UiO : Department of Chemistry
University of Oslo

The role of particles and phosphorus bound to particles in eutrophication

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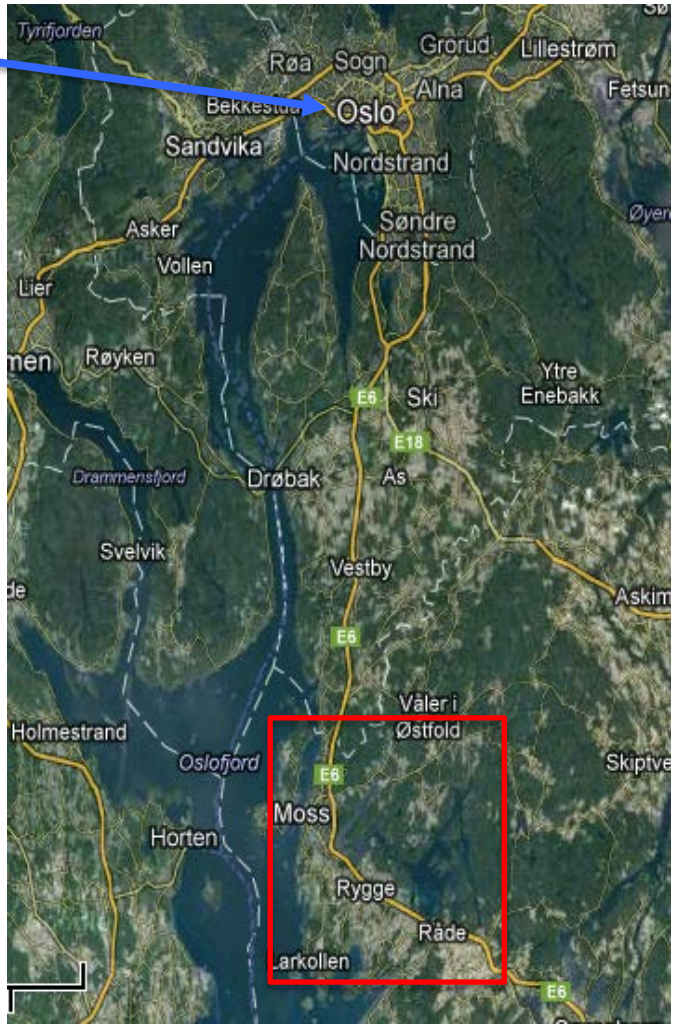
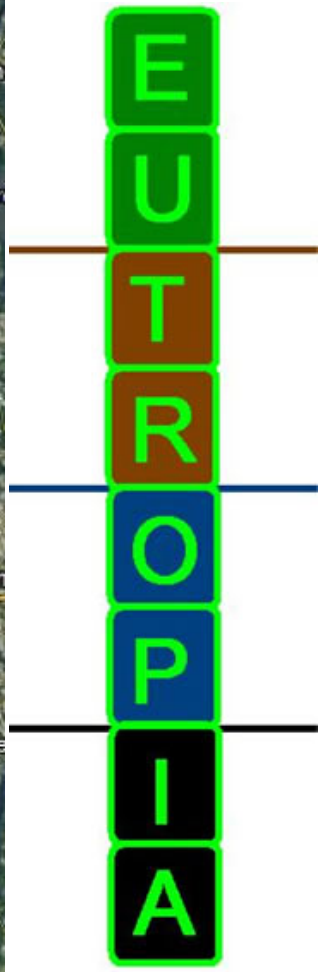
Lake Vansjø

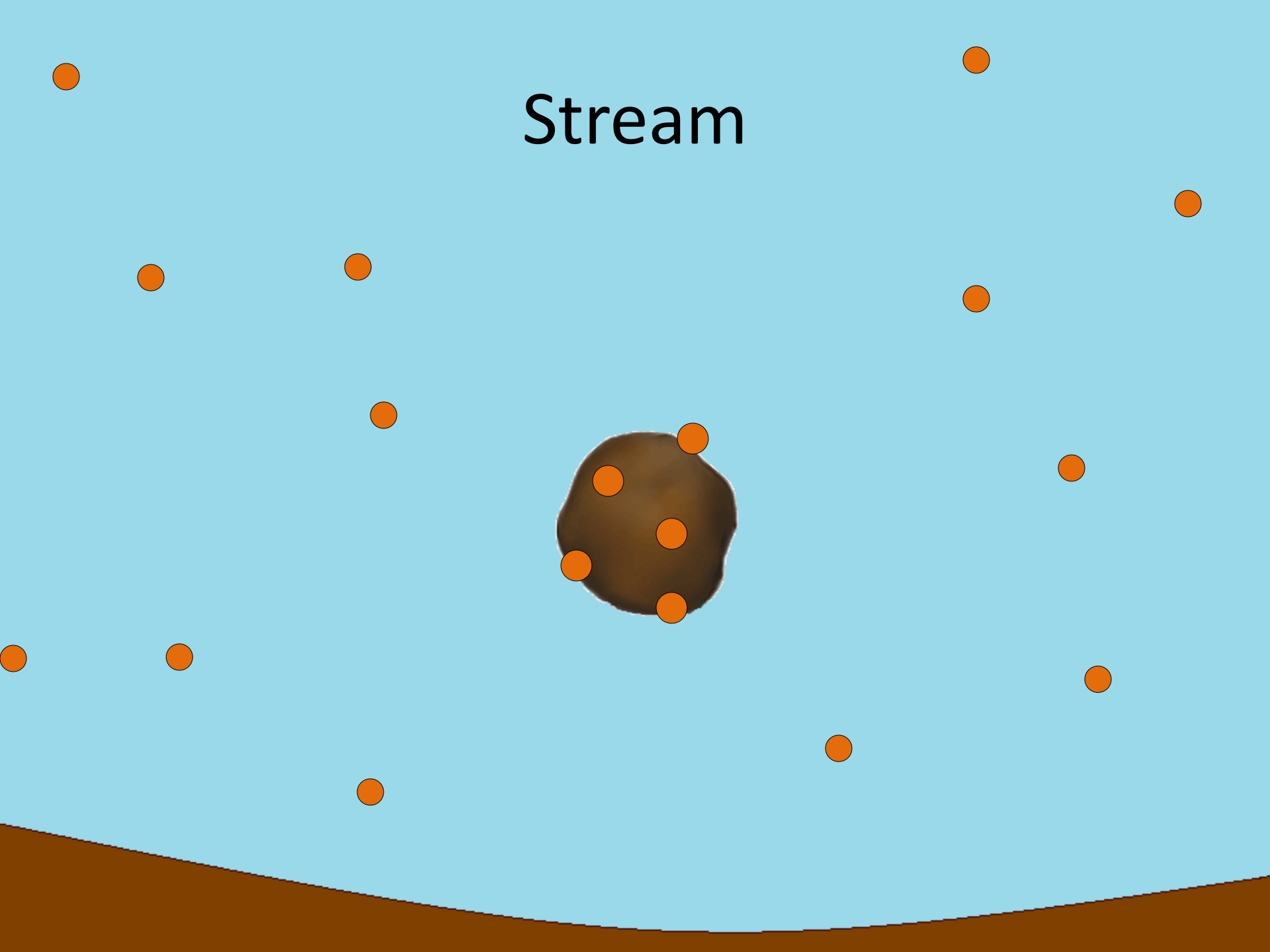

Tyrifjorden
Røa
Sogn
Grorud
Lillestrøm
Alna
Fetsun
Oslo
Sandvika
Nordstrand
Asker
Søndre Nordstrand
Vollen
Lier
Røyken
Ytre Enebakk
E6
Ski
E18
Drammensfjord
Drøbak
As
Svelvik
Vestby
Askim
Holmestrand
Oslofjord
Våler i Østfold
Skiptve
Moss
Horten
Rygge
Råde
Larkollen


EUTROPIA

Particles

- The main transport of phosphorus (P) to lakes is associated with particles
- Fate and impact of the particle bound P is not adequately known

