

Phosphate recovery from Iron Coated Sand granules by alkaline desorption

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Iron Coated Sand (ICS)



Integration of P-adsorbing material in a circular process

Introduction

Agriculture water flows, e.g., drainage water originating from tile drained agricultural fields or greenhouse effluent, often contain phosphate amounts of unused fertilisers above the standard limits for surface water sources.

Proposed solution:

Adsorption technology using Iron Coated Sand (ICS) = a side/waste product of the local drinking water company Pidpa and produced during the deferrization of groundwater

In this study:

- The main objectives: **Regeneration of the saturated sorbents** and **recovery of phosphorus**.
- A desorption process using **alkaline** solutions is proposed without harming the sorbent grains.

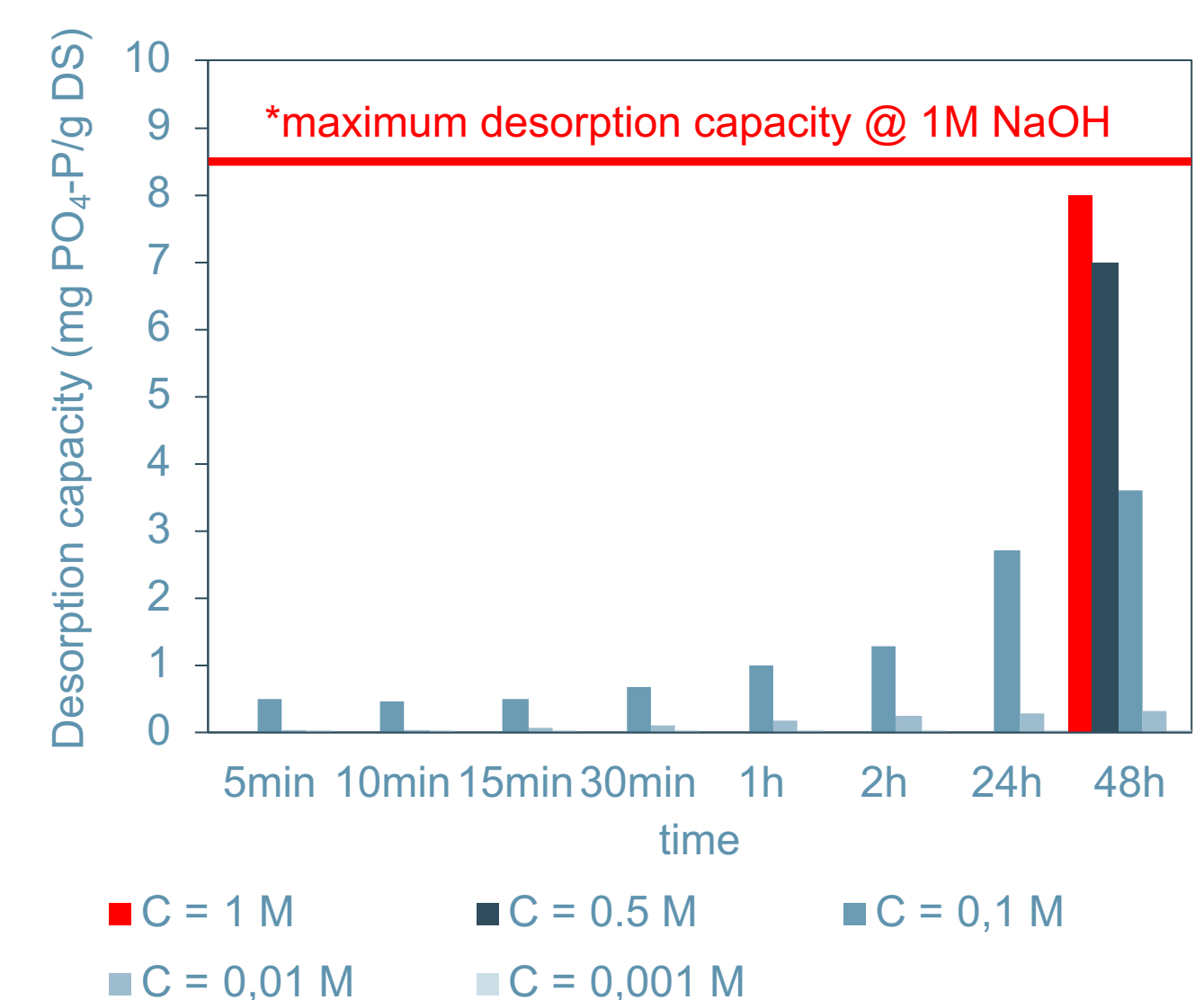
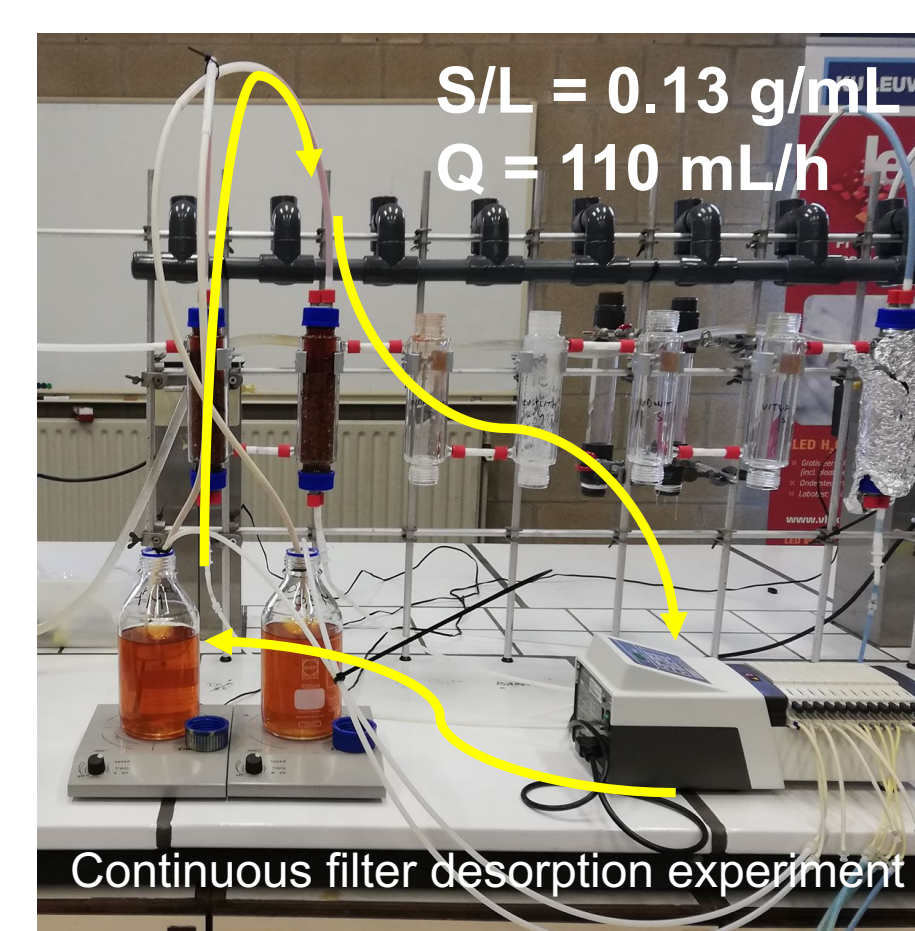


