LCA OF TAILINGS MANAGEMENT: CURRENT STATUS, POTENTIALS AND CHALLENGES

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Overview

LCA of tailings management: what, and what for?

Key challenges

A way forward

Life Cycle Assessment (LCA)

Definition

- to assess **environmental impacts** associated with all the stages of the **life cycle** of a product / system
- through several environmental impact **indicators**

Sala S., et al. (2016), Life cycle assessment for the impact assessment of policies, EUR 28380 EN; doi:10.2788/318544

How can LCA support decisions on tailings management? (1)

Identification of environmental hotspots

- Key **process steps**
- Key **inputs to the processes** (e.g. energy, reagents), **direct emissions** to the environment

Comparison of alternative management solutions

- determination of the **most favourable option**
- identification of **potential *trade-offs*** between:
  - ***life cycle phases*** / *process steps*
  - ***impact categories***

Support to the ecodesign of processes

How can LCA support decisions on tailings management? (2)

Some key results from the literature

- Tailings **final disposal** a **hotspot** in the production of several **metals, manufactured goods and systems**
- Associated key impacts on **human toxicity and ecotoxicity** are highly sensitive to **metals mobility**
- **Construction materials** with using tailings: **environmental benefits** compared to classical production routes
- Environmental performance of **reprocessing** needs to be **explored**

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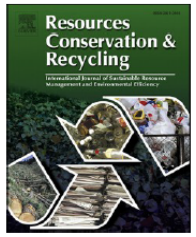

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LCA as a support to more sustainable tailings management: critical review, lessons learnt and potential way forward

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Géosciences pour une Terre durable
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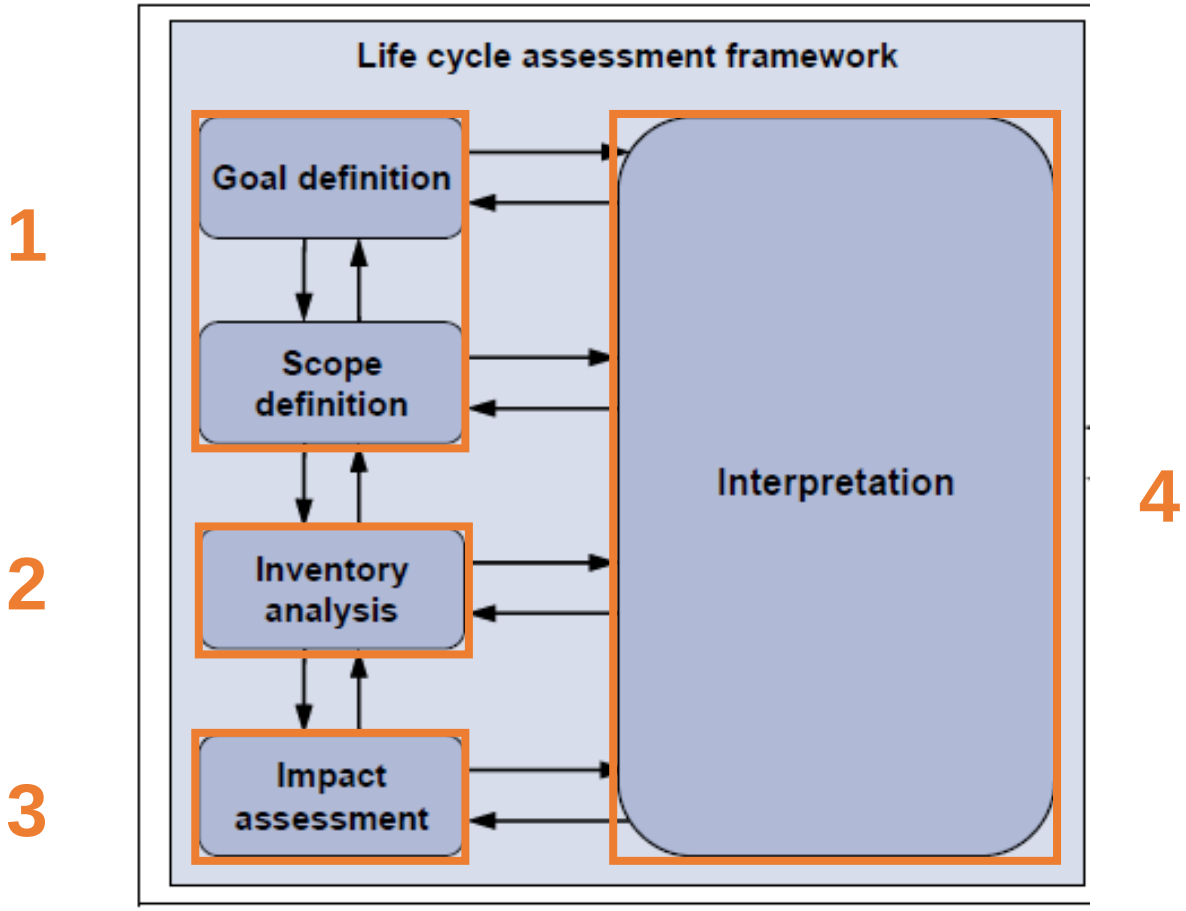
Highlights on some key challenges in the LCA of tailings management