Stream



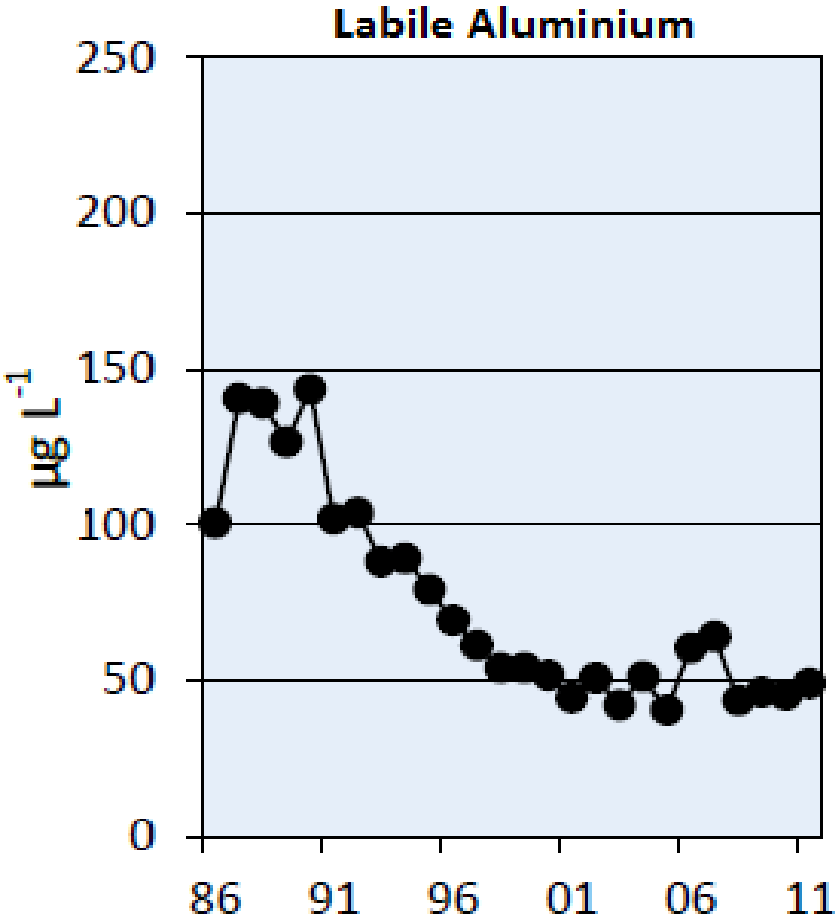
Lake

Lake

Research questions

- Will eroded particles increase or reduce the available P in a lake?

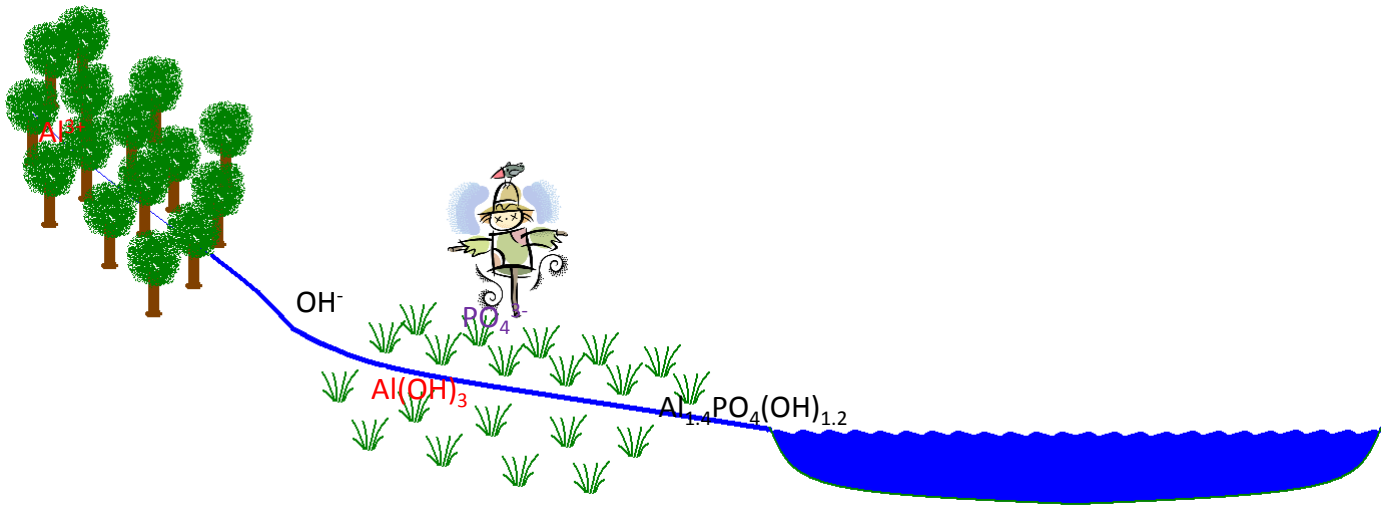
Reduction in acid rain



(Skjelkvåle et al., 2012).

Mixing of water

$$1.4Al^{3+} + PO_4^{3-} + 1.2OH^- \rightarrow Al_{1.4}PO_4(OH)_{1.2}(s)$$



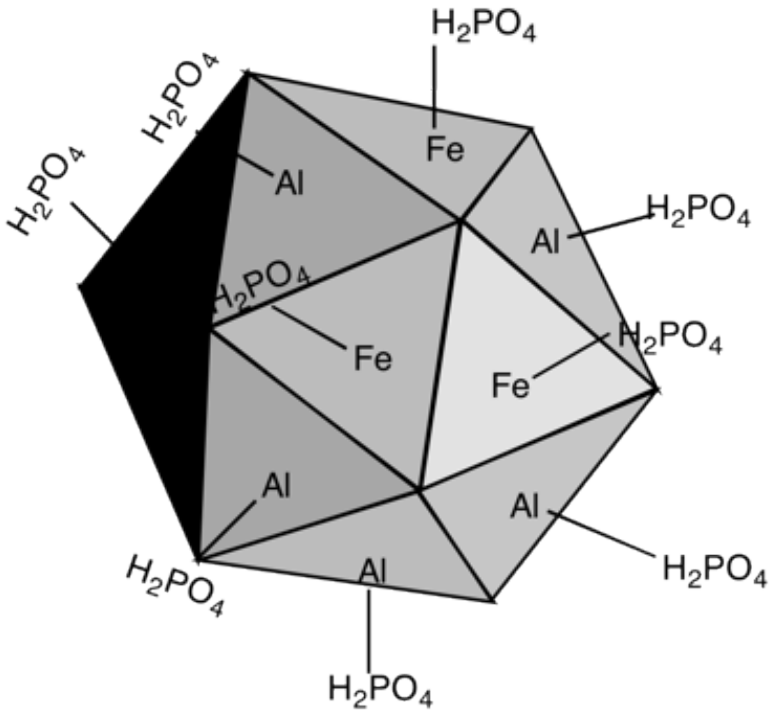
Research questions

- Will eroded particles increase or reduce the available phosphorus (P) in a lake?

- Has the reduction in acid rain led to more P being available for algae growth?

Fractionation of phosphorus

- Total P – dissolved P = Particulate P (PP)

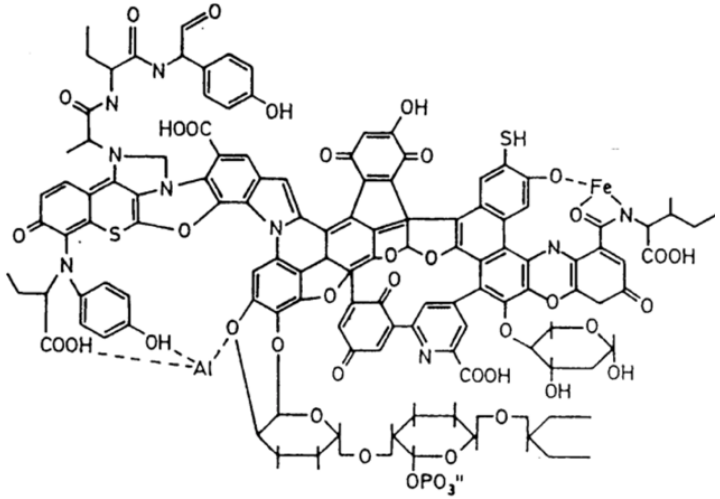


Fractionation of phosphorus

- Total P – dissolved P = Particulate P (PP)
- Dissolved reactive P (DRP)

$$H_3PO_4 \leftrightarrow H_2PO_4^- \leftrightarrow HPO_4^{2-} \leftrightarrow PO_4^{3-}$$