Figure 1: Influence of NaOH concentration and desorption time.

Materials & Methods

- Batch desorption experiments:** 5g of pre-dried saturated ICS was brought into contact with NaOH solution. Variable parameters: NaOH concentration (1M, 0.5M, 0.1M, 0.01M & 0.001M), desorption time (5min-48h) and solid/liquid ratio (0.03-1 g/mL)
- Continuous filter desorption experiment:** 1 liter of NaOH solution was recirculated over an adsorption column filled with 128 g of saturated ICS granules.
- Analysis of the samples:** **Liquids:** PO₄-P determination by ion chromatography after .45 µm filtration. **Solid grains:** SEM-EDX



Continuous filter desorption experiment

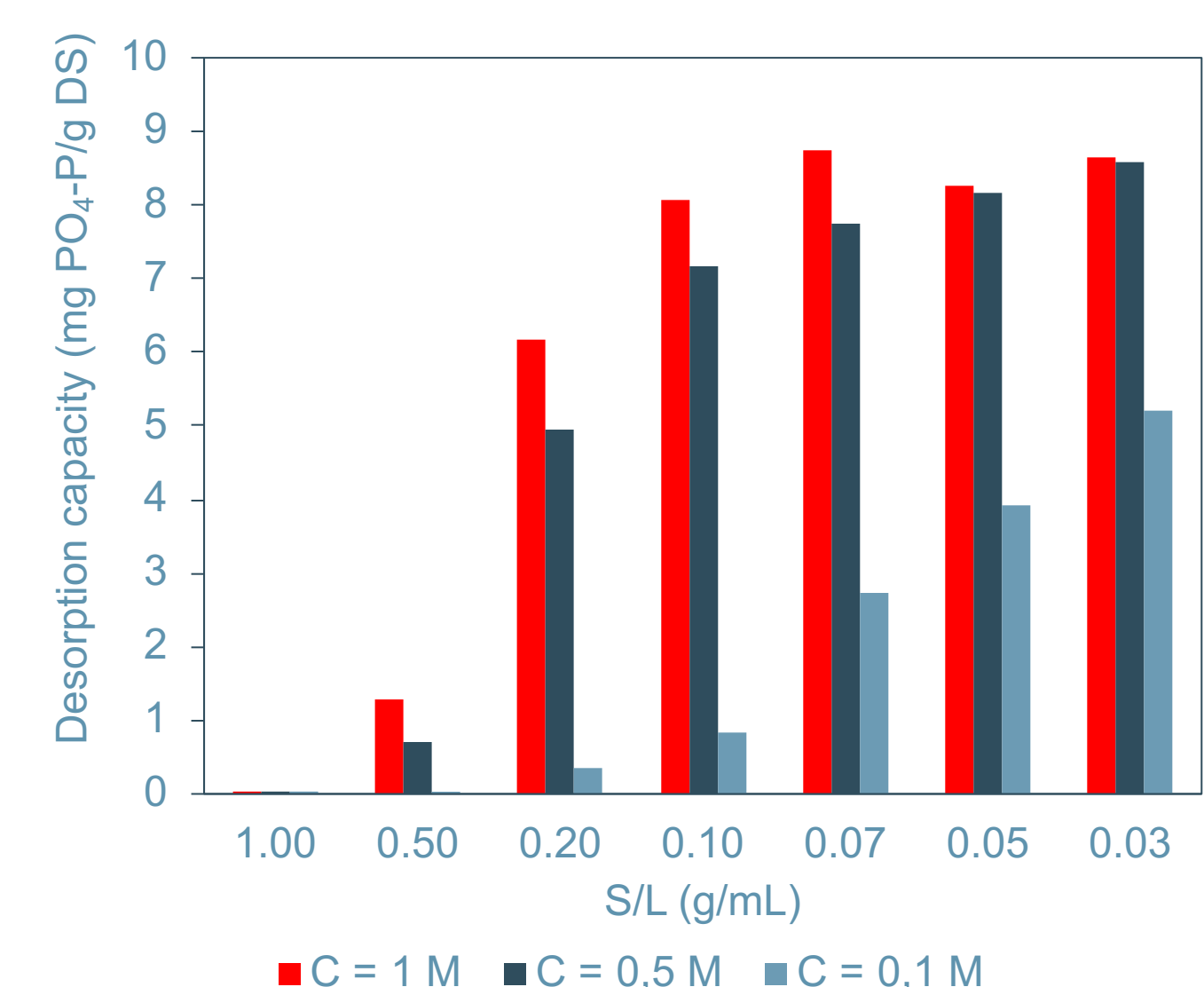


Figure 2: Influence of solid/liquid ratio.