Inventory analysis

Challenges in LCA? Data, data, data!

Data is (one of) the most crucial issue in LCA of metals production

- **Representativeness**
- Level of **disaggregation** (“black-box” issue)
- **Completeness**
- **Consistency**

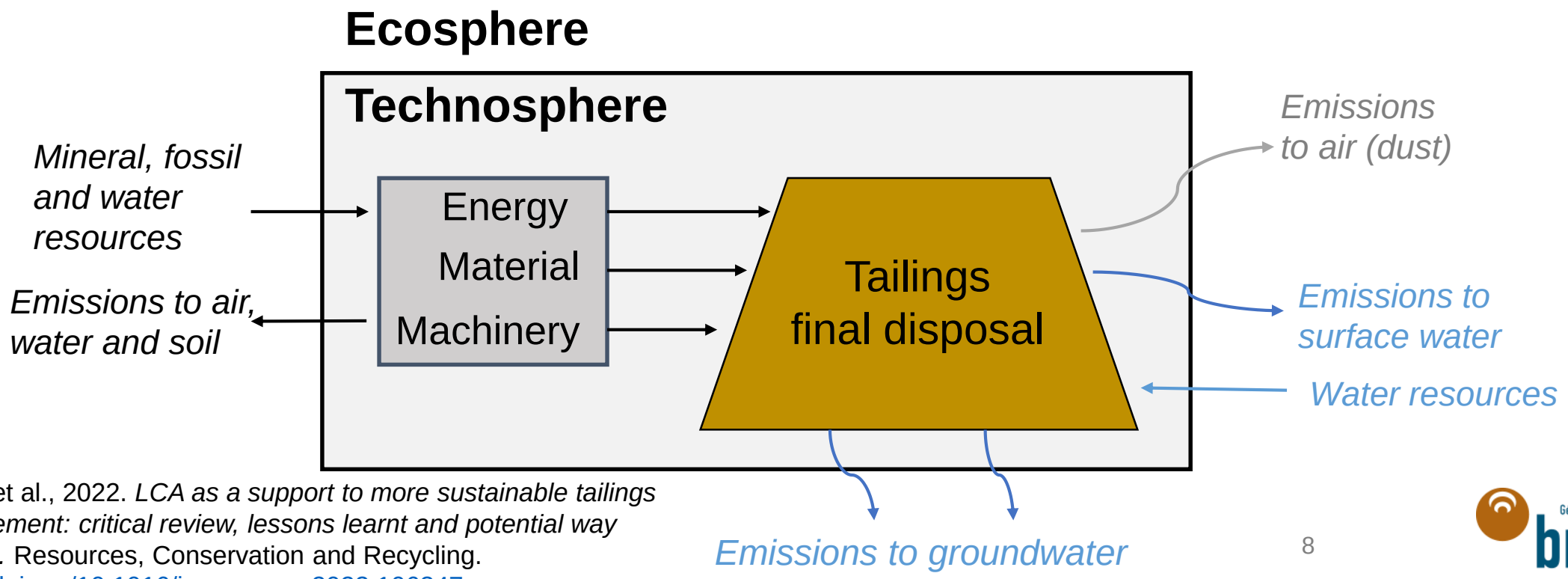
Coping with data challenges

- ***Extensive data collection***
- *Use of* ***complementary models***

Complementing LCA data collection with models: reactive transport modelling

LCA of tailings final disposal

- **Emissions to groundwater: hotspots** for some impact categories