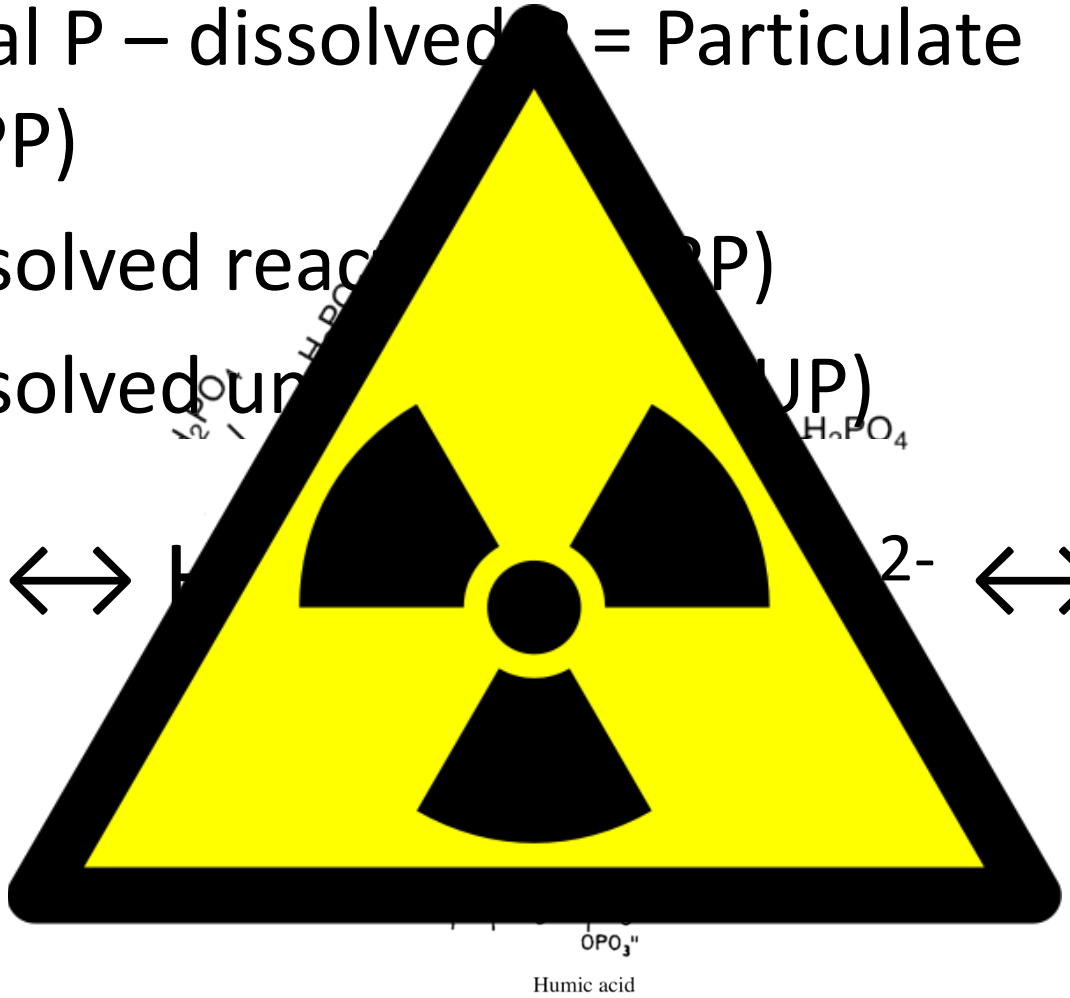
- Dissolved unreactive P (DUP)



Humic acid

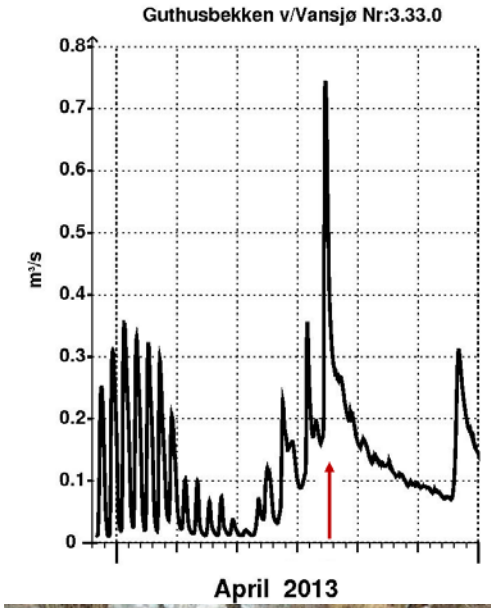
Fractionation of phosphorus

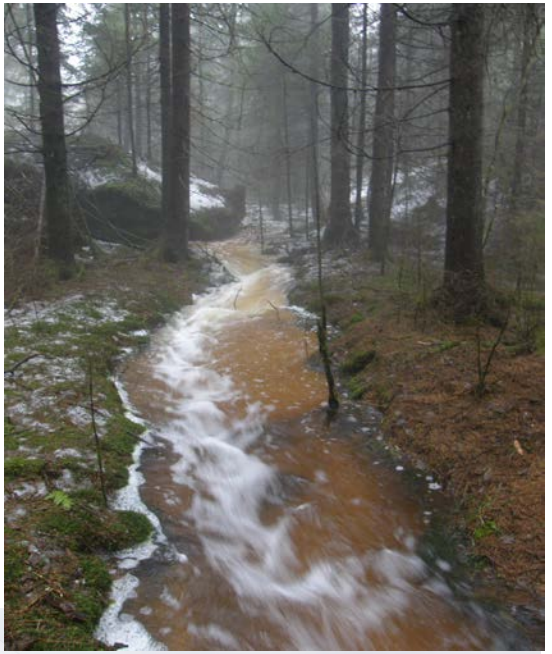
- Total P – dissolved = Particulate P (PP)
- Dissolved reac P)
- Dissolved un UP)



$H_3PO_4 \leftrightarrow$ $^{2-} \leftrightarrow PO_4^{3-}$

Sampling

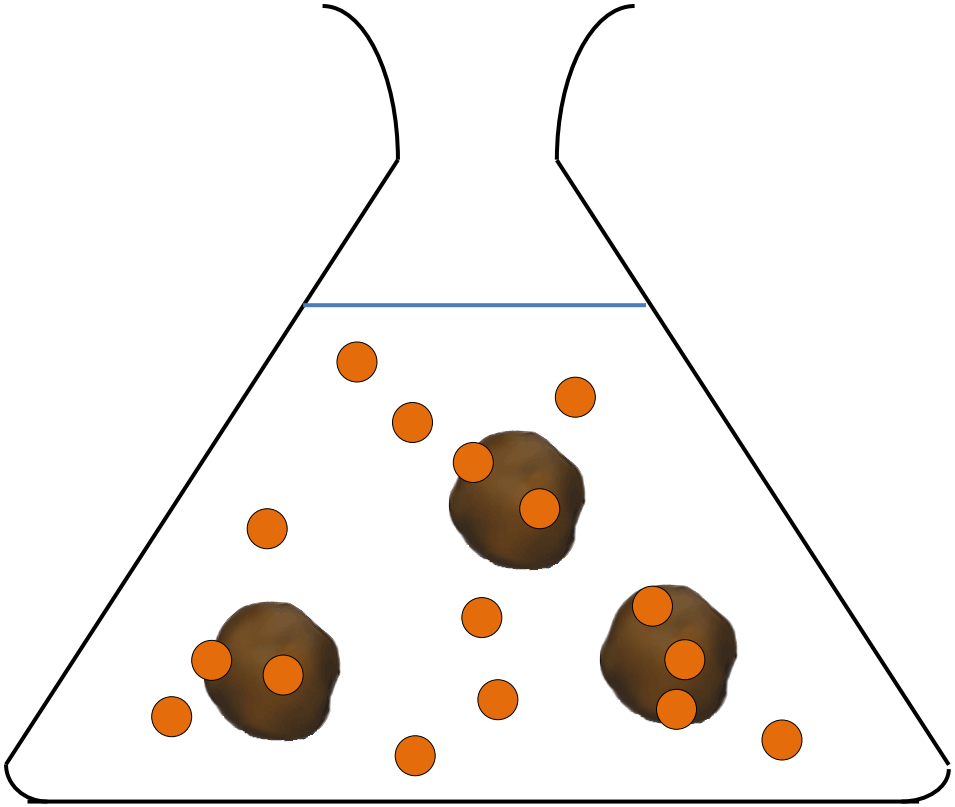

Guthusbekken v/Vansjø Nr:3.33.0
m³/s
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
April 2013



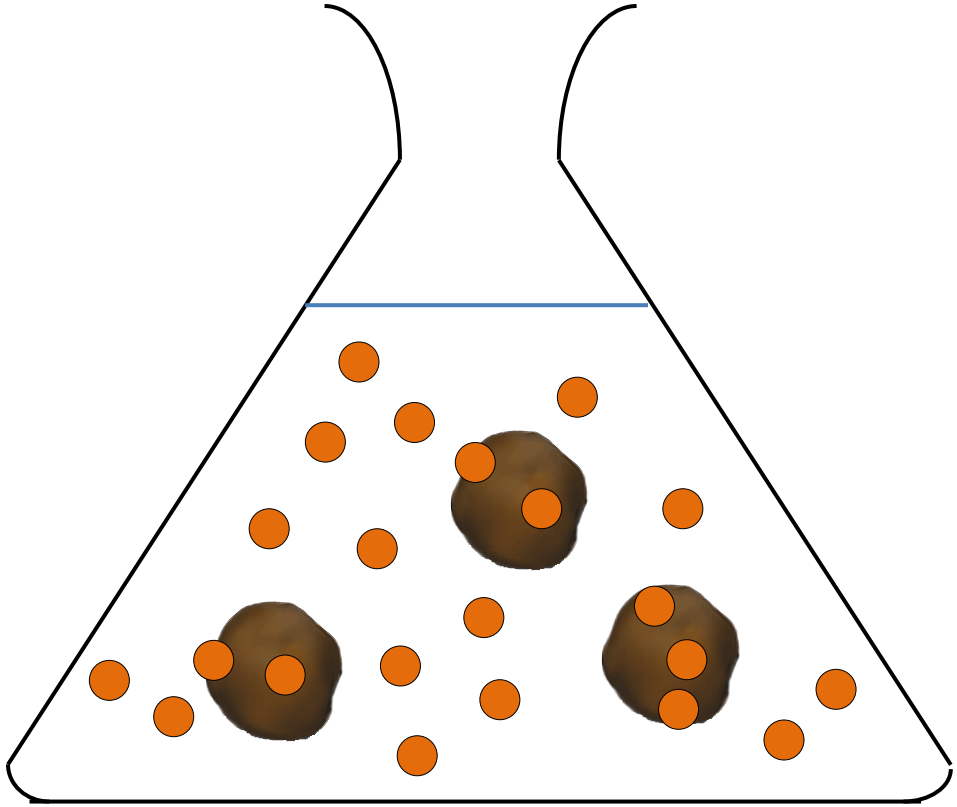
Characterization

	Watershed	Agriculture	Forest	Lake	Unit
pH	6.6	6.8	4.5	6.7	
Conductivity	360	135	53	95	µS/cm
Alkalinity	230	850		290	µM
Aluminium (Ala)		1.7	10.6	1.5	µM
TP	2.8	5.5	0.4	0.6	µM
DTP	2.1	2.5	0.4	0.5	µM
DRP	1.5	2.1	0.4	0.5	µM
DUP	0.6	0.4	0.0	0.1	µM
PP	0.6	3.0	0.0	0.0	µM

