight against siltation in ports and harbours by mixing the sediment *in situ*, turning it into a **navigable** fluid mud (figure 1)[1]. This is done by pumping the sediment using a low-power underwater pump to a hopper dredger, where it is exposed to the air before being pumped back to the sea and forms a fluid mud cloud for weeks before it has to be repeated. The implementation of AND allows a reduction of dredging need and thus has the potential, among other benefits, to decrease carbon emission associated with sediment transportation. Moreover, by changing the physicochemical properties of sediment, AND could also stimulate the **biodegradation** of harmful contaminants found in ports, such as the previously widely used antifouling compound called tributyltin (TBT)[1].

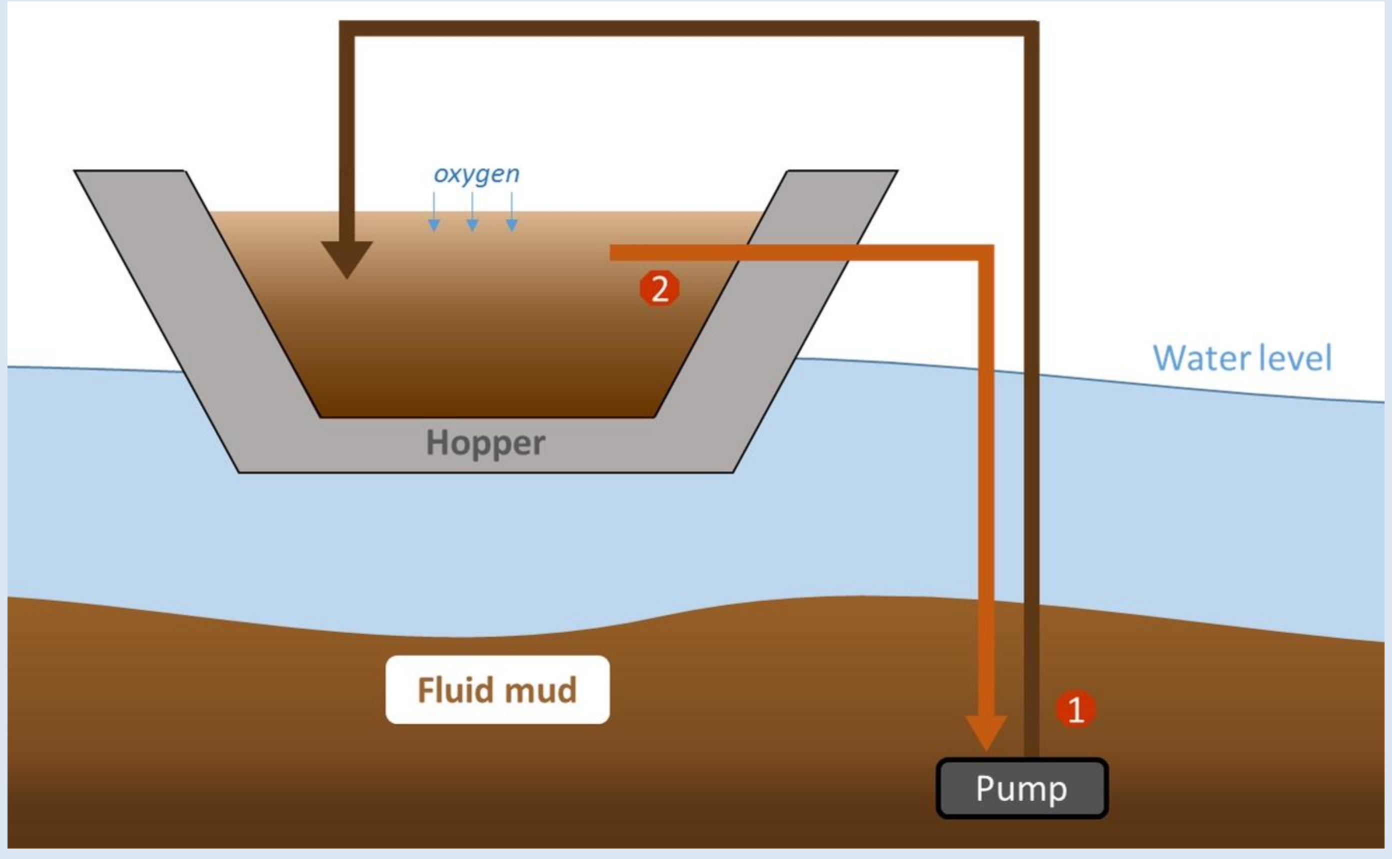

Figure 1: Active Nautical Depth principle

TBT is a highly toxic contaminant commonly found in ports, it is rapidly degraded in the water column but it is very persistent in anoxic sediment where it can remain for decades. It has been stated that the major pathway for TBT degradation in sediment and water is the degradation by organisms (biodegradation). Consequently, research has been done to evaluate the communities implicated and the parameters of this degradation [2], but it is still poorly understood.

This project thereby aims to assess the microbial degradation of TBT in sediment under different environmental scenarios in order to understand the factors implicated and provide insights to optimize the implementation of AND. It is based around two hypotheses: TBT is aerobically degraded into a less toxic compound: Monobutyltin (MBT) and this biodegradation is more efficient for higher temperature.

2 Method: Microcosm experiments (figure 2)

- Varying parameters (chosen according to the flexibility of AND):
  - Temperature (season)
  - Aeration (duration of exposure to the atmosphere)
  - Agitation frequency (adaptation of pumping method/frequency of application)

