Investigating intrinsic toxicity of rare earths to algae – How far to go when ecological relevance is limited?

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Introduction

Because of the **strong interaction of rare earths** with the **phosphate** in the test medium, **standard algal growth inhibition tests** (OECD 201) **performed in view of EU REACH registration** do not yield information on the intrinsic toxicity of the rare earths (see Figures 1 and 2).

- All rare earths are precipitated when phosphate is in excess.
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- Test results show the point where phosphate deprivation occurs, inhibiting algal growth.
- The results **do not inform on intrinsic toxicity.**
- The observed **phosphate deprivation effects are not ecologically relevant** and might occur to a limited extent directly at a hypothetical point of discharge but certainly not at larger ecosystem scale.

Modelling REE speciation in a standard OECD 201 study

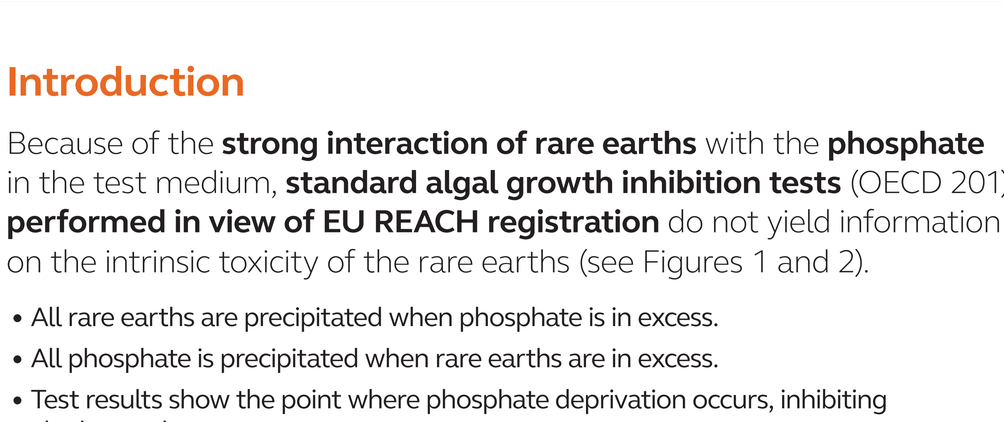

Figure 2. Example of Visual Minteq 3.1 modelling for OECD 201 study with $CeCl_3$

Key considerations for REE hazard assessment

- Current **PNECs (aquatic) for REEs** are **between 0.11 (Dy) and 3.5 µg/L (Nd).**
- Calculated **without taking into account algae data** (either no reliable study available or only studies demonstrating phosphate deprivation effect → not considered relevant at ecosystem scale).
- **Knowing exact intrinsic toxicity of REEs to algae** is **not thought to significantly lower current PNECs.**
- Current **PNECs** are **within the range of naturally occurring dissolved REE concentrations** (see Figure 3).
- Indicates potential knowledge gap: toxicity mitigating factors not fully quantified (valuable research done (ECOTREE, PANORAMA, NRC, …) but no fully reliable biotic ligand model (BLM) developed yet for predicting REE toxicity as a function of water chemistry.
- Further **quantification of effects of toxicity mitigating factors is considered more useful from regulatory point of view** than trying to quantify exact intrinsic toxicity to algae.

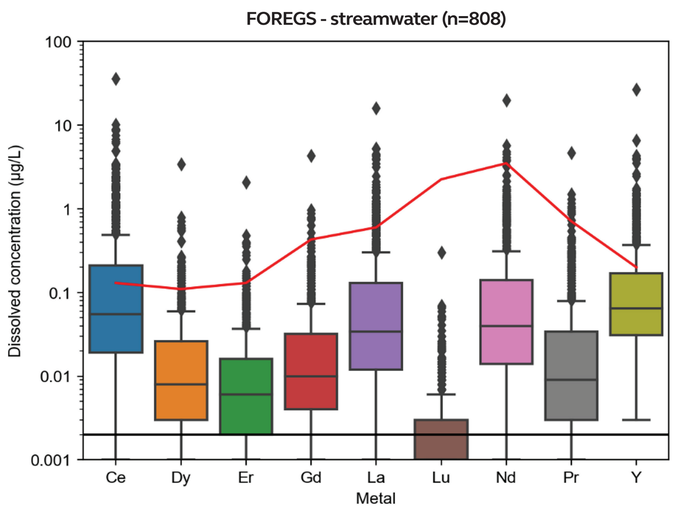

Figure 3. Current PNECaquatic values for different REEs (red line) versus the distribution of observed dissolved REE concentrations in pristine EU surface waters (FOREGS data).

RE-phosphate complexation

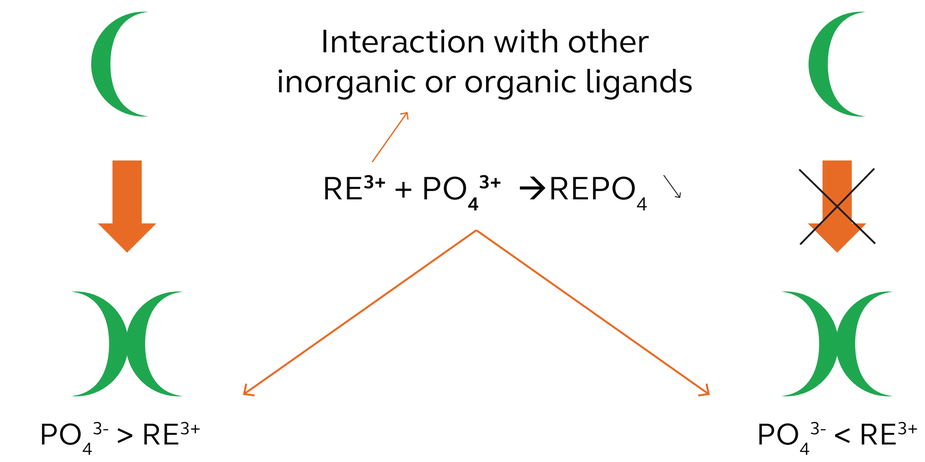

Figure 1. Conceptual presentation of the rare earth-mediated phosphate deprivation effect in standardised algal growth inhibition tests.

Screening recent literature on (adverse) effects of REEs on algae

Identified recent literature* went through relevance and reliability screening.

Multiple issues (resulting in Klimisch 3 scoring) were observed (alone or in combination).

* Contact the authors to know more about screened literature.

- None of the evaluated studies could be scored as sufficiently reliable (K1/K2).
- **3 studies** (Joonas et al., 2017; Aharchaou et al., 2020; Natural Resources Canada, 2021) **clearly indicated that REEs do have intrinsic toxicity** towards algae, although no K1/K2 score could be assigned.

Key considerations after evaluation of published research

- **Specific points of attention** when performing (aquatic) ecotoxicity **tests with metal compounds** are **often not followed**, which **hampers** comparability, potential for interpretation of test results, and **regulatory applicability.**
- When medium adjustment is needed to investigate intrinsic toxicity, **all changes to the test medium need to be justified and verification is needed that toxicity is not affected in a way that confounds the hazard assessment.**