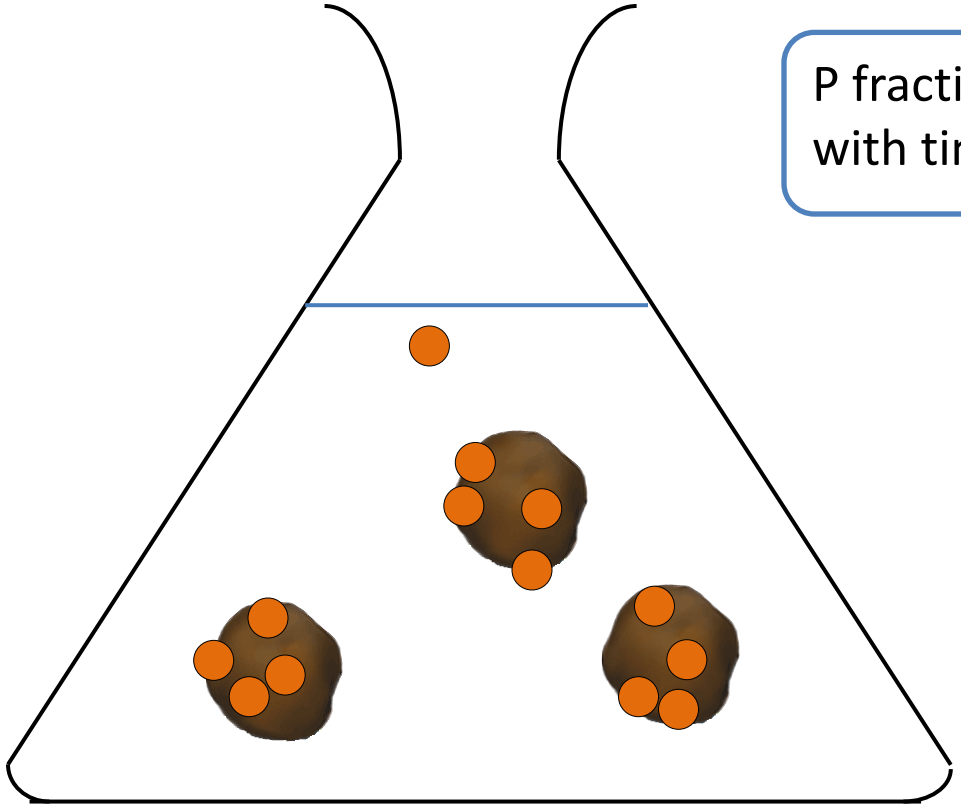
Sorption-desorption experiment: Sorption



