Are polluted sediments a source of contaminants for the water column?

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Context

> Many aquatic ecosystems may be threatened by a possible remobilisation of pollutants accumulated in sediments.

> Any disruptive event of water/sediment equilibrium may induce a contaminant release in the water column.

> Re-deposition following re-suspension of initially anoxic sediment in oxic water is then a potential episode of increasing mobility of pollutants.
Objective

> A laboratory experiment was performed to understand the sediment ability to release metals in solution during re-deposition following re-suspension in oxic condition.

> Special care was given to the kinetics of the phenomena involved by coupling physical and chemical mechanisms.
Material: Sediment characteristics

Material originating from the Scarpe river in the North of France

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Material: *Sediment characteristics*

**semi-quantitative mineralogy:**
- Quartz ~ 40%, Calcite ~ 15%, Microline, Plagioclase and clay;

  with:
  - Interstratified smectite/illite ~ 47%;
  - Kaolinite ~ 30%;
  - Illite and/or mica ~ 20%;
  - Chlorite ~ 3%.

**Particle size distribution:**

![](image.png)

- \(d_{10} = 7.3 \mu m\)
- \(d_{50} = 22.2 \mu m\)
- \(d_{90} = 552.4 \mu m\)
- \(d_mL = 147.6 \mu m\)
Method: *Experimental devices*

> overview of column set and sampling operation

At each sampling time, 3 heights were collected and analysed:
- 2 cm under the air/water interface
- At the middle of the water column
- 2 cm above the sediment/water interface

**Experimental devices**
- **Sampling syringe**
- **Septum**
- **pH, Eh**
- **O₂**
- **Electrodes**
Method: *Experimental devices*

> overview of column set for density measurement
Results: *Settling kinetic*

Initial MES = 56 g/l
Settling speed: \( V = 0.3 \) m/h
Compression starts after about 6 hours
Results: $E_H$ and $pH$
Results: *Ca and Na*
Results: Fe and Mn
Results: *Fe*

Six samples are plotted in a pE/pH stability diagram for aqueous iron species (Kölling *et al.*, 1999).

At the sediment/water interface:
1. after 3.3 days
2. after 7 days
3. after 12 days
4. after 36 days
5. after 72 days jours d’expérience

In the middle of the column:
6. after 36 days

\[
Fe^{2+} + O_2 + H_2O \rightarrow Fe(OH)_3^0 + 2H^+_3
\]

*EPI*
Results: $\text{SO}_4^{2-}$ and aqueous P

![Graph showing concentrations of $\text{SO}_4^{2-}$ and P over time](image)
Results: metals

- **Zn**
  - Concentration /µg l⁻¹
  - Time /days

- **Cd**
  - Concentration /µg l⁻¹
  - Time /days

- **Pb**
  - Concentration /µg l⁻¹
  - Time /days

Graphs show the concentration of Zn, Cd, and Pb over time at different interfaces:
- Air/water interface
- Middle of the water column
- Sediment/water interface
Results: synthesis

1. Settling and compression, release of oxidation products ($SO_4^{2-}$, $H^+$, $Ca^{2+}$, $Mg^{2+}$, $Mn^{2+}$)

2. Degazing and compression, release of reduction and mineralization products ($Fe^{2+}$, $P_{aqueous}$) – possible release of pollutants in colloidal form

3. Dispersion of solutes probably due to colloids destabilisation due to iron hydroxides precipitation

4. Equilibrium: 2 systems with opposite redox co-exist.
Conclusion

> Equilibrium of both water and sediment is not reached before 50 days of experiment,

> During the first 30 days following re-deposition, release of metals may occur. It is probably link to the mechanical release of colloids due to bubbling,

> This source of contaminants for the water column is difficult to quantify,

> Is it a significant source of pollutants for the biocenose?
Perspectives

> What is the behavior of other pollutants?
  • As, which may compete with P?
  • Organics, which are mainly linked to organic matter in sediment?

> GedSet, a new Interreg 4 research project, has been accepted and should bring some answers.