



SWISS NATIONAL SCIENCE FOUNDATION



Swiss Agency for Development
and Cooperation SDC



Министерство на
образованието и науката

Innovative P-recovery from waste sludge

Collaborative aspects and main
results

*Presented by: Assoc. Prof. Irina Ribarova, UACEG, Sofia, Bulgaria
Assoc. Prof. Hussein Jemendjiev, BU, Bulgaria*

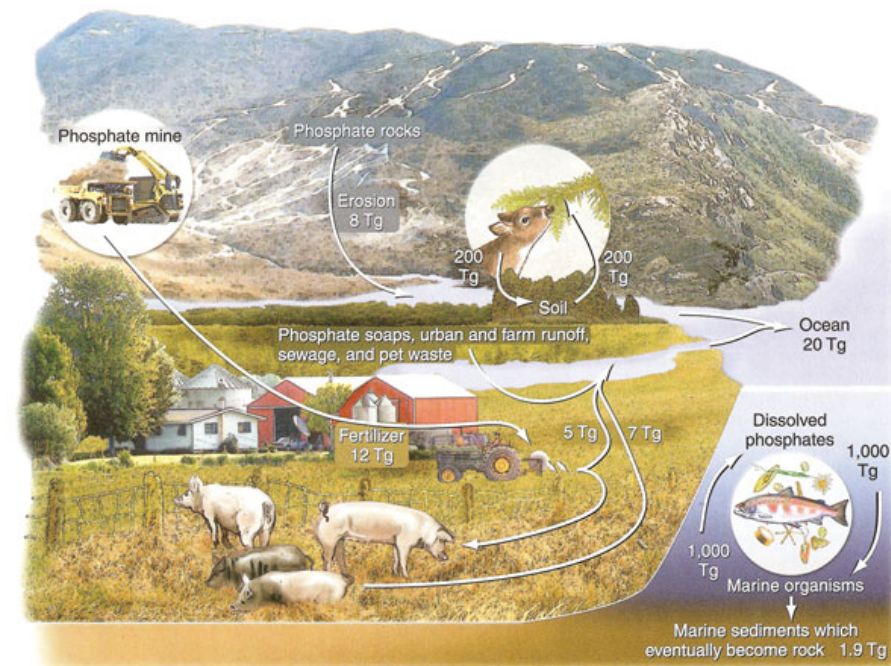
Structure of the presentation

1. Project overview
2. Collaborative aspects
3. Brief overview of the research results

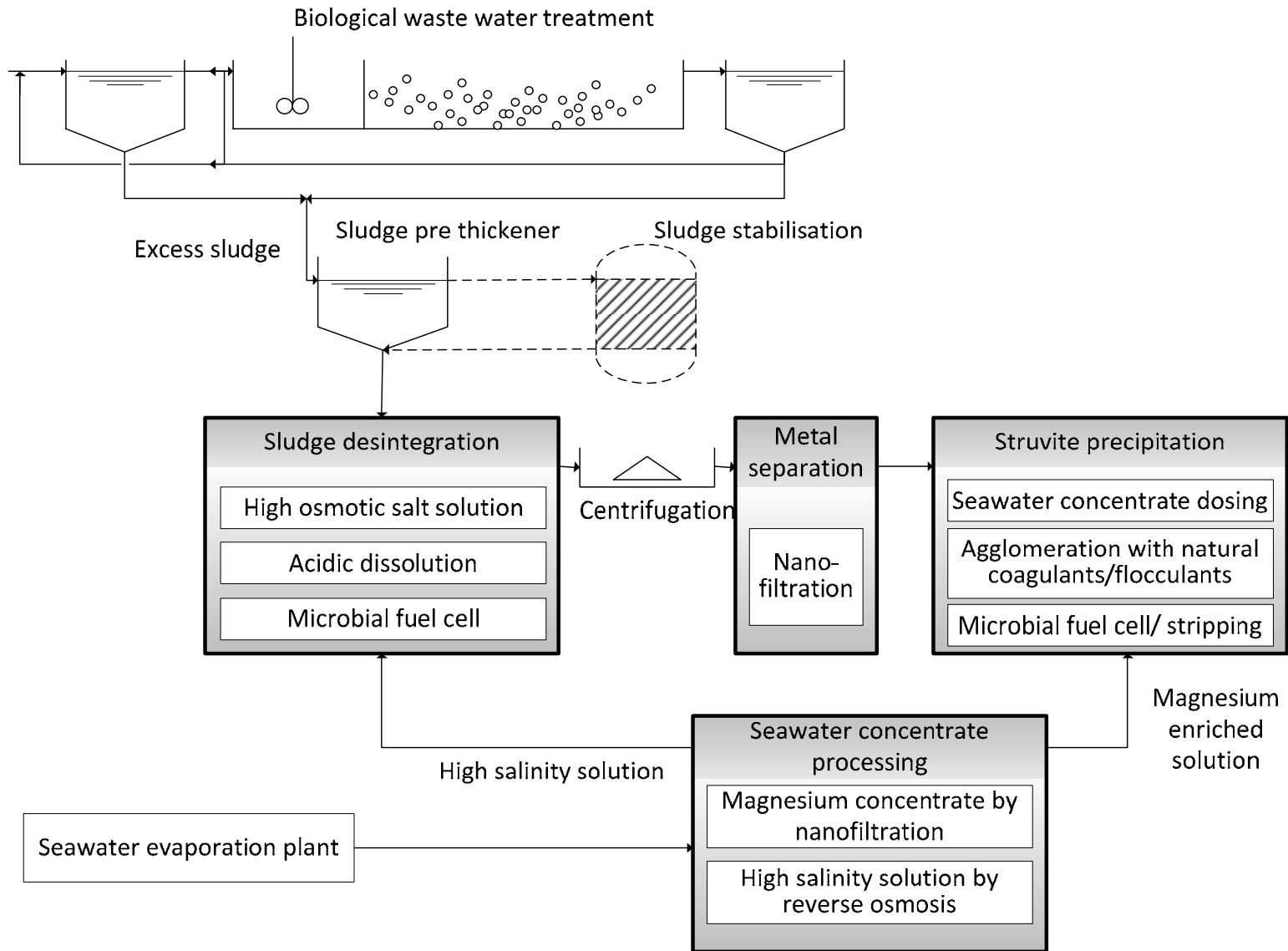
1. Project overview

The importance of the phosphorus recovery

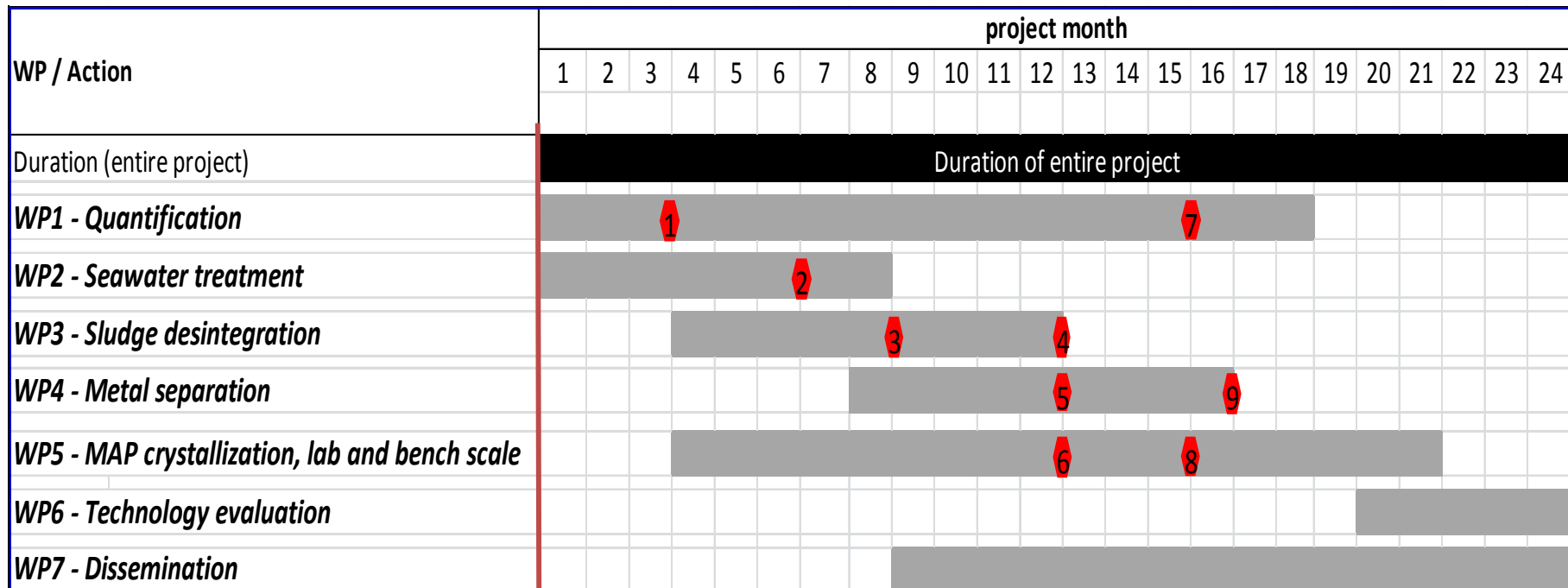
- Irreplaceable natural resource;
- It disappears from the food chain as **animal manure, human excreta and organic waste**;
- Largest part mining phosphate rock are located in Morocco, the US and China. In Europe hardly any raw phosphorus is available, except for a very small quantity in Finland. Increasing prices
- Closing cycles of matters is an important measure towards higher independence and better sustainability.