- Yet **few case studies**; often based on **uncertain** and **incomplete data** collected on-site



Beylot et al., 2022. *LCA as a support to more sustainable tailings management: critical review, lessons learnt and potential way forward.* Resources, Conservation and Recycling. https://doi.org/10.1016/j.resconrec.2022.106347

Complementing LCA data collection with models: reactive transport modelling

LCA of tailings final disposal

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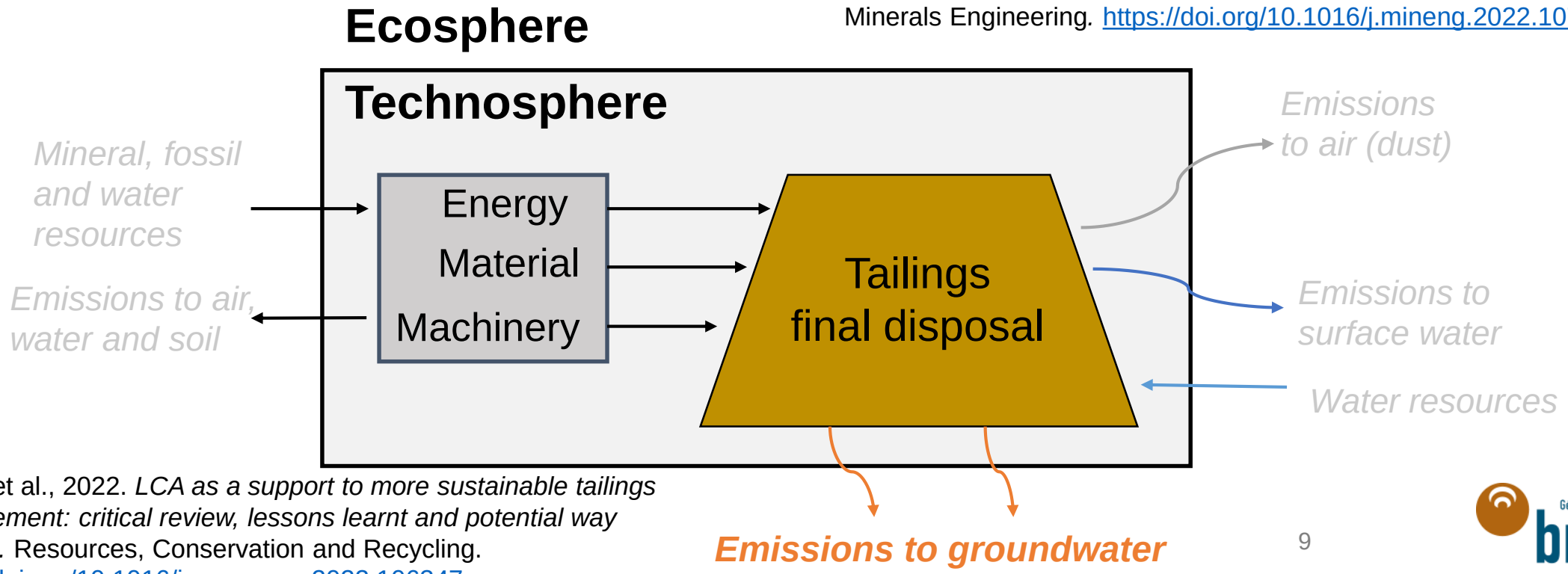
Reactive transport modelling