Results & Discussion

- The composition of 1 g of saturated ICS pellets was determined by a complete destruction of the granules by Aqua Regia and ICP analysis:
 - Phosphorus: 15.30 +/-1.25 mg P/g DS
 - Iron: 590.7 +/-8.7 mg Fe/g DS
- Figure 1:** A minimum desorption time of 24 hours and a NaOH concentration of 0.1 - 1M is necessary to ensure a sufficiently high desorption efficiency.
- Figure 2:** The solid over liquid ratio (S/L expressed in g/mL) has a pronounced effect on desorption efficiency. An S/L lower than 0.10 g/mL is recommended.
- Figure 3:** Continuous desorption filter experiments show that only a concentration of 0.5 and 1M NaOH lead to a desired desorption of phosphorus from the ICS granule. At least 24 hours desorption time must be provided.
- Figure 4:** During the first hour of the continuous desorption experiment only 0.4 mg P/g DS and 0.9 mg P/g DS can be leached for a NaOH concentration of 0.5 and 1M respectively. A concentration of 0.1M NaOH desorbed almost no phosphorus.
- Figure 5:** The ICS granules have a solid structure with a sand core surrounded with iron. The phosphate is mainly adsorbed at the outer layers of granules.

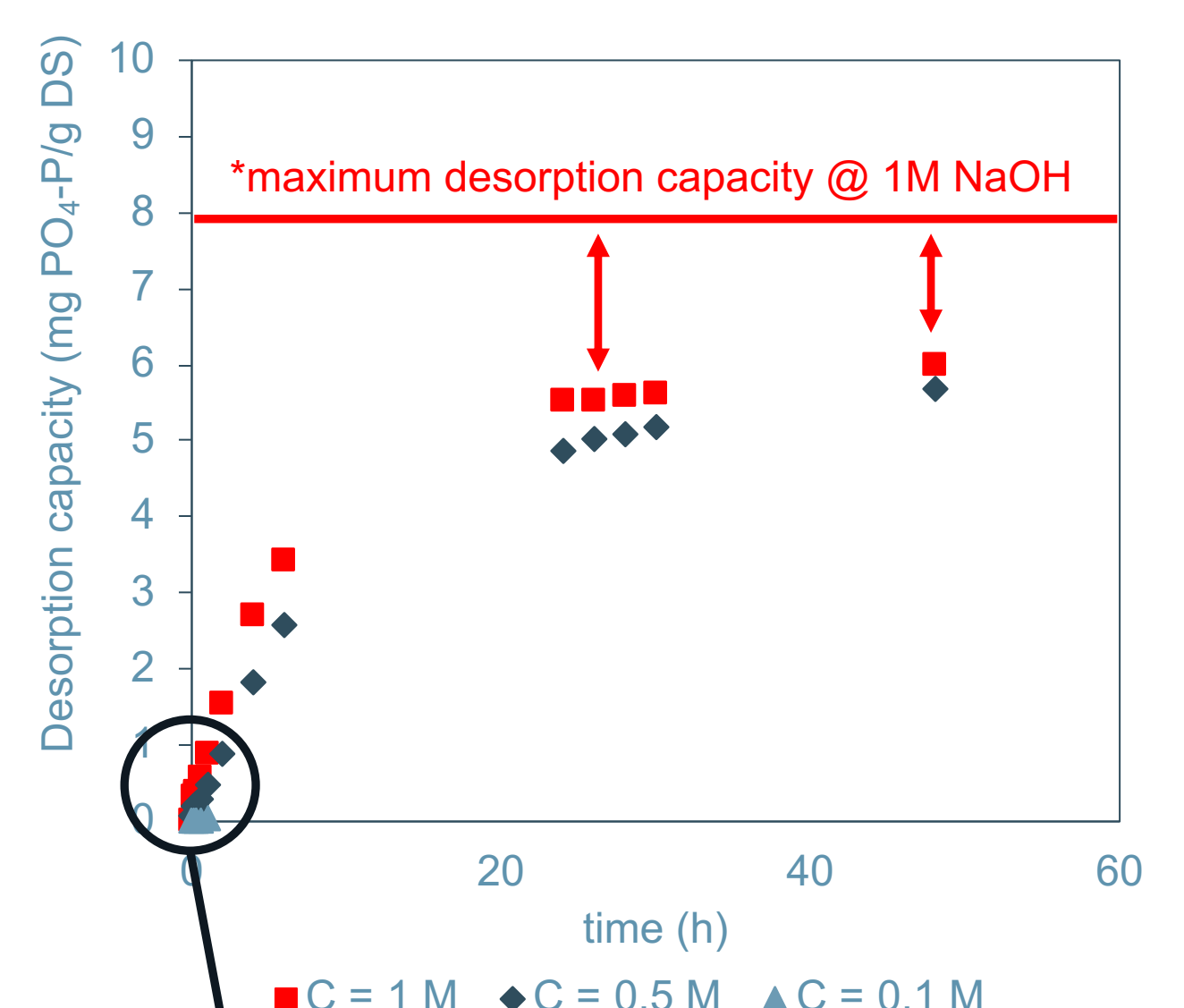


Figure 3: Continuous filter desorption experiment and the effect of the NaOH concentration on desorption capacity