The concepts of the project

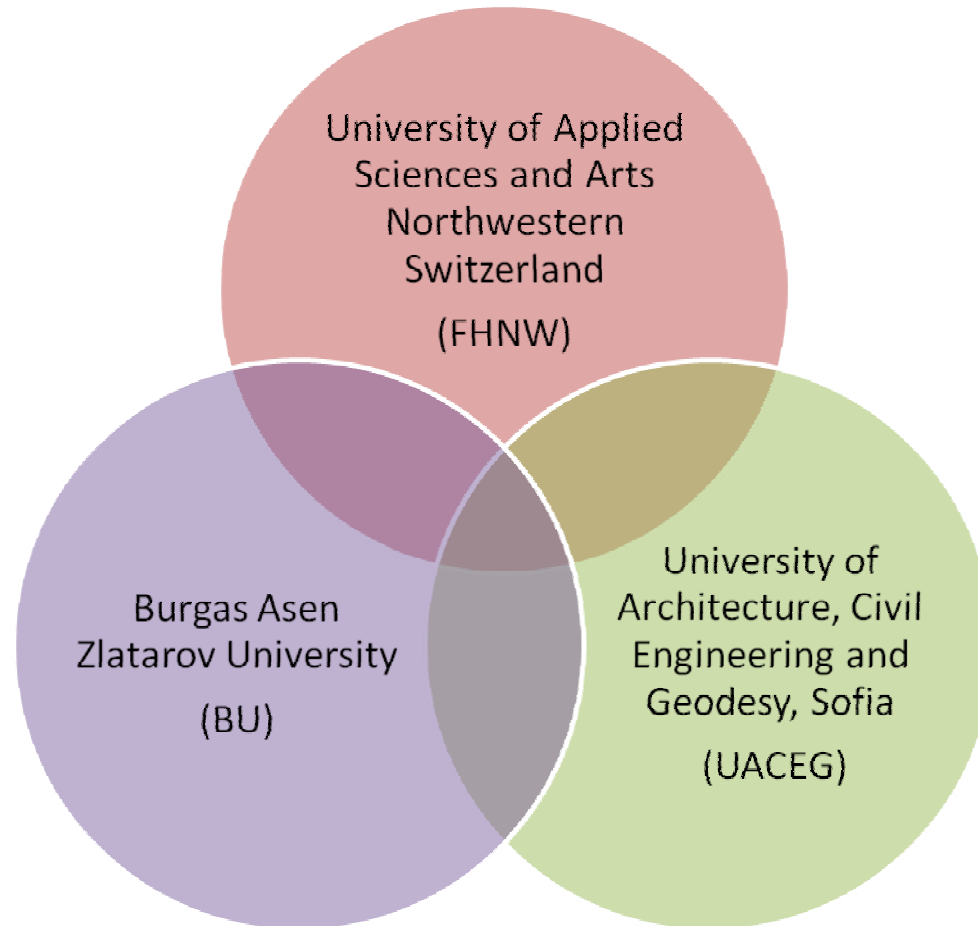


Timeline



2. Collaborative aspects

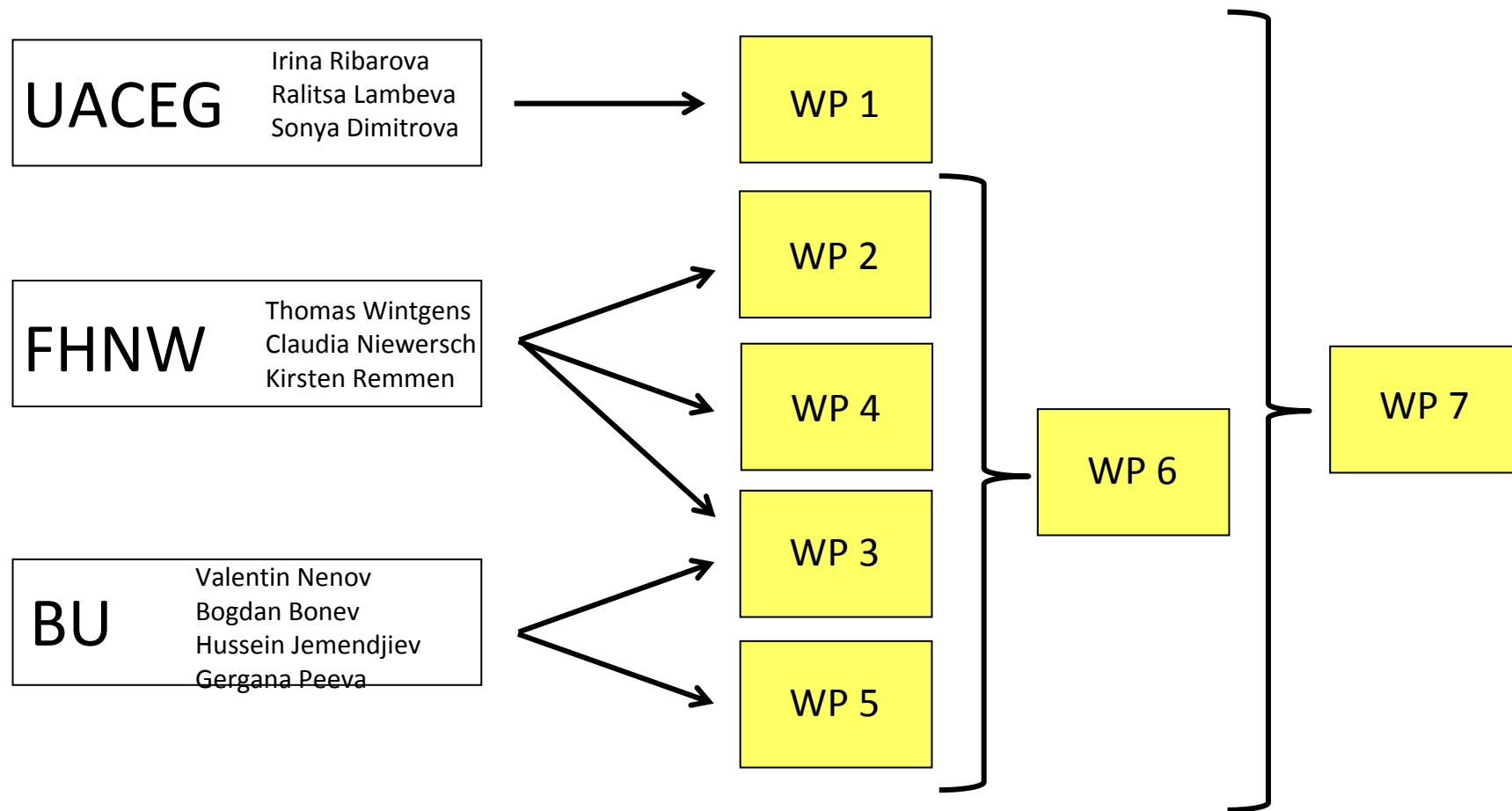
Partners



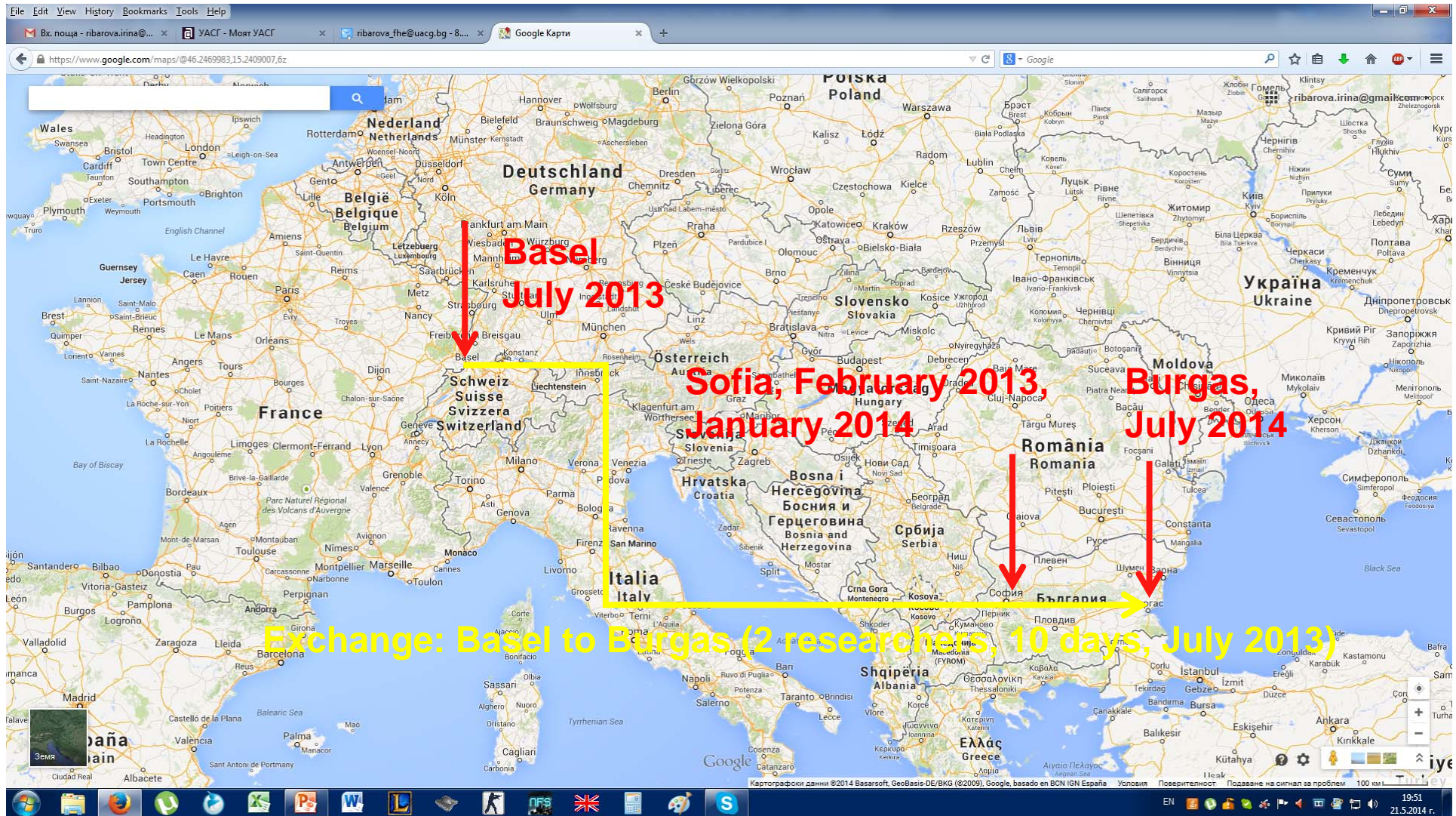
Partners together



Project structure – responsible partners

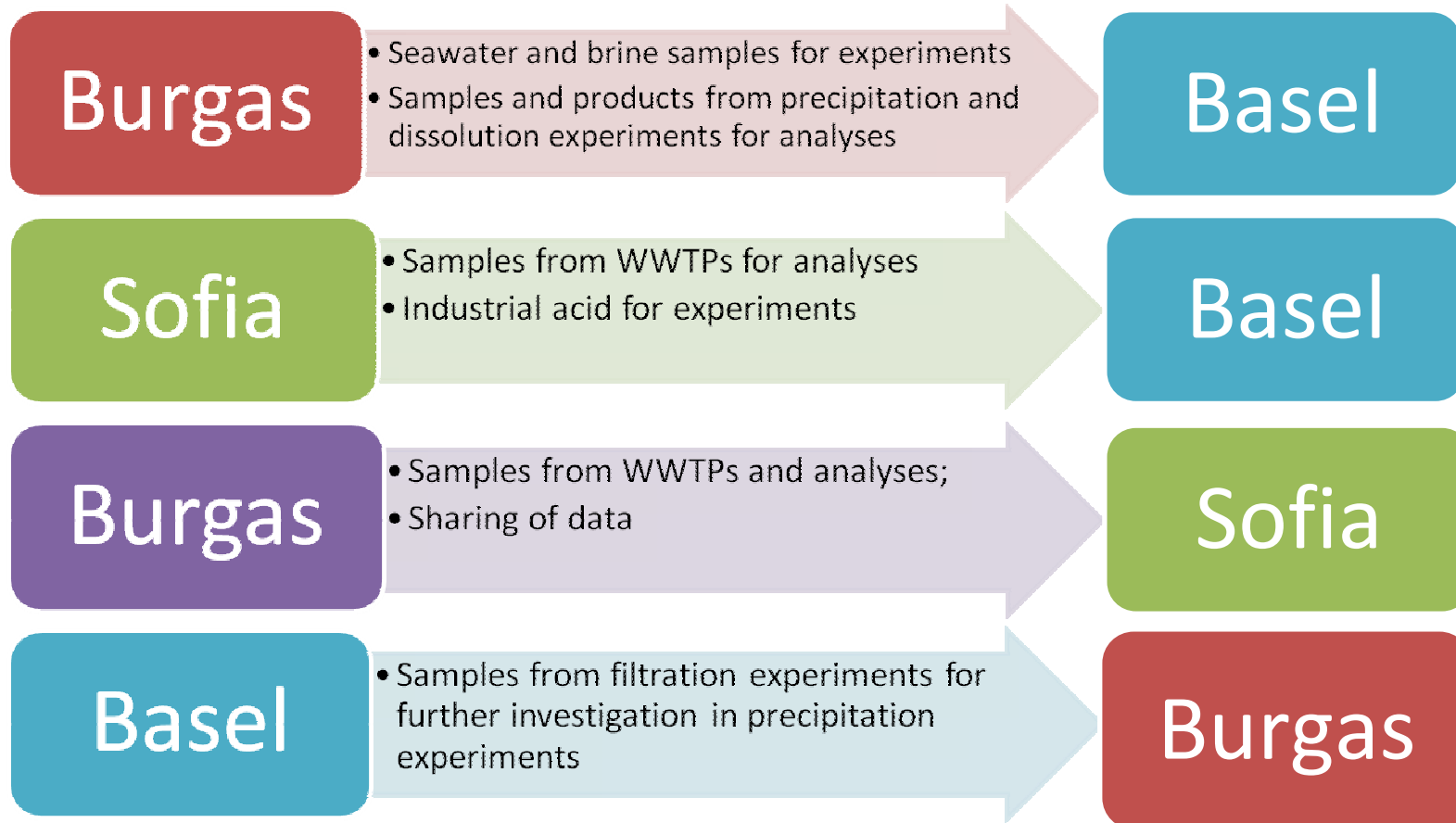


Collaborations: Project meetings (3 hold, 1 forthcoming) and Exchange visit



BSRP midterm meeting 22 May 2014 Sofia

Other collaborations



Summary of the collaborative activities

- Mutual learning - exchange of knowledge and ideas, discussions for overcoming of the difficulties;
- Better planning of the research needs and steps by joint efforts;
- Sharing of techniques and research methods;
- Sharing of laboratories – overcoming the need to equip every laboratory

Next collaboration steps

- Already approved International Exploratory Workshops (will be financed by the Swiss National Science Foundation)
- 24-26 November 2014 in Basel
- The topic: “Phosphorus recovery technologies: from labs to practice”