Sorption-desorption experiment: Sorption

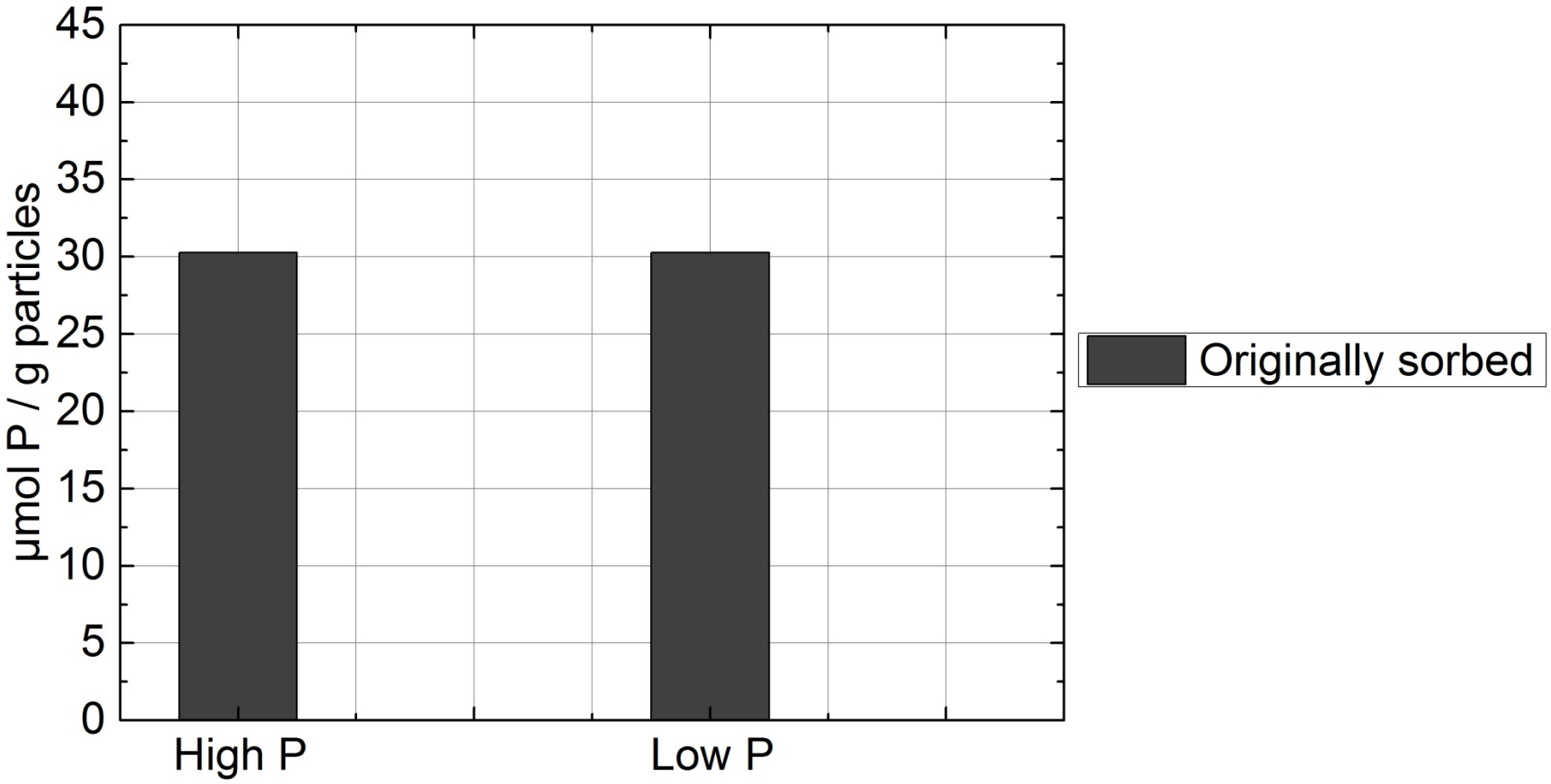


Sorption-desorption experiment: Desorption

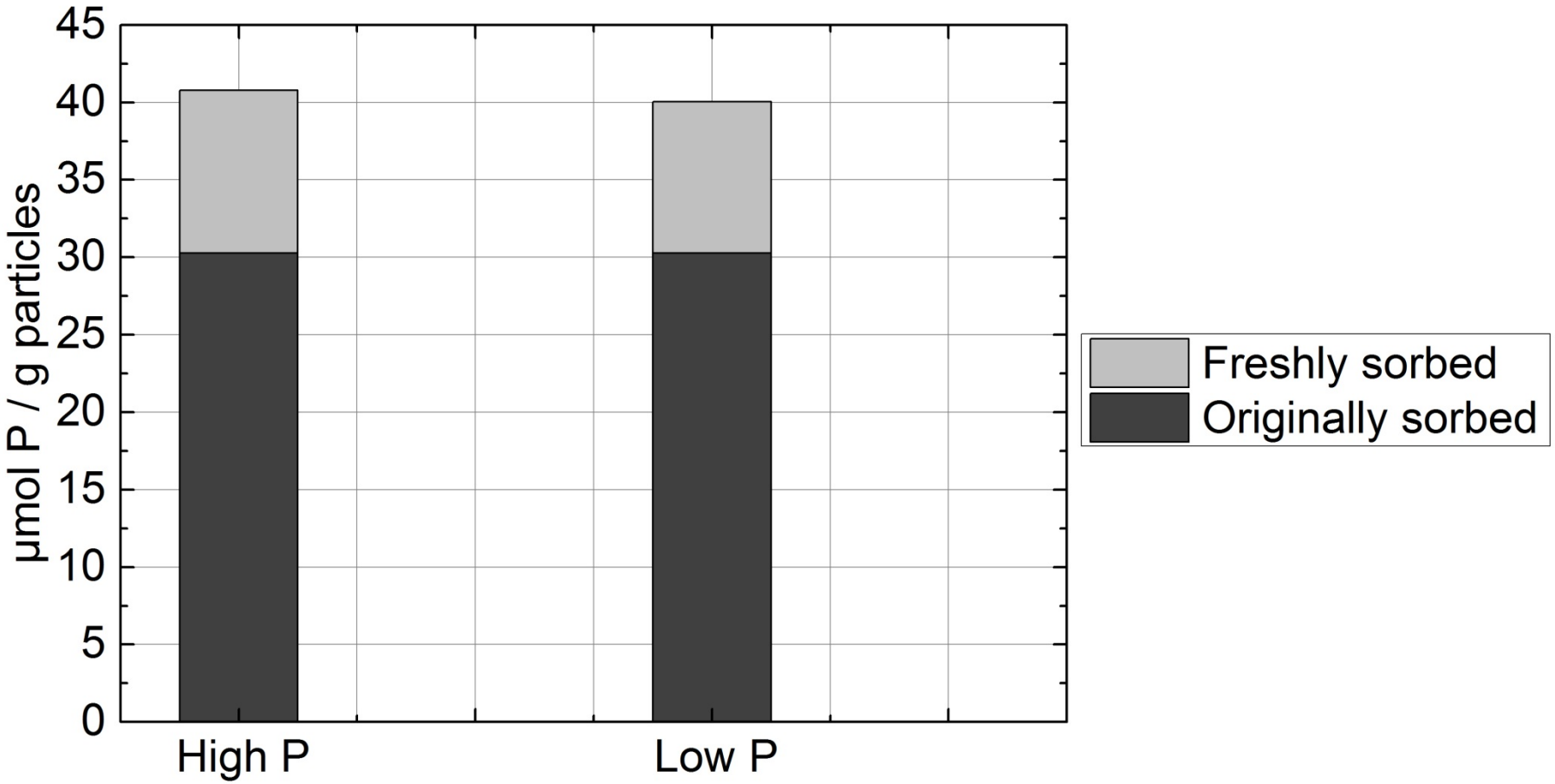


P fractions measured with time

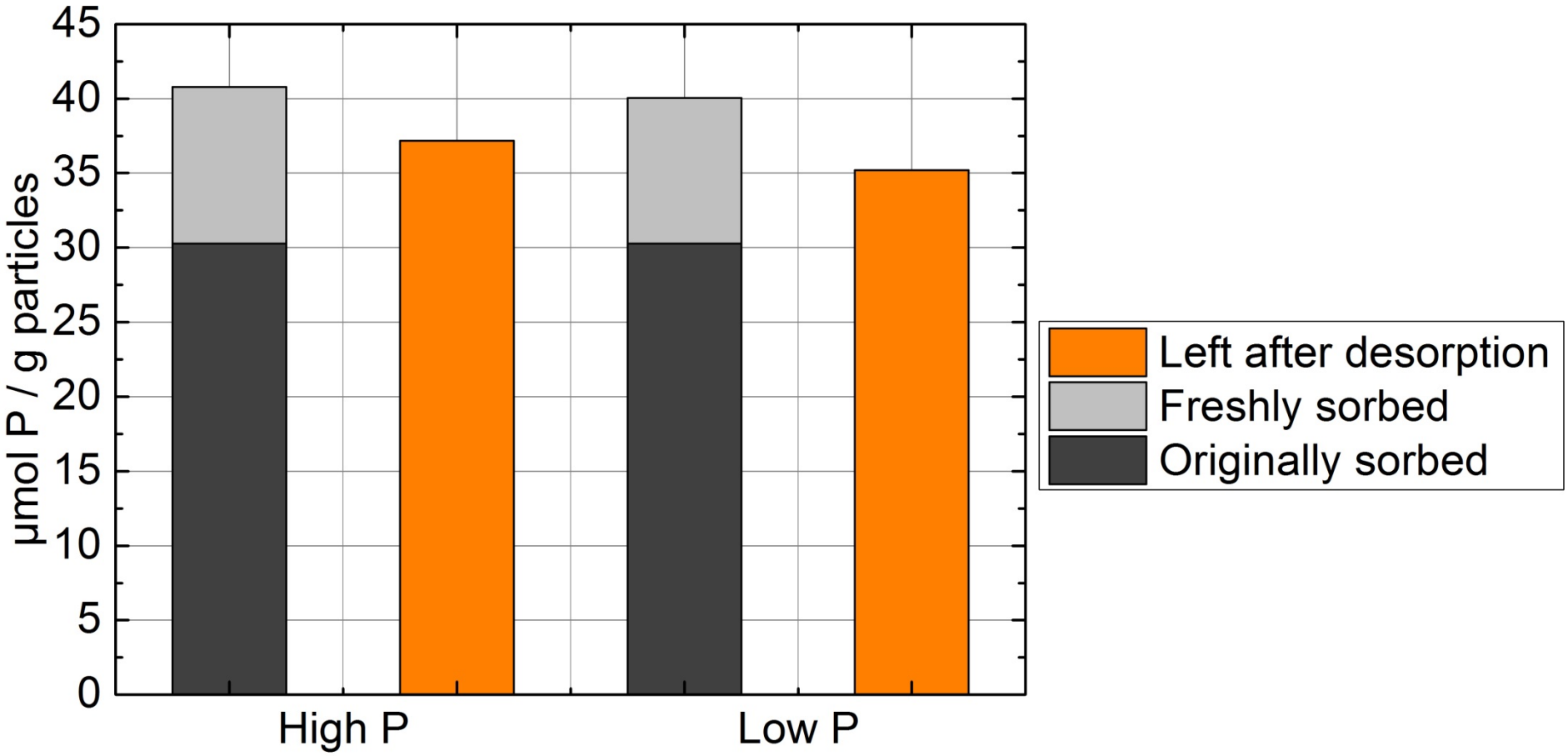
Sorption-desorption experiment: Sorption



Sorption-desorption experiment: Sorption



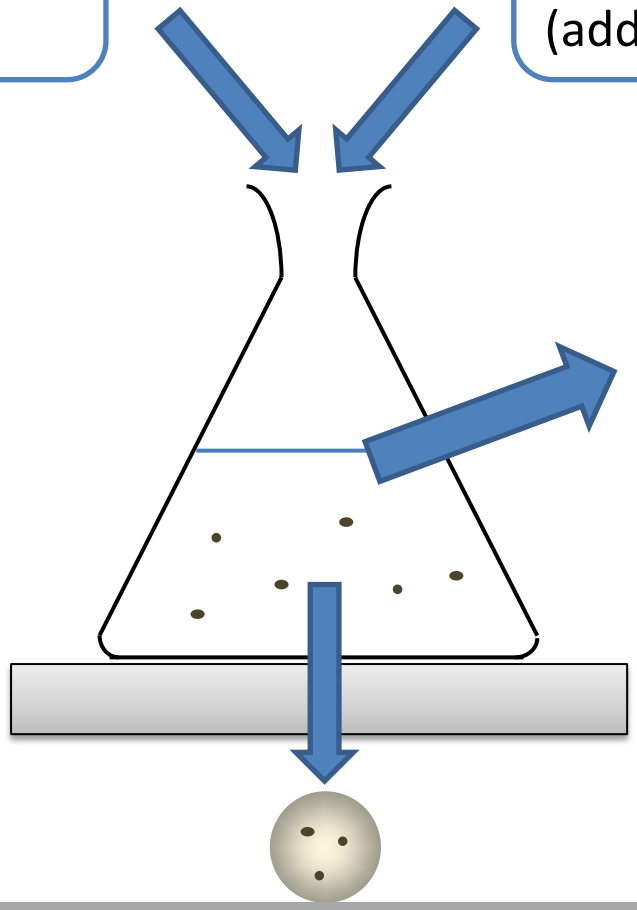
Sorption-desorption experiment: Desorption



Mixing experiment: Mixing

Forest water
(with or without added Al)

Agricultural water
(added ^{32}P)