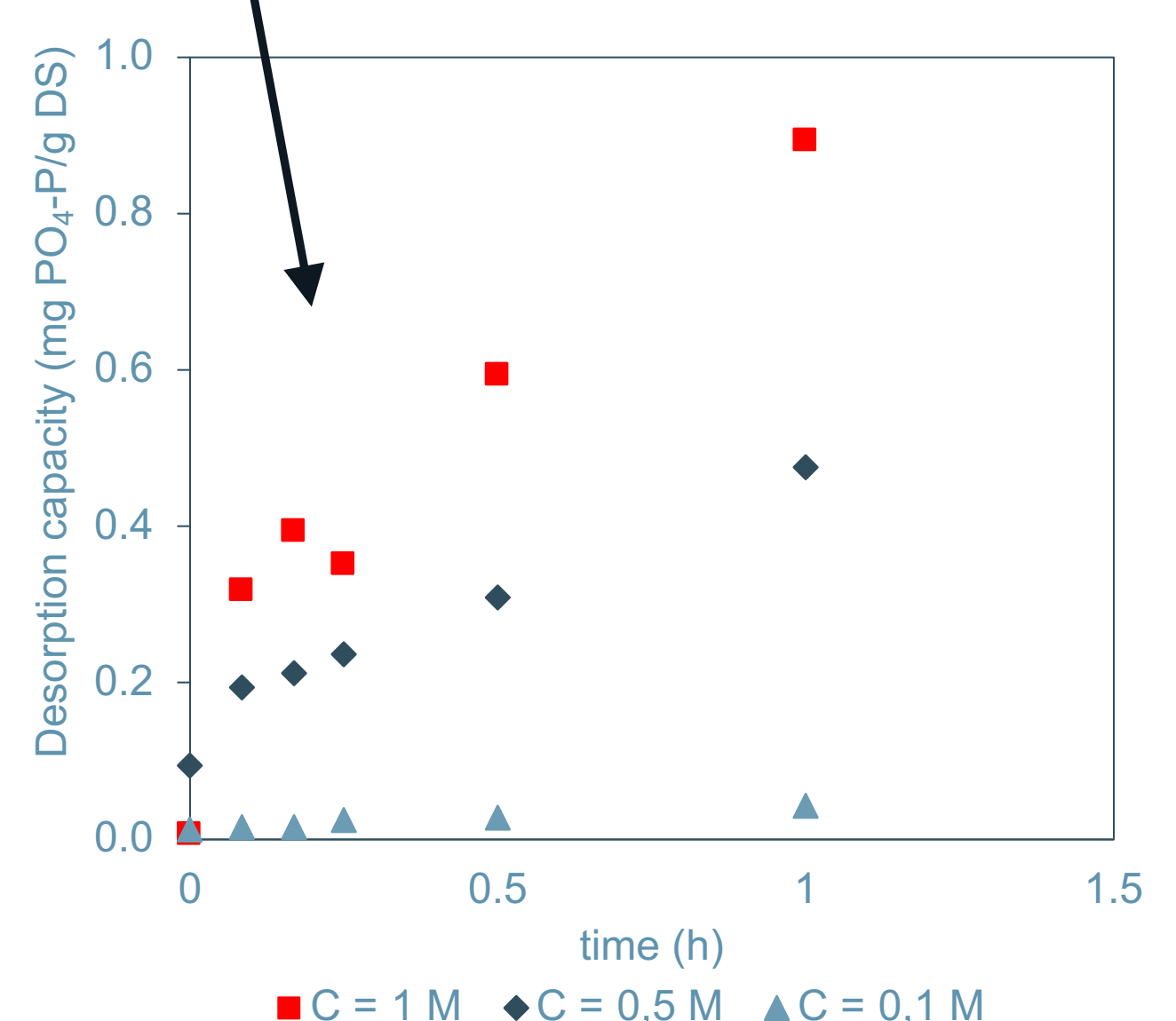


Figure 4: The progress of the desorption during the first hour of the continuous filter desorption experiment

Conclusion

- Optimal NaOH concentration = 0.5 M
- Optimal contact time = 24 hours or more