3. Brief overview of the main research results

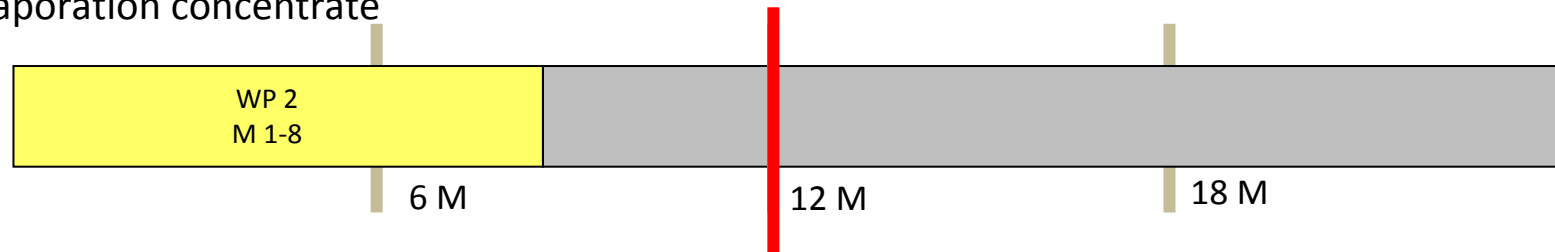
WP1 Selected WWTPs

City (above 10 000 pe)	PE	P-removal	Stabilization	Dewatering
Sofia	1 291 054	ch/bio	digestor	belt filterpress
Burgas	170 792	ch/bio	anaerobic open	centrifuges
Meden Rudnik	43 757	ch	ext aeration	centrifuges
Kustendil	48 052	ch/bio	aerobic stabilisation	drying beds/centr
Samokov	26 591	n.n.	ext aeration	chamber filter press
Gorna Orjahovitsa	43 834	ch/bio	digestor	belt filter press
Dimitrovgrad	38 677	ch	digestor	belt filter press
Ruse	149 294	ch/bio	digestor	belt filter press
Sevlievo	23 390	ch	aerobic stabilisation	belt filter press
Sliven	92 530	ch/bio	digestor	mechanical
Stara Zagora	172 492	ch/bio	deigestor	mechanical
Trojan	22 225	ch/bio	ext aeration	belt filter press
Haskovo	89 812	n.n.	ext aeration	belt filter press

WP2 Sewewater treatment

Goal: Process combination of nanofiltration and reverse osmosis for treatment of solar seawater

evaporation concentrate

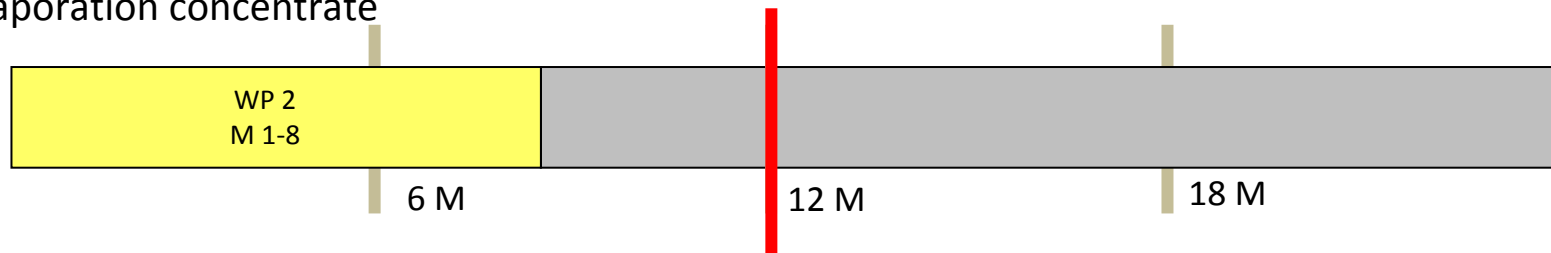


Task 2.1: Membrane screening (FHNW)

Task 2.2: Filtration experiments (FHNW)

WP2 Sewewater treatment

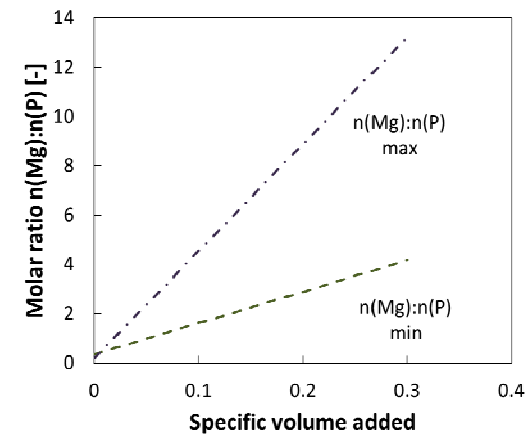
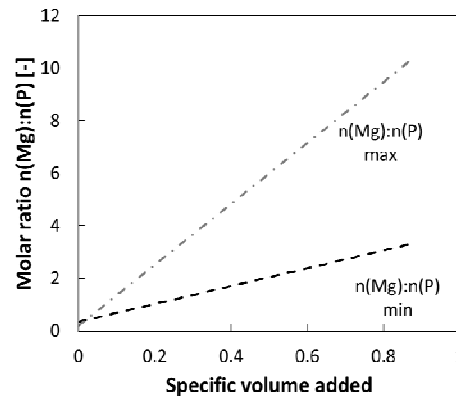
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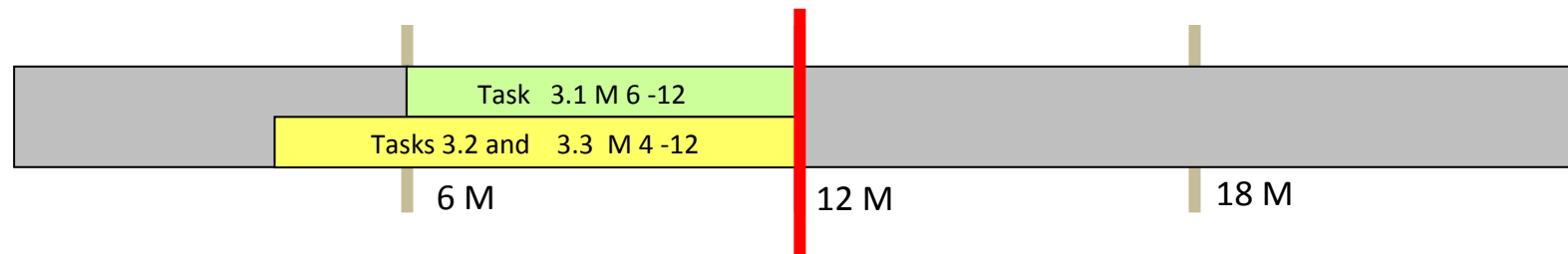


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WP 3 Sludge disintegration

Goal: Provoke an increased release of phosphorus from the sludge into the liquid phase



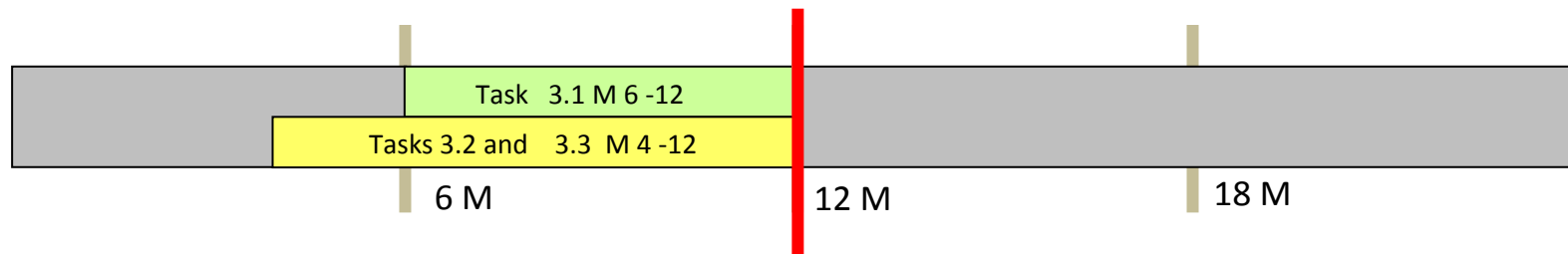
Task 3.1: Phosphate dissolution from sludge by applying solution of high salinity (FHNW)

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Task 3.3: Lab scale Studies on acidic dissolution of phosphate from sludge (FHNW)