- Determining the concentration of chemical species at the outlet of the system
- Resulting in **mass of chemical species emitted to groundwater** over time

Muller, S., et al. 2022. *Modelling releases from tailings in life cycle assessments of the mining sector: From generic models to reactive transport modelling.* Minerals Engineering. https://doi.org/10.1016/j.mineng.2022.107481



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Challenges in the LCA of tailings management

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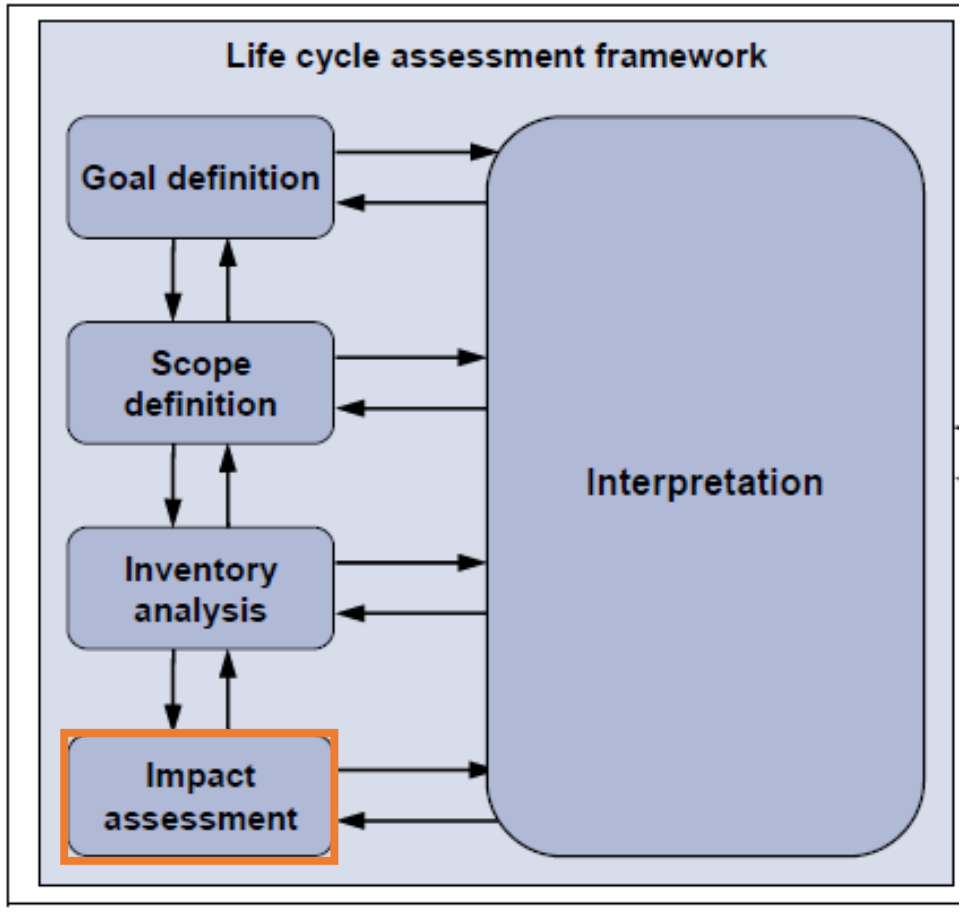
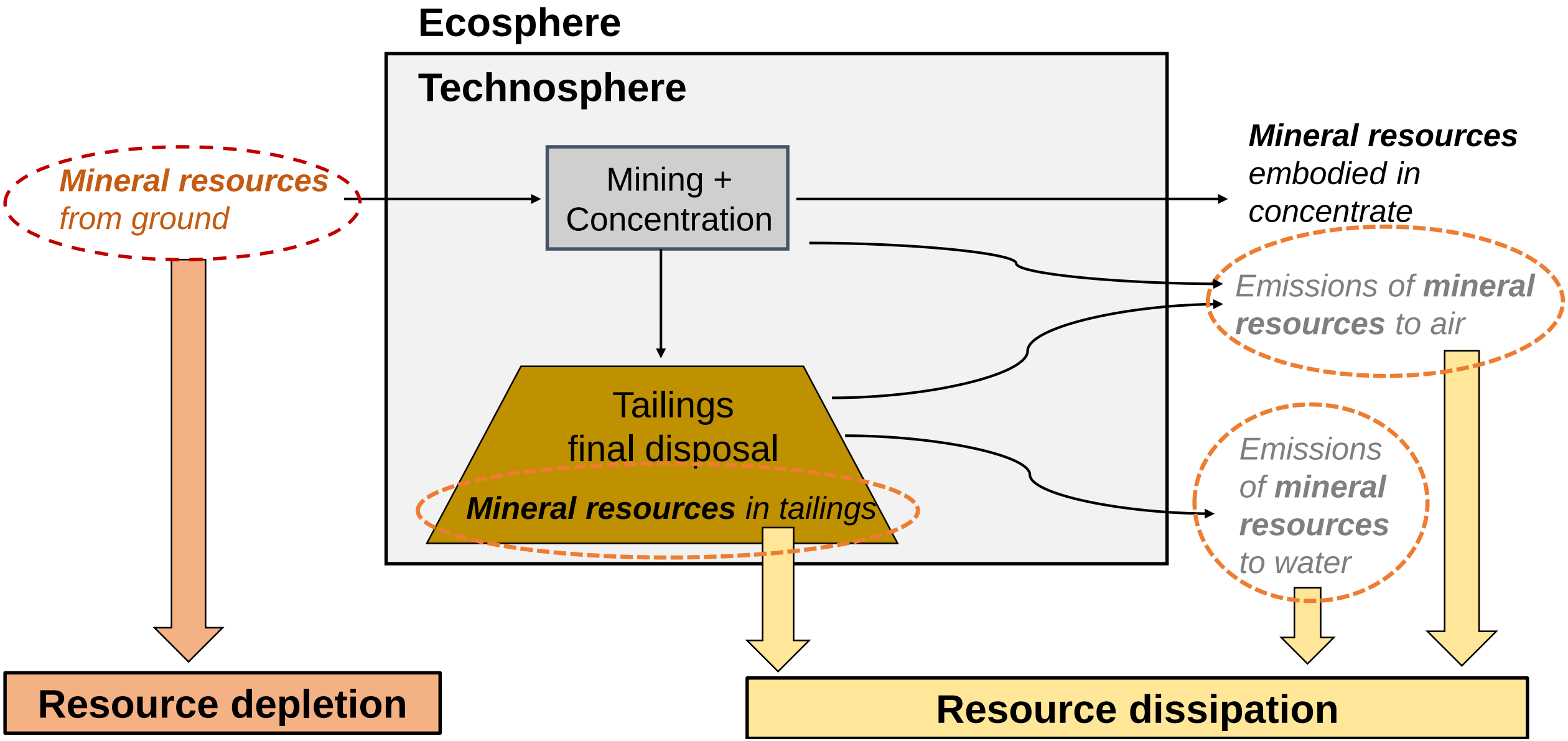
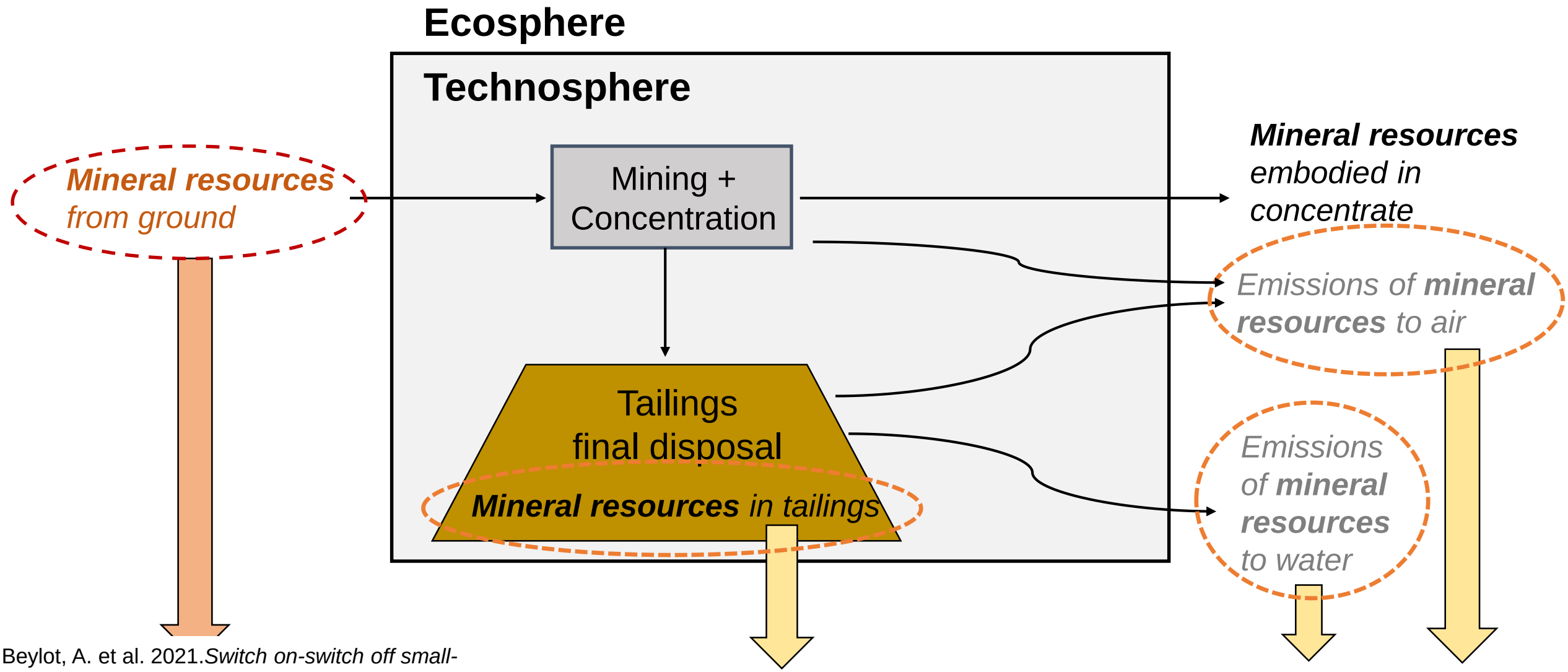


