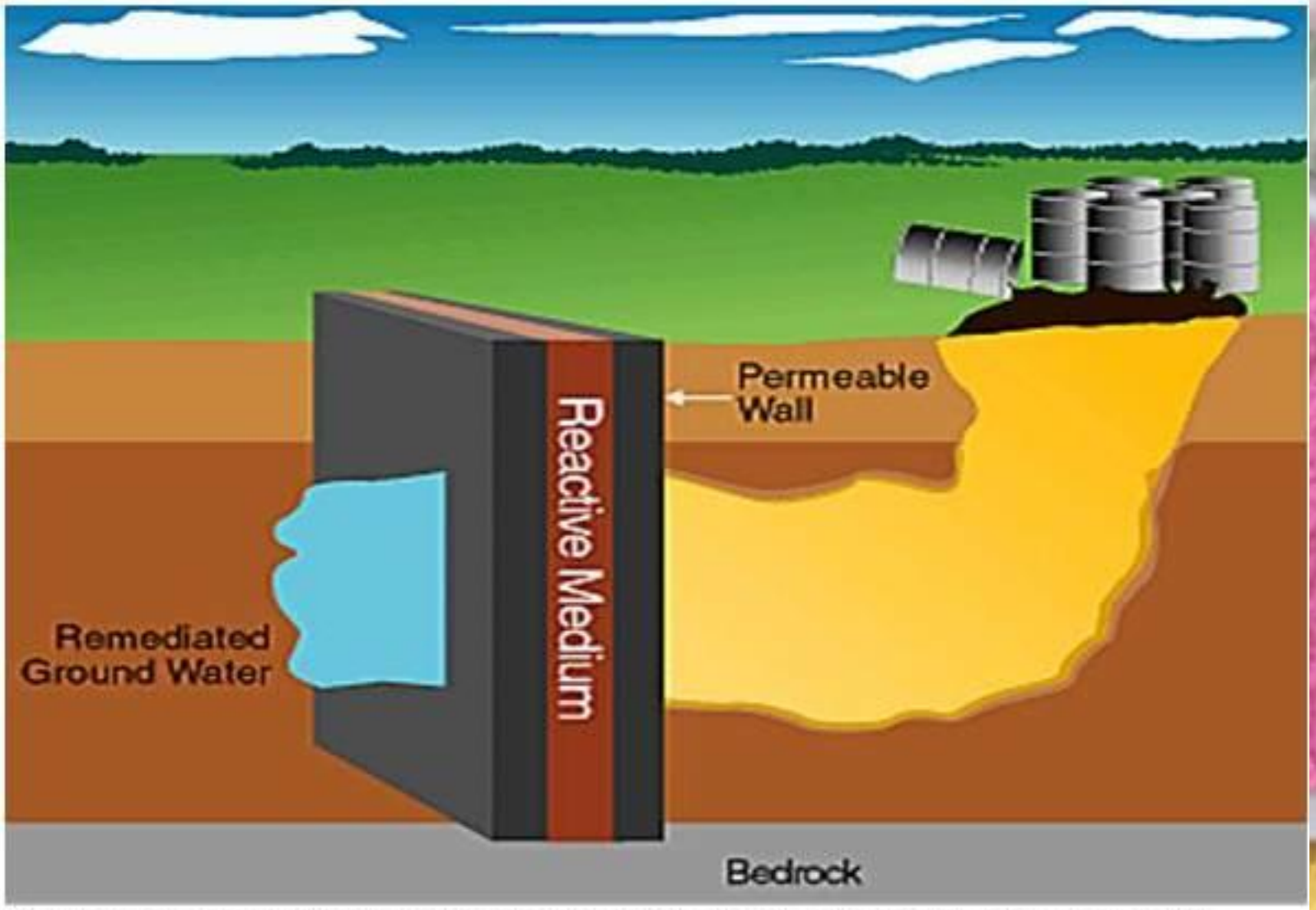
Permeable reactive barriers made with ZVI-doped porous plaster for the treatement of organic nitro compounds on laboratory scale

Saliha Boudia, Marina Fiallo, Patrick Sharrock

Université Mouloud Mammeri
Université Toulouse 3 Paul Sabatier

Permeable Reactive Barrier



Permeable reactive barriers have the potential to lower the cost and increase the effectiveness of groundwater cleanup

Source: http://grida3.crs4.it/grida3/doku.php?id=activity:prb-zvi

USE OF PRB

Remediation of groundwater

Immobilization
Transformation (chemical reduction)