  (influences)
- GC-MS => TBT degradation rate

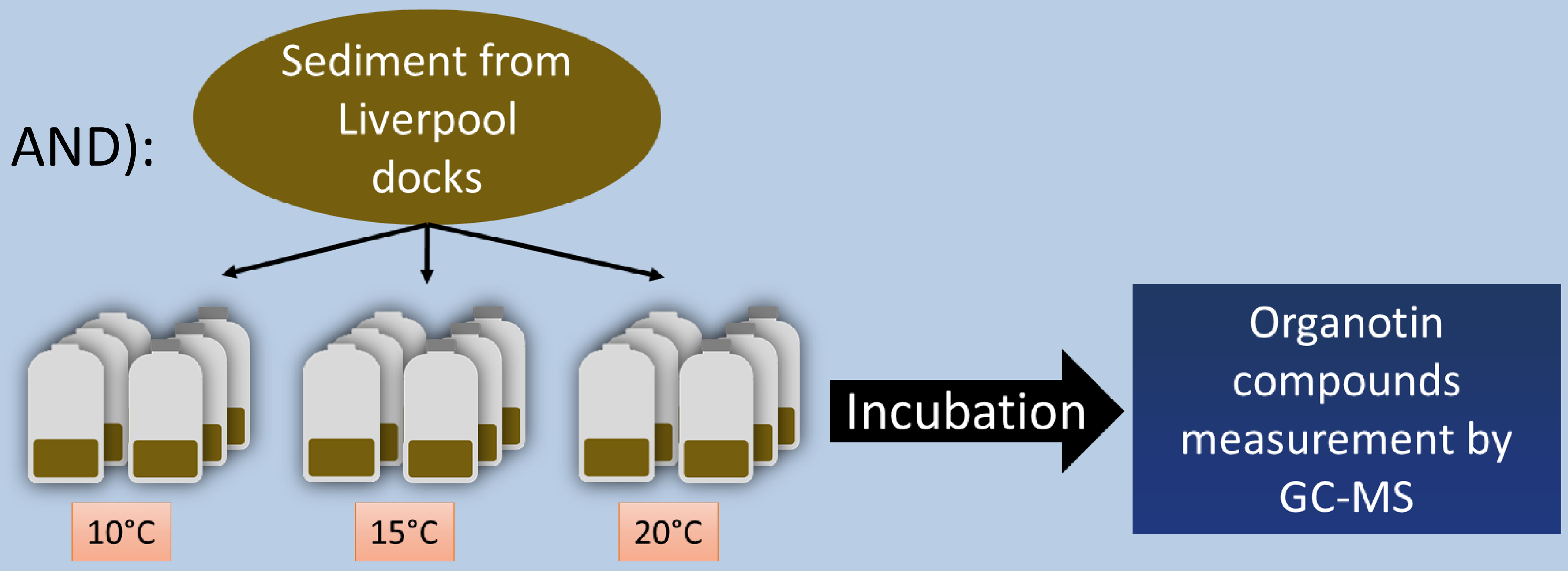

Figure 2: Experimental design of microcosm experiments

3 Hypothesised results:

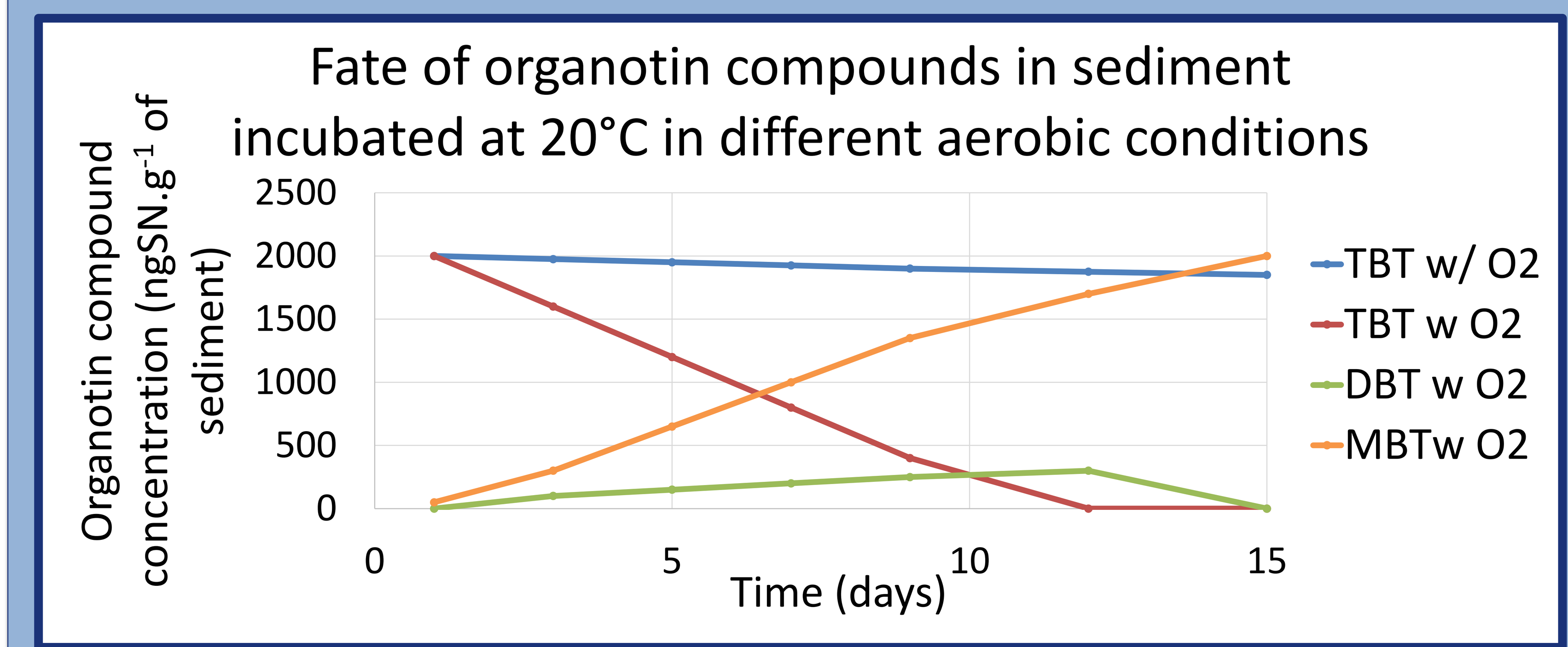

Figure 3: TBT degradation rate is low in absence of oxygen (blue), high in presence of oxygen (red), TBT is rapidly degraded into MBT (orange) and only low amounts of DBT is produces (green).