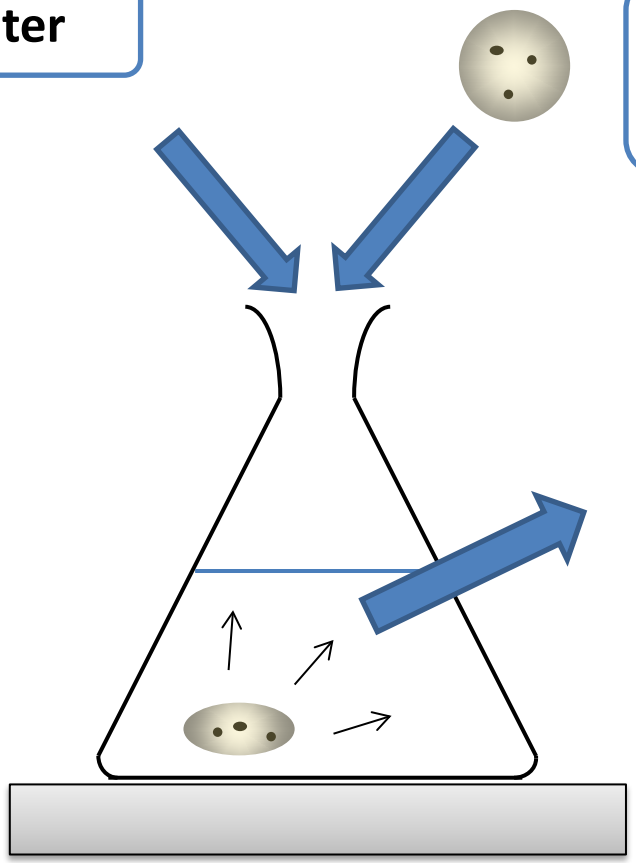


Take water aliquots with time and measure:

- P fractions
- Al fractions

Mixing experiment: Desorption

Lake water

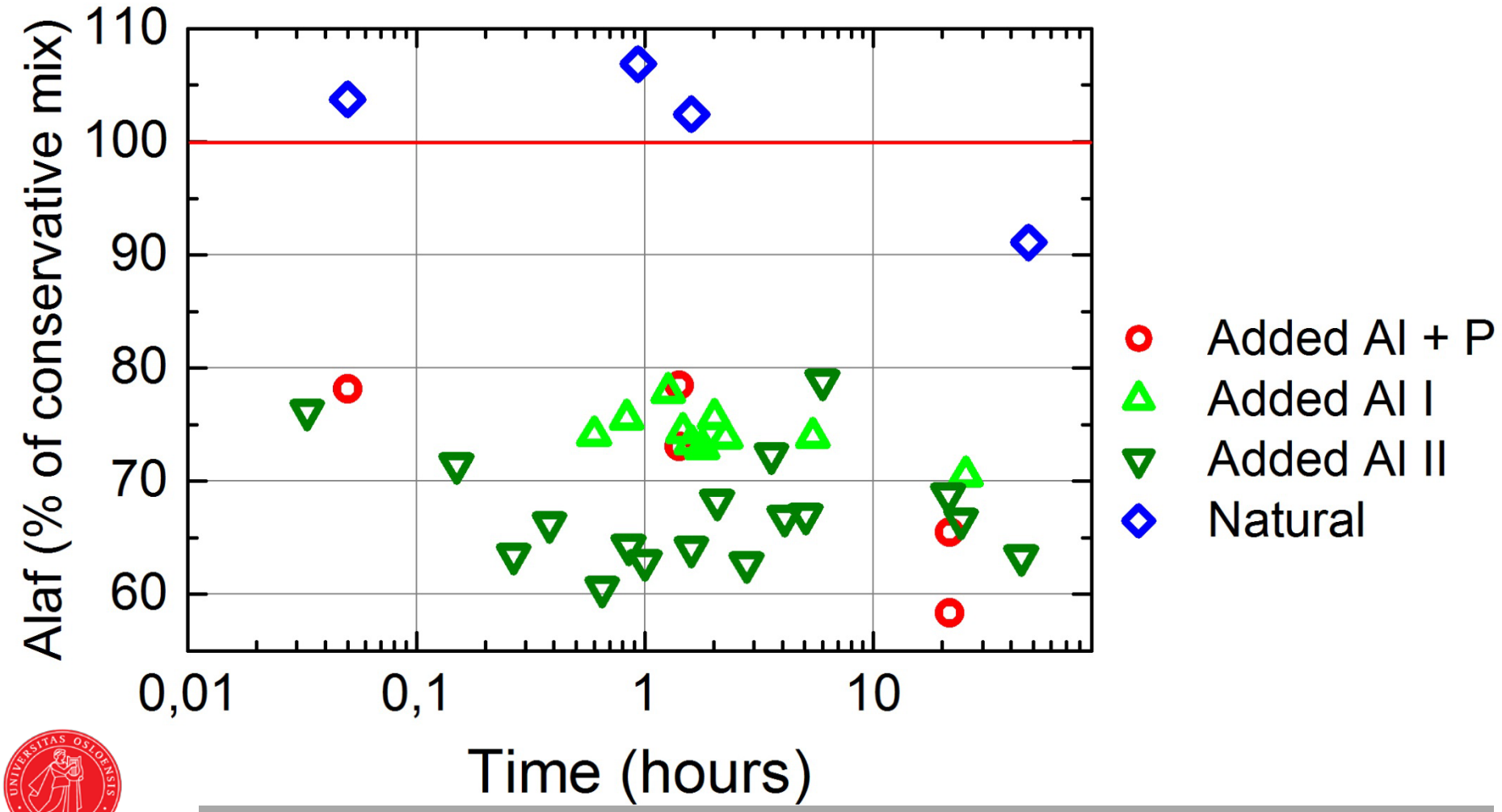


Filter paper from mixing part

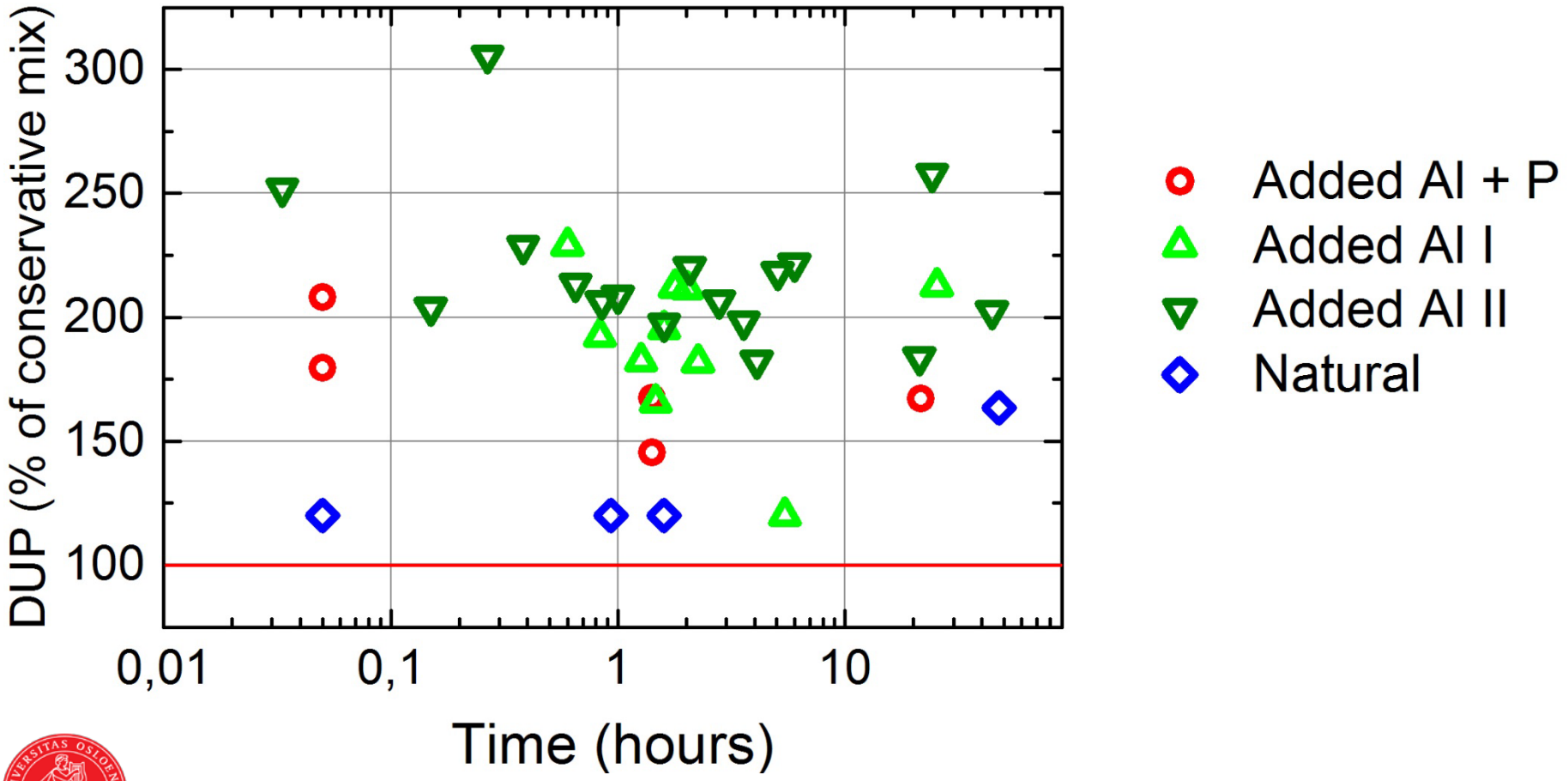
Take water aliquots with time and measure:

- P fractions
- Al fractions

Mixing of water: Aluminium

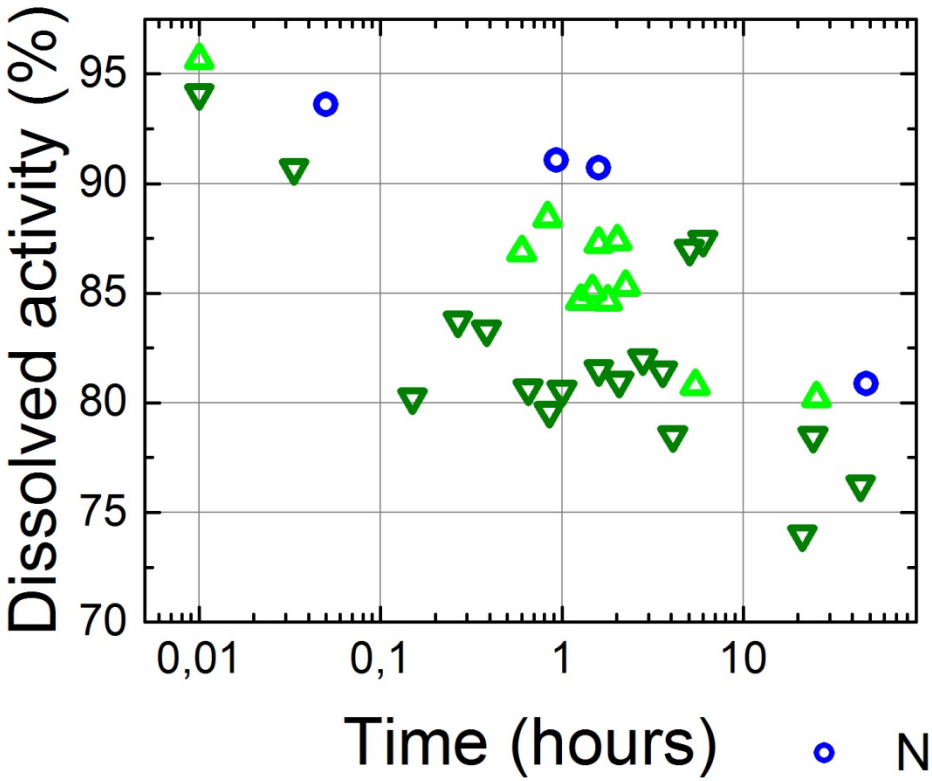


Mixing of water: Dissolved unreactive phosphorus

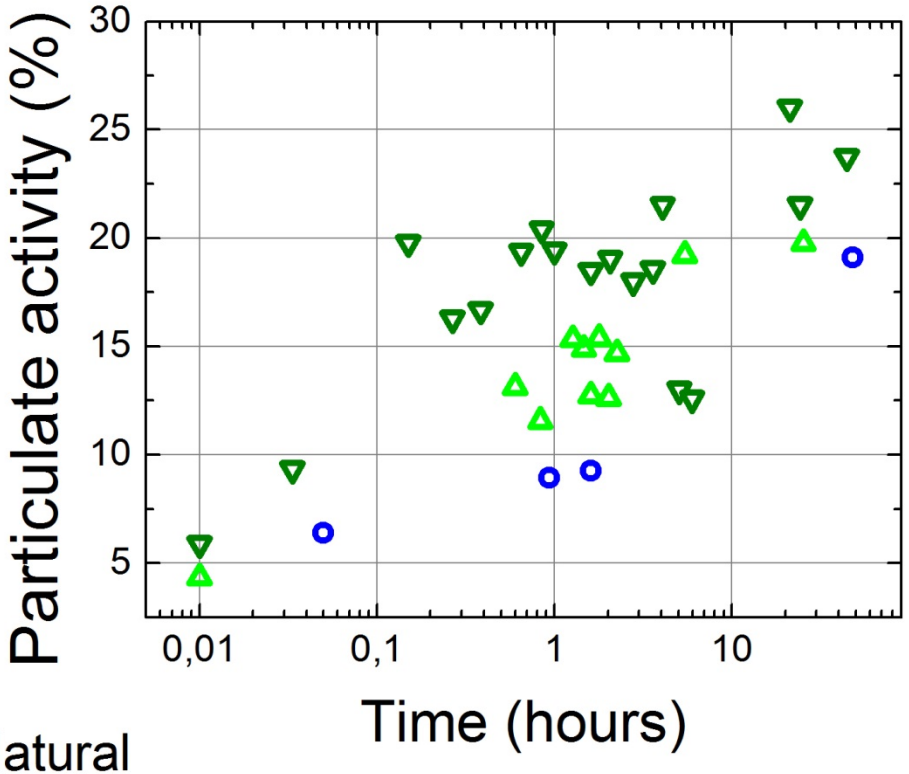


Mixing of water: Radioactive phosphorus

Dissolved radioactive P



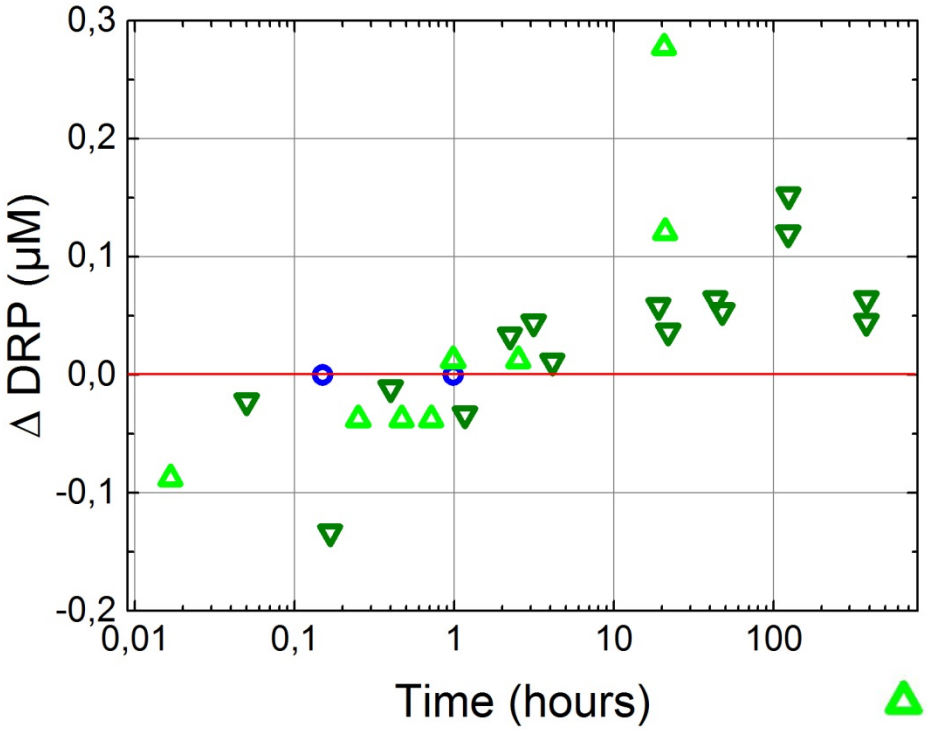
Particulate radioactive P



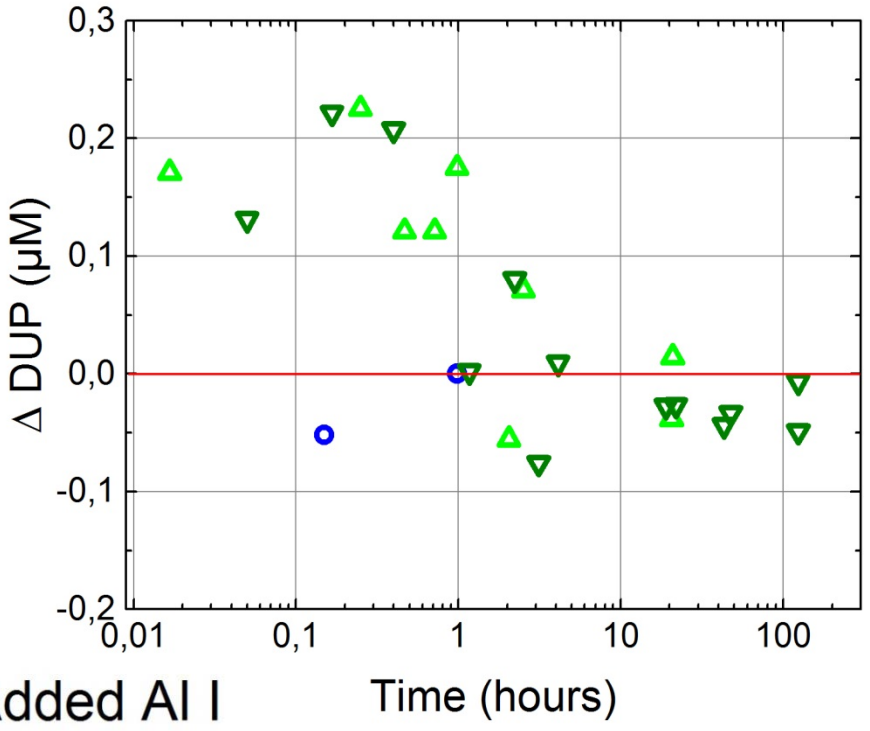
Natural
Added Al I
Added Al II

Desorption: Phosphorus

Dissolved reactive P



Dissolved unreactive P

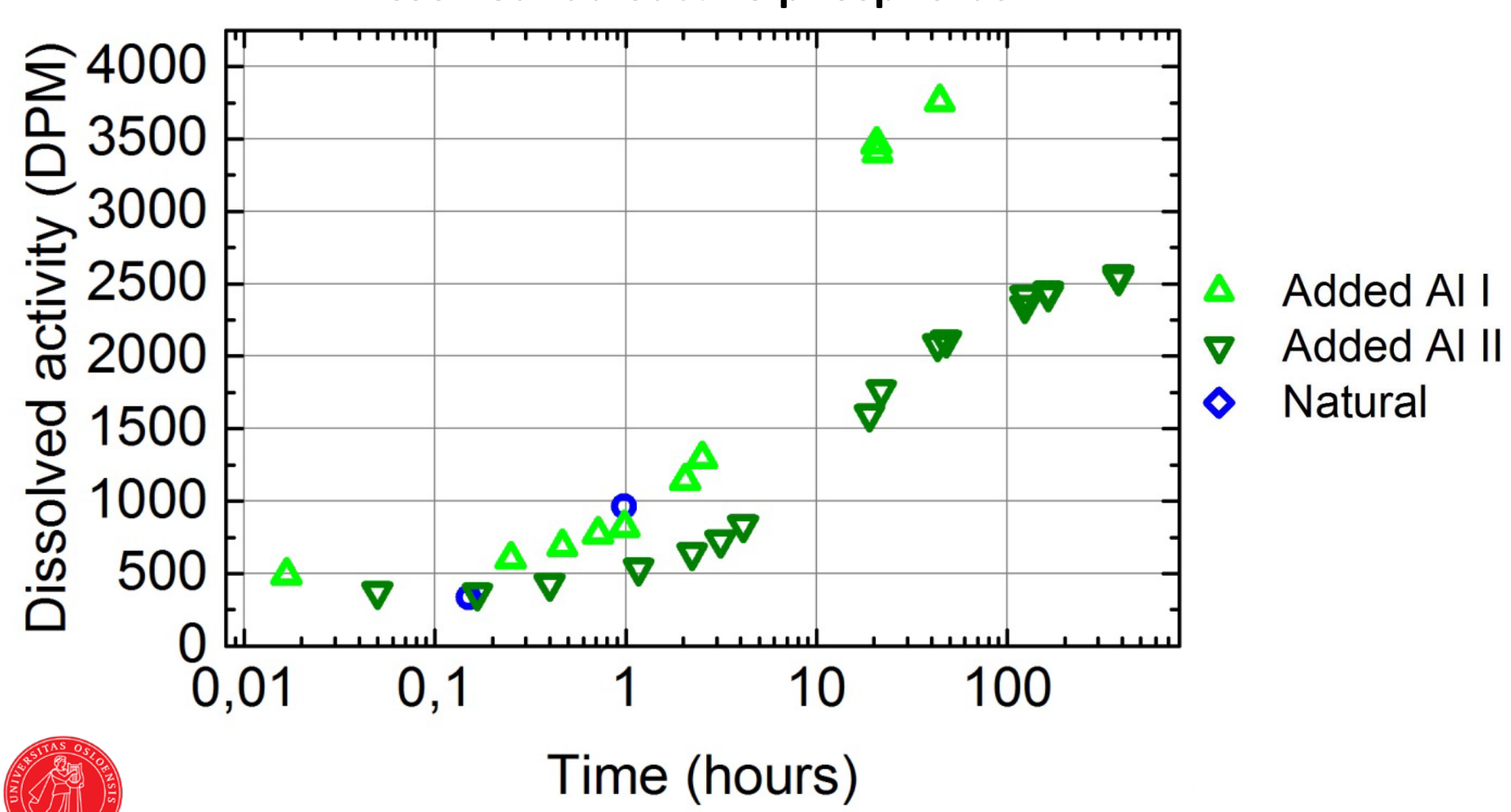