Resource indicators



Beylot, A., et al. 2021. *Mineral resource dissipation in life cycle inventories*. Int J Life Cycle Assess 26, 497–510. https://doi.org/10.1007/s11367-021-01875-4

Resource indicators



Beylot, A. et al. 2021.*Switch on-switch off small-scale mining: Environmental performance in a life cycle perspective,*
Journal of Cleaner Production,
https://doi.org/10.1016/j.jclepro.2021.127647

Further questions at the interface with the mineral processing community

- How far are metals in **tailings** (technologically/economically) **accessible**?
- Or on the **contrary « lost »/dissipated**?

Conclusions

LCA as a support to decisions for improved environmental performance of tailings management

- **Hotspots and trade-offs identification, comparison** of alternatives

A range of challenges ahead to support even sounder decision-making

- **At each step of a LCA study**
  - Data is key… but also: goal and scope definition, impact assessment, and interpretation are challenging
- **Different levels of complexity**
  - From guidelines implementation...
  - … to still open research questions (e.g. resource dissipation, modelling of emissions from tailings disposal)
- Probably just a **sample of challenges presented** here
  - Social LCA, prospective LCA, etc. (*to be completed!*) are also challenging

The way forward

- **Collaboration is the key!**
  - Process simulation
  - Reactive transport modelling
  - Economy (prices of resources)
  - …

Thank you for your attention!

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For more details:

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