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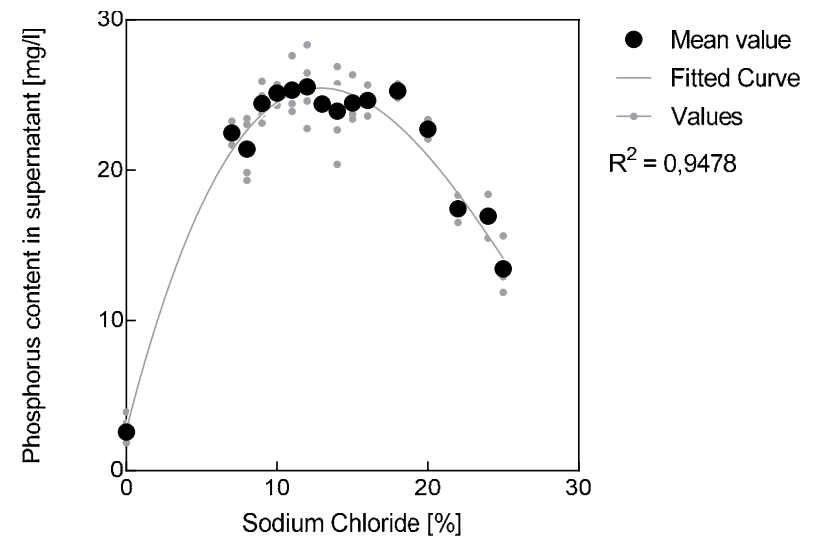
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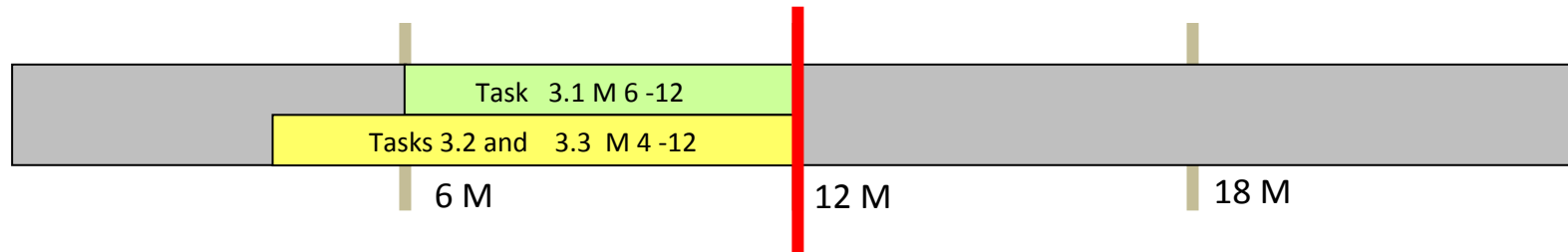
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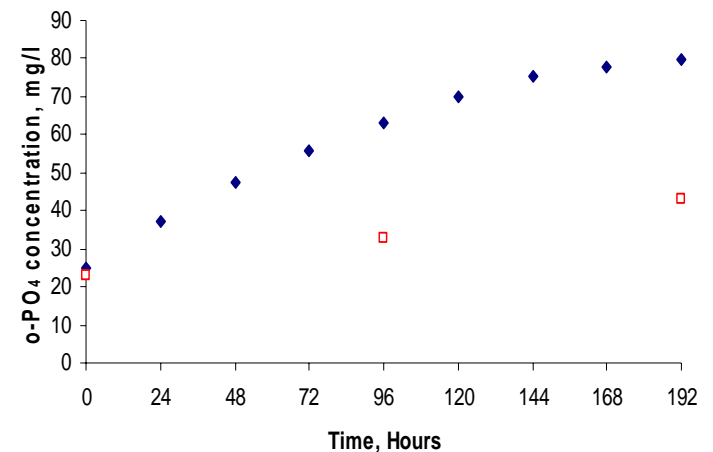


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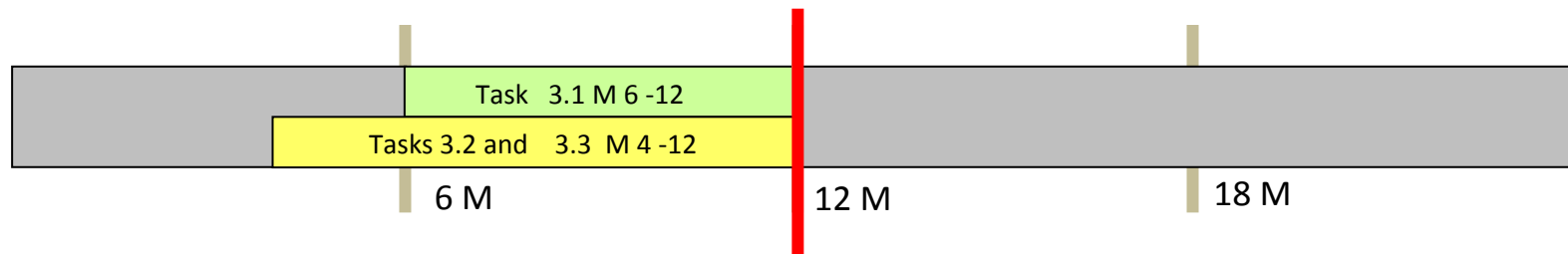
Task 3.3: Lab scale Studies on acidic dissolution of phosphate from sludge (FHNW)

o-PO₄ concentration in the MFC (blue) and control sample (red) vs. Time



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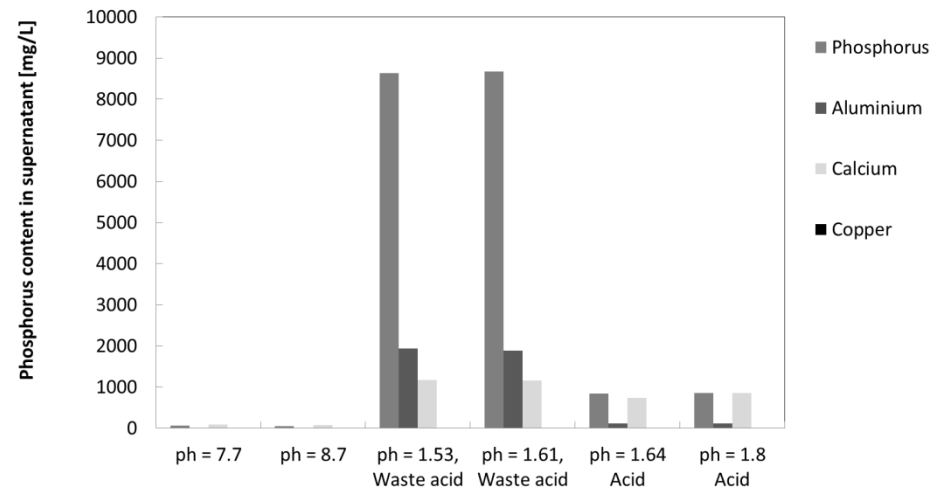
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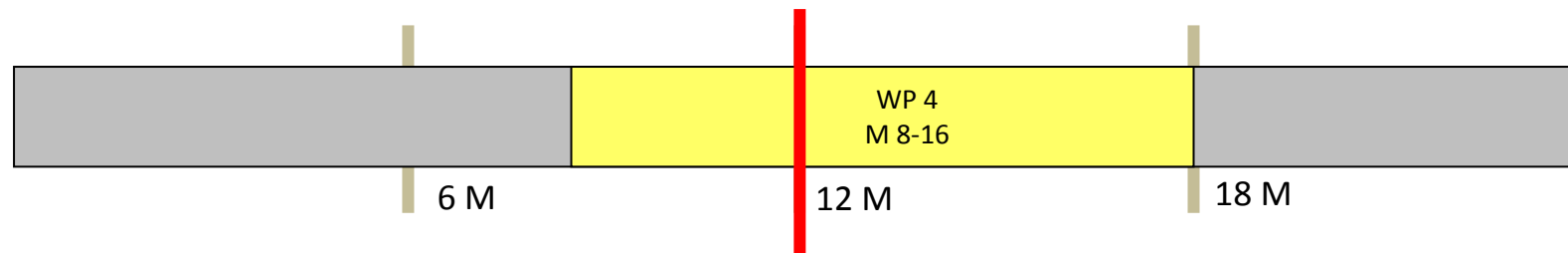


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WP4 Metal separation

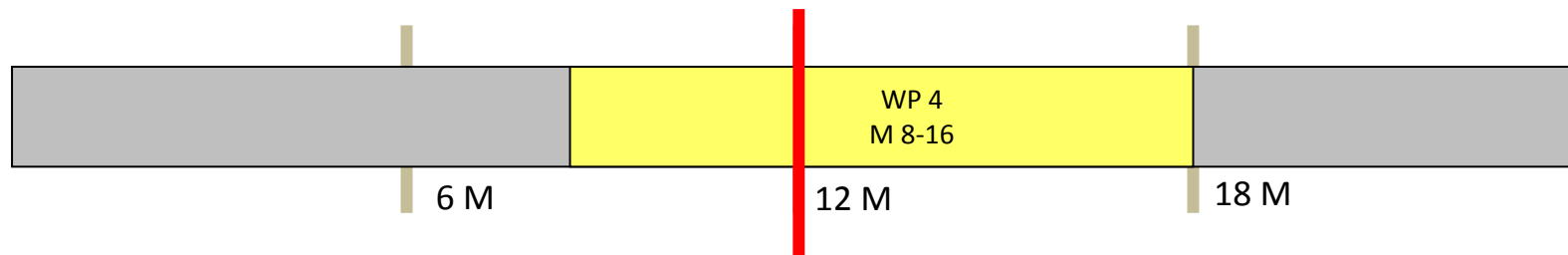
Goal: Low phosphorus loss and an effective purification