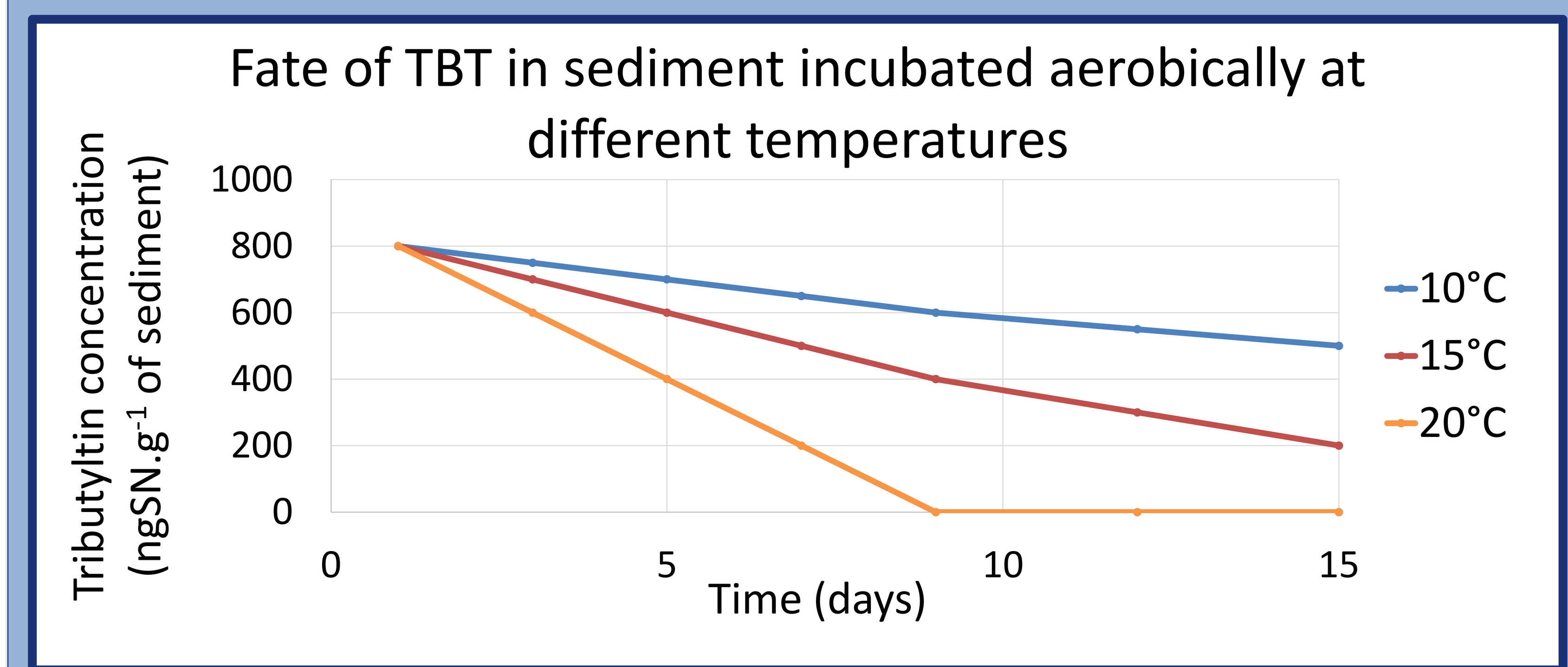

Figure 4: The rate of TBT degradation increases with temperature.

4 Summary and conclusions:

In order to better understand the factors controlling TBT biodegradation in sediment, this study will perform microcosms experiments under different conditions.

We expect higher rates of degradation when sediment is incubated in aerobic conditions and at higher temperatures as microbial degraders are known to be aerobic and microbial activity is higher at high temperature.

If the experiments confirm these hypotheses, the results can be considered by applying AND during warmer seasons and adapting the duration of sediment exposure to the air before its pumping back to sea bottom.

To go further, a better understanding of the microbial community implicated in biodegradation is desirable. This will be done by tracking known microbial degraders in the microcosms via PCR and isolating new degraders.

Acknowledgement:

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References:

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[2] Cruz, A., Anselmo, A.M., Suzuki, S., Mendo, S., 2015. Tributyltin (TBT): A Review on Microbial Resistance and Degradation. Crit. Rev. Environ. Sci. Technol. 45, 970–1006.