Evaluating possibilities for flow bypass due to reduced porosity

Trench excavation

Pump and Treat Methods

Scrap iron and wood

Zero Iron Valent

Anaerobic corrosion

$Fe^0 + 2H_2O \rightarrow Fe^{2+} + H_2 + 2OH^-$

Aerobic corrosion

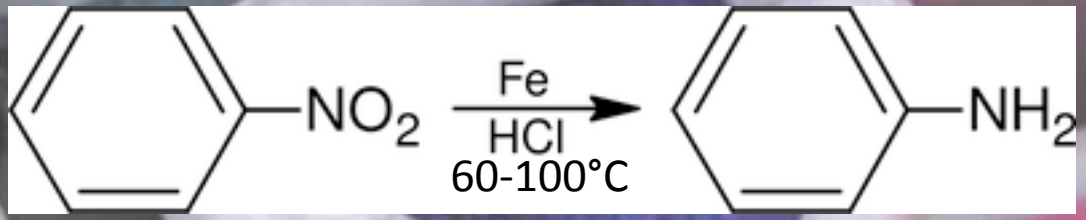
$2Fe^0 + O_2 + 2H_2O \rightarrow 2Fe^{2+} + 4OH^-$

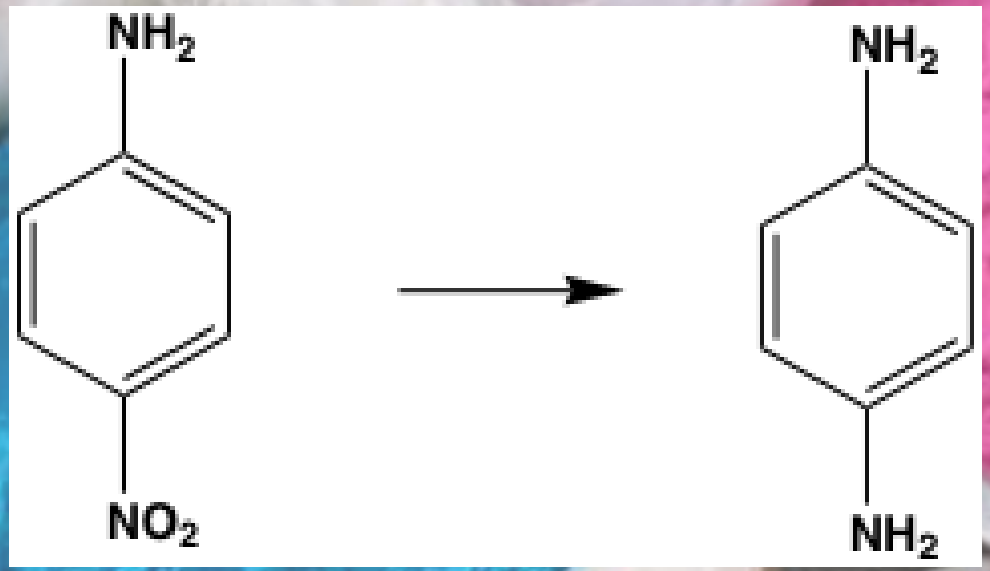
Table 1. Contaminants of Concern and Treatment Reactive Materials

Contaminant	ZVI	Biobarriers	Apatite	Zeolite	Slag	ZVI-carbon combinations	Organophilic clay
Chlorinated ethenes, ethanes	F	F			L	F	
Chlorinated methanes, propanes						F	
Chlorinated pesticides						P	
Freons						L	
Nitrobenzene	P						
Benzene, toluene, ethylbenzene, and xylenes		F					
Polycyclic aromatic hydrocarbons							L
Energetics	P	F				P	
Perchlorate		F	F	L		L	
Creosote							F
Cationic metals (e.g., Cu, Ni, Zn)	L	F	F		L	F	
Arsenic	F			L	F	F	
Chromium (VI)	F			L	L	F	
Uranium	F	P	F			F	
Strontium-90			F	F			
Selenium	L					L	
Phosphate					F		
Nitrate		F	F			F	
Ammonium				L			
Sulfate		F				L	
Methyl tertiary butyl ether		F					

F=Full Scale Application, L=Laboratory Application, P=Pilot Scale Application
Source: ITRC 2011 Interstate Technology and Regulatory Council USA

Bechamp reduction (1854)