Added Al I

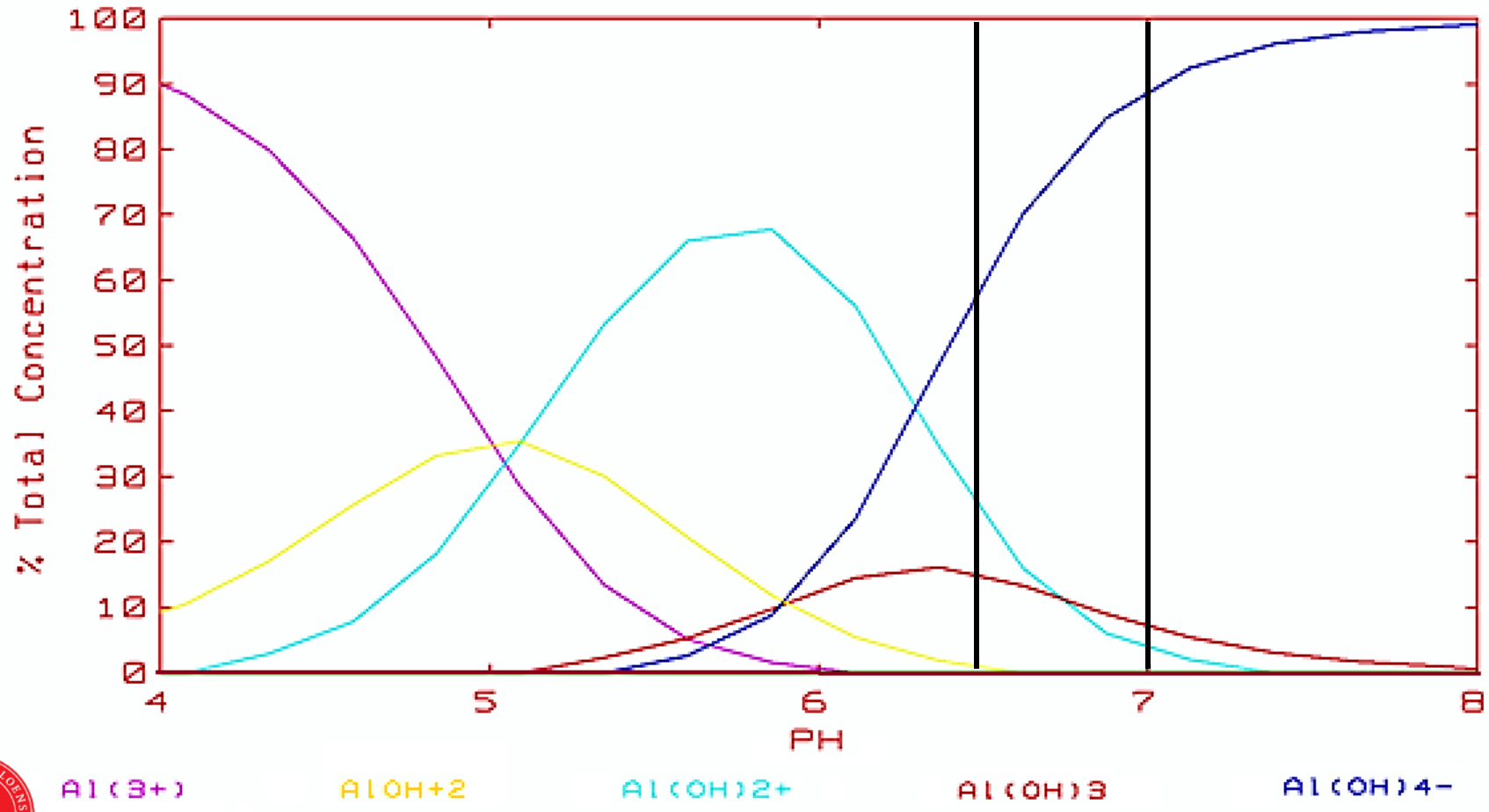
Added Al II

Natural

Desorption: Radioactive phosphorus



Water mixing experiment



Implications for Lake Vansjø

- Previous experiments have shown that leaching of Al can have reduced the transport of P to Vansjø. However, pH seem to be a controlling factor for this process and its effect should be further investigated
- Particles eroded from agricultural soil seem to sorb P, and abatement actions to reduce erosion might increase the P available to algae in Lake Vansjø