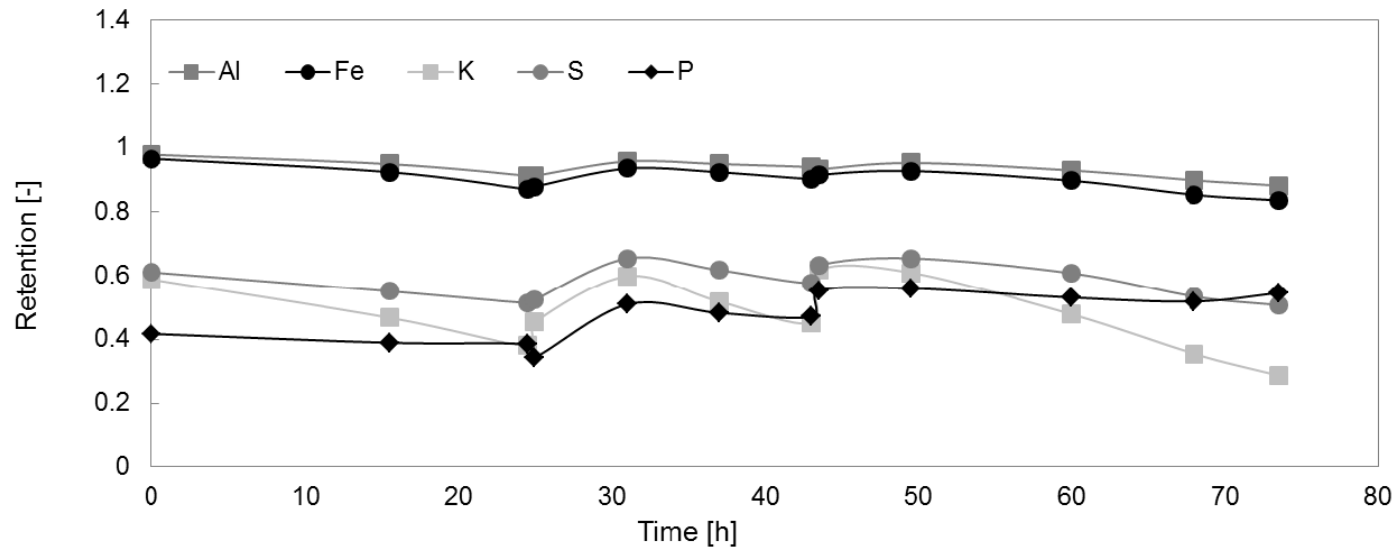
Task: Lab scale studies on metal separation with nanofiltration → optimize operational parameters (FHNW)

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WP-5 MAP crystallization, lab and bench scale

Goal: To develop innovative and environment friendly methods of struvite precipitation

Task 5.1: Lab scale studies on the application of low cost natural seawater concentrate

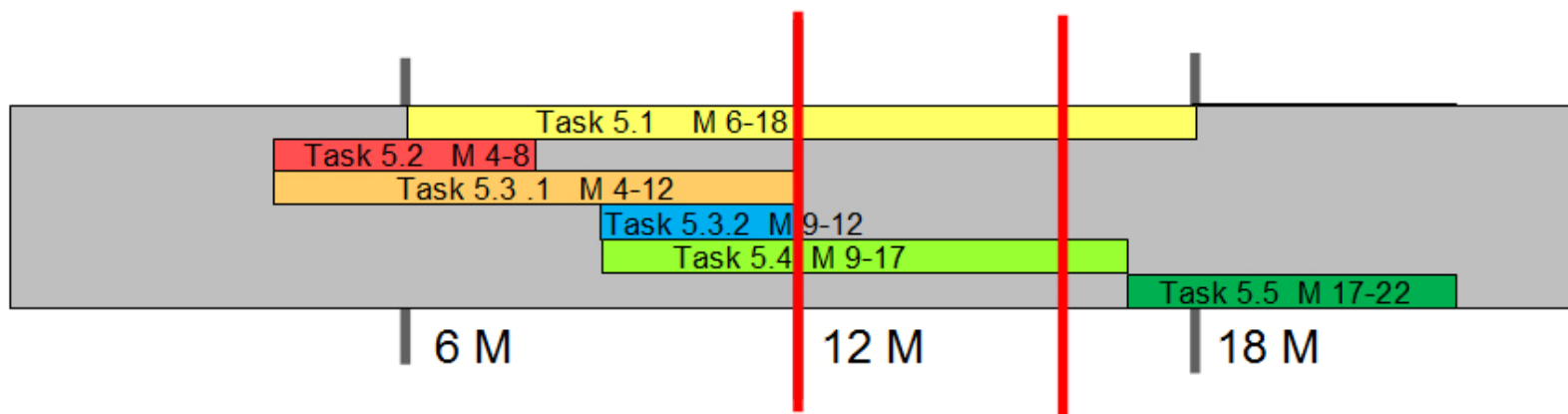
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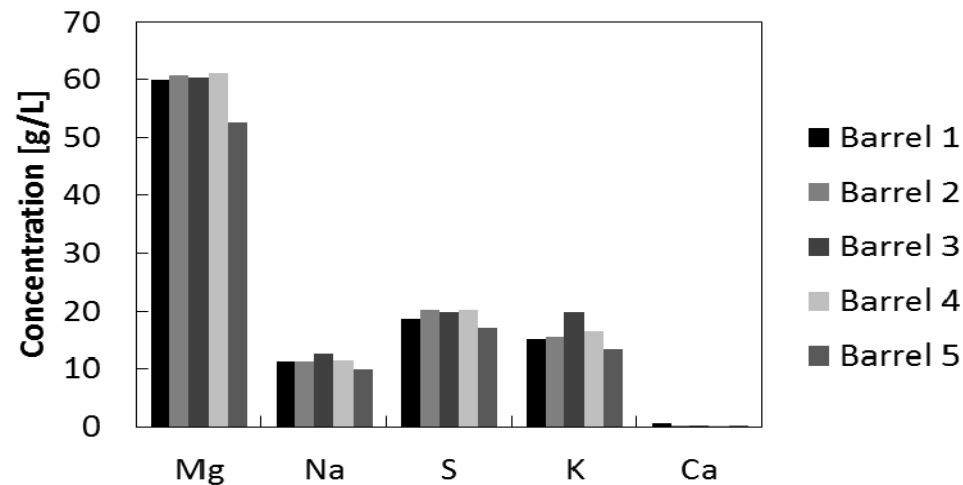
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BSRP midterm meeting 22 May 2014 Sofia