- Optimal S/L ratio = 0.10 - 0.05 g/mL
- P-desorption efficiency = 40% @ 0.5 and 1 M NaOH
- Leaching of Fe during the desorption process is a problem

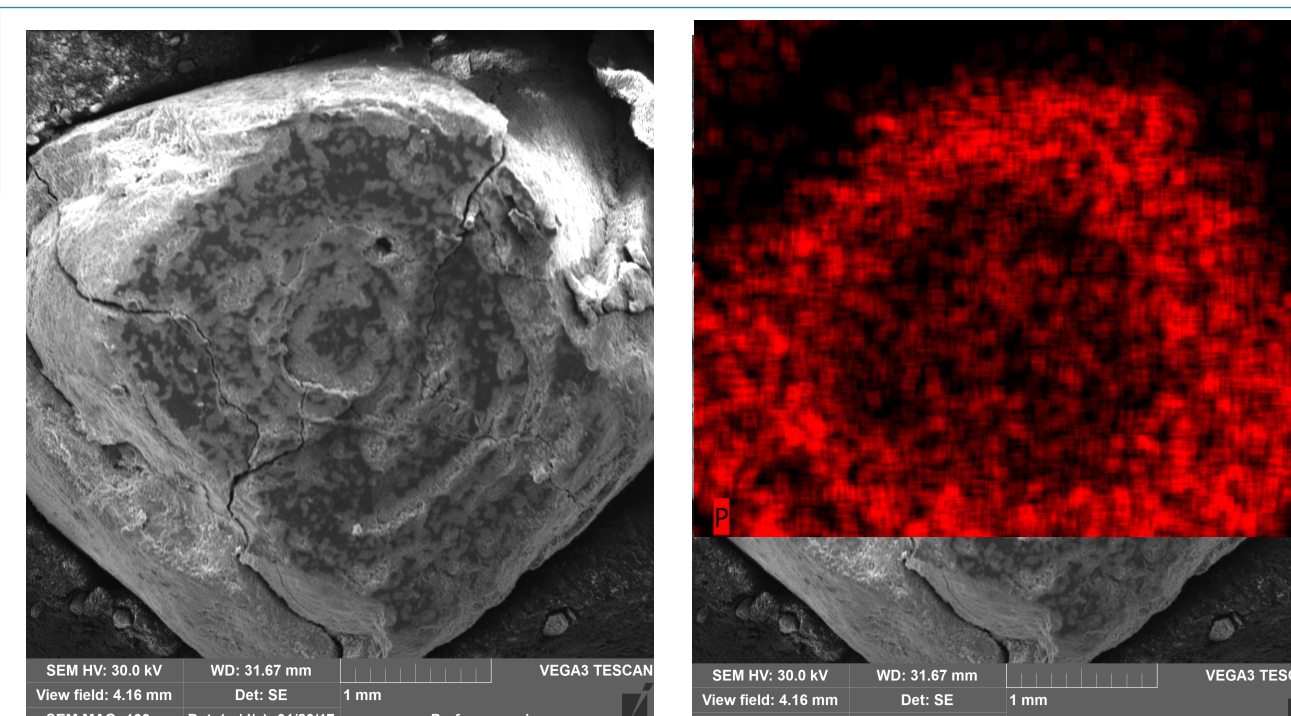


Figure 5: SEM-EDX analysis of the ICS granules