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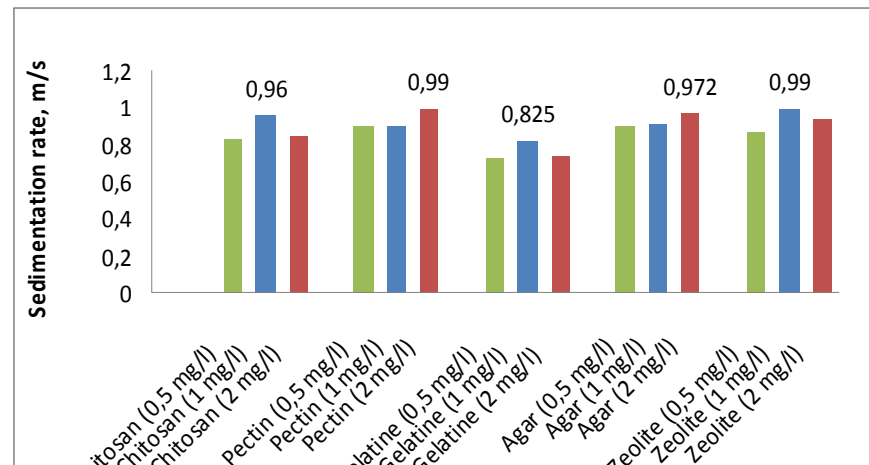
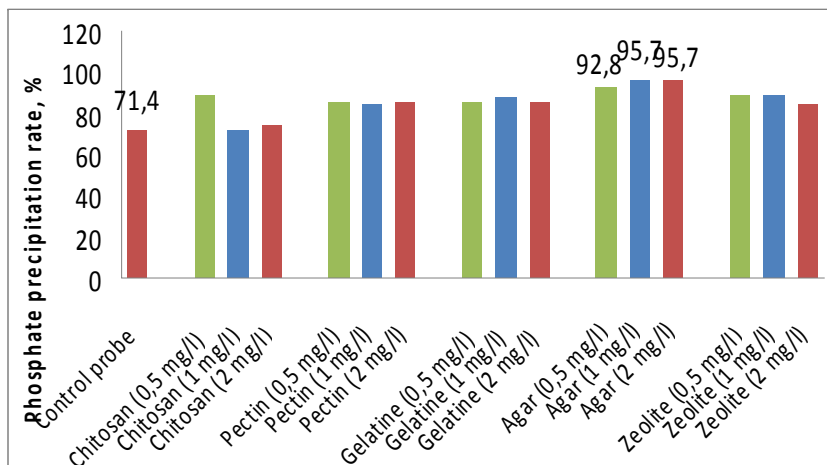
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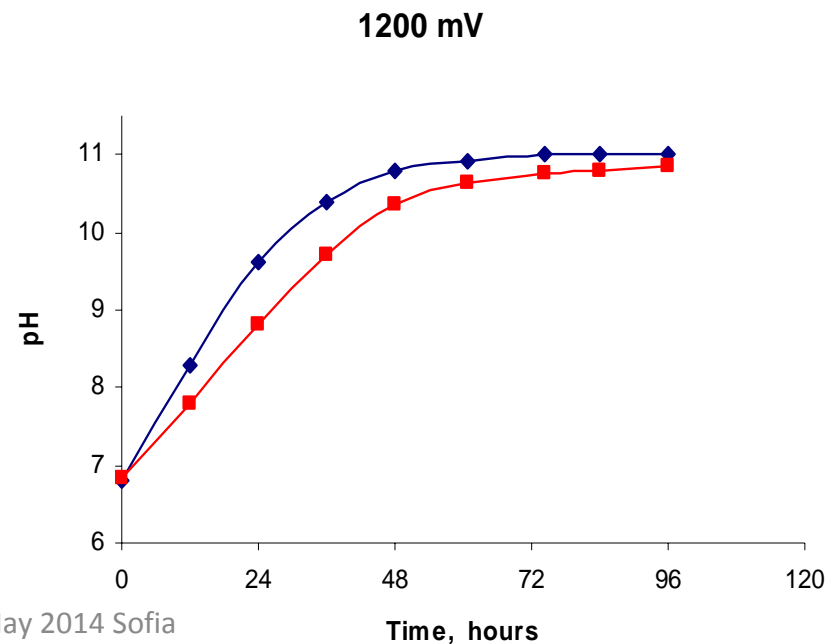
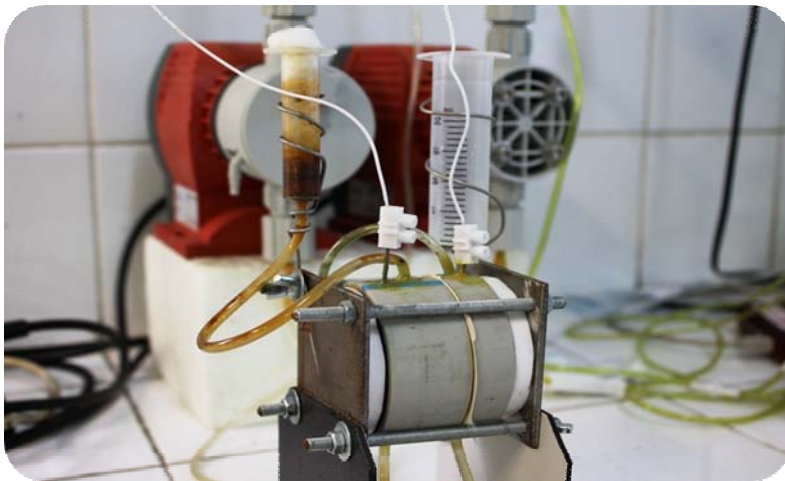
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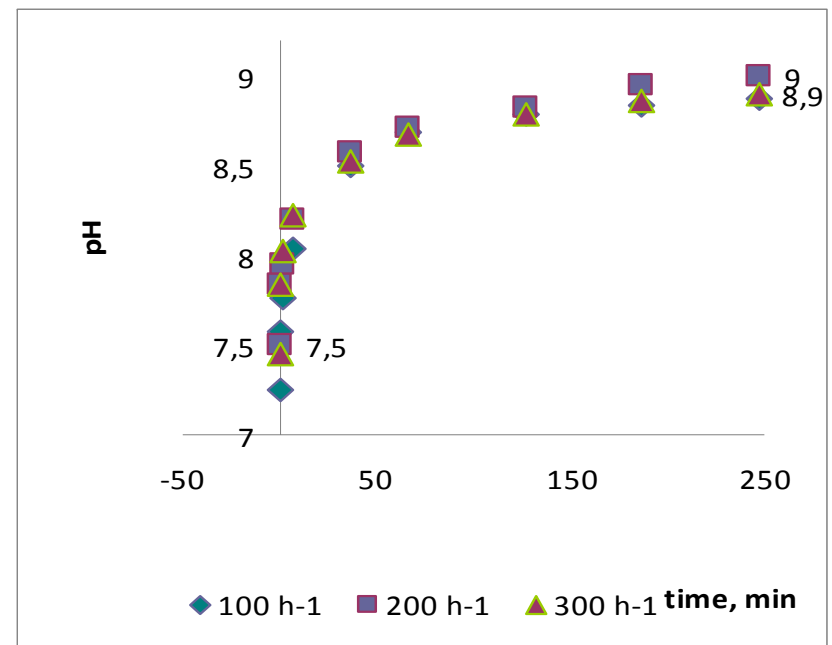
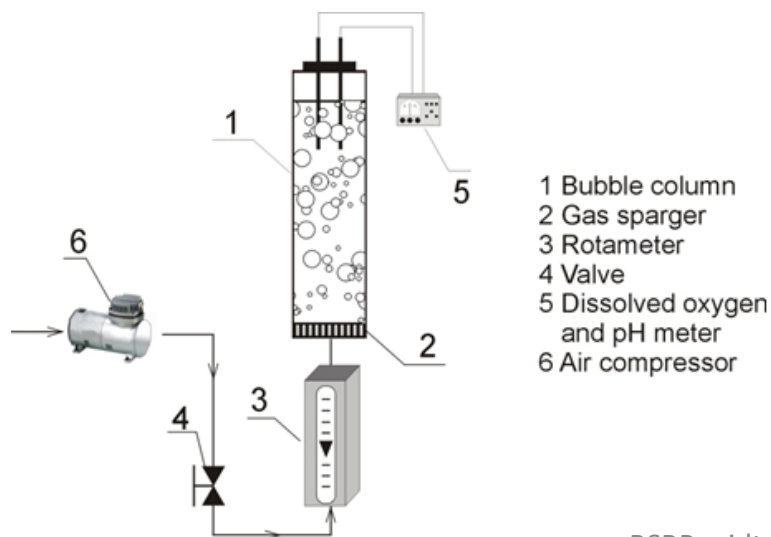
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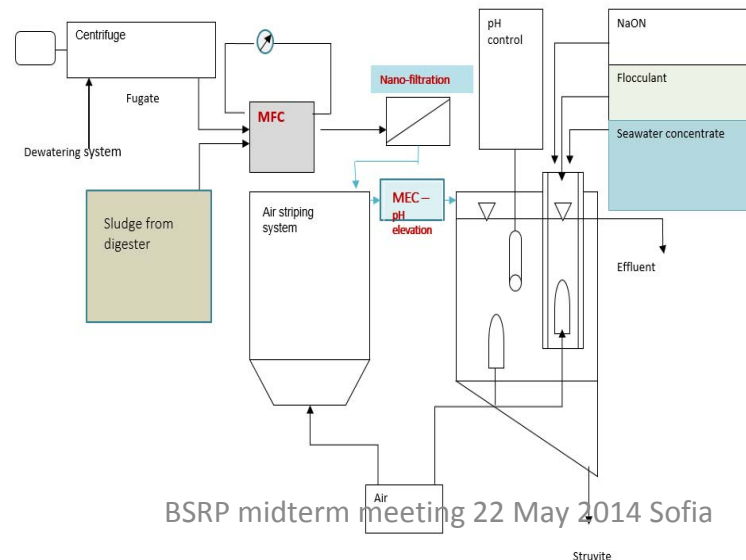
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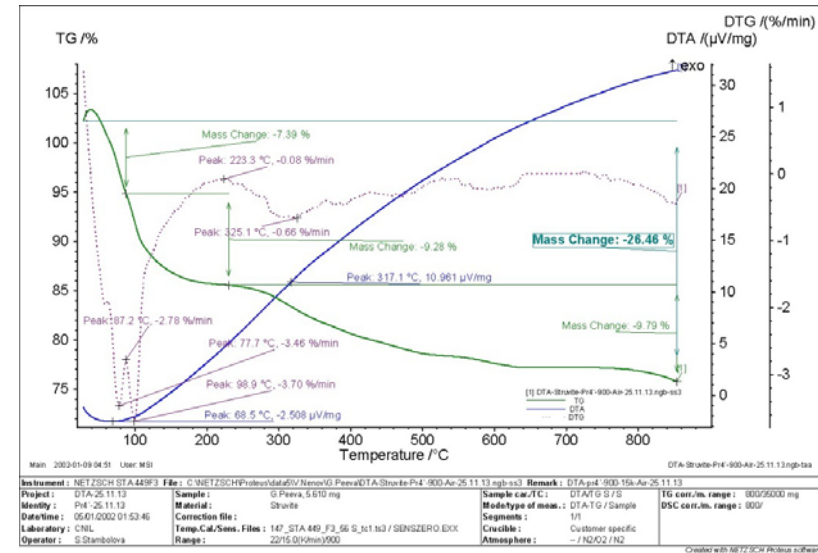
IN PROGRESS.....

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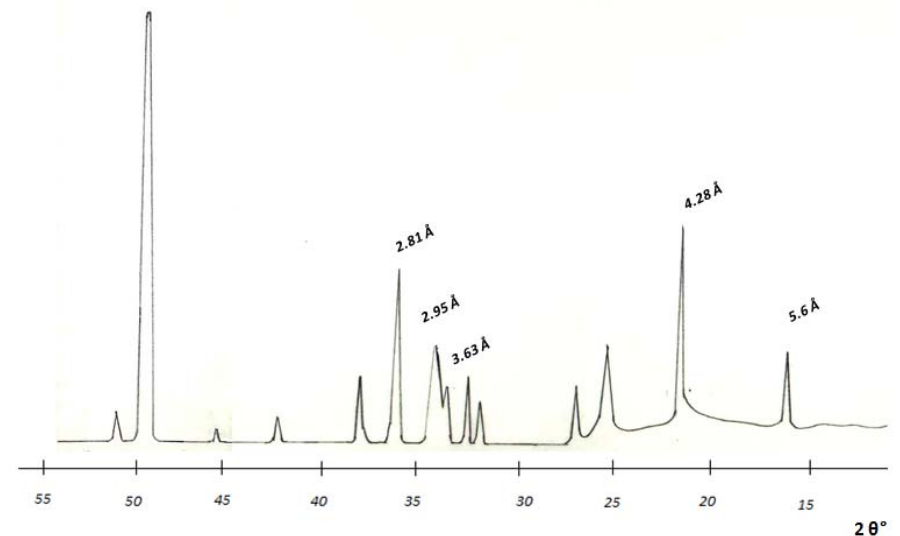
MAP CHARACTERIZATION

✓ Thermo-gravimetric analysis

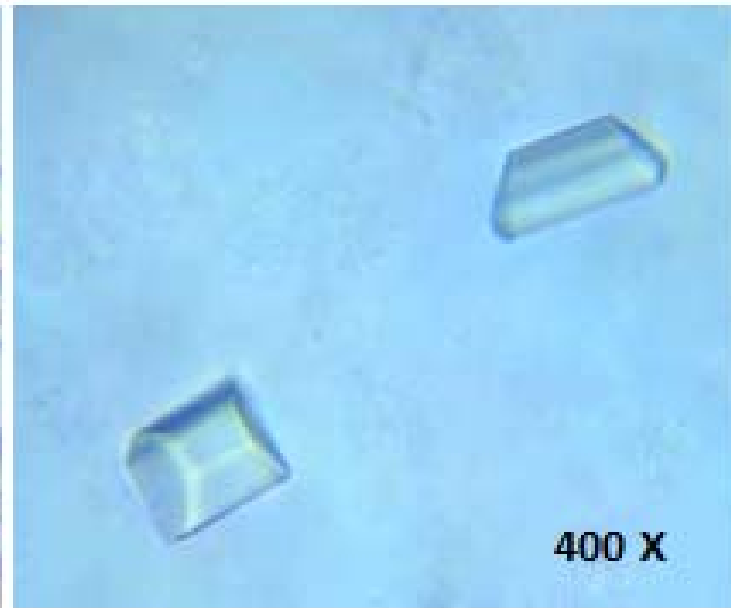
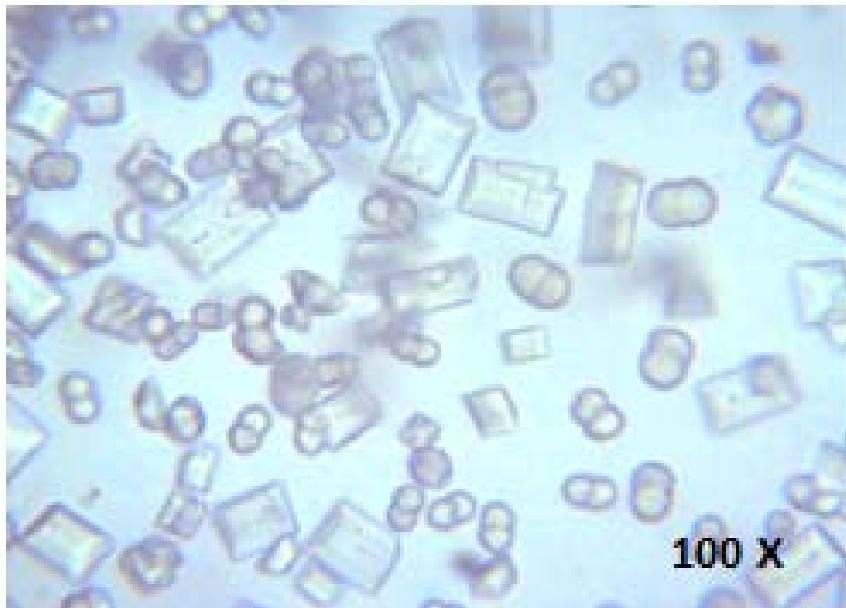


✓ X-ray diffractometry

✓ Microscopic observation



Microscopic pictures of the struvite from the in the experimental work



First year results (1)

- Two innovative processes for phosphorus extraction:
1) Sludge disintegration by high osmotic salt solution and 2) Bio-electrochemical, non-reagent dissolution of ferric phosphate by application of Microbial Fuel Cells;
- An innovative configuration of nanofiltration for the purification of phosphorus and removal of heavy metals;
- Several innovative aspects regarding the crystallisation of struvite as fertiliser product;
- Precipitation initiation by air stripping, agglomeration by addition of natural coagulants and flocculants and non-reagent pH elevation using microbial fuel cells.

First year results (2)

- Identification of synergies and improvement of process efficiency. Different experimental studies about the application of seawater or seawater concentrate as magnesium or salt source.
- The identification of types of waste acids suitable for an application for the acidic extraction of phosphorus from the
- Link to the real conditions given in the WWTPs. A comprehensive study on an assessment of mass flows, loads and concentrations in Bulgarian WWTPs

Research Output

- Master thesis (Kirsten Remmen): finished 09/2013
- Master thesis (Georgi Kirov): finished 02/2014
- Master thesis (Ralitsa Lambeva): to be finished in 07/2015
- Master thesis (Therese Schütte): finished 05/2014
- PhD work of Gergana Peeva: to be finished in May 2015

- Annual Report: finished 03/2014

Activities in implementation of WP7

- Journal publication about sludge disintegration with salt solutions (WP3.1)
FHNW: status: draft available
- Journal publication about nanofiltration (WP4): FHNW: status: draft available

Acknowledgement

Highly acknowledged is the funding of the “INNOVA P-recovery” project (No. IZEBZO_143004/1) by the Bulgarian-Swiss Research Programme.

Thank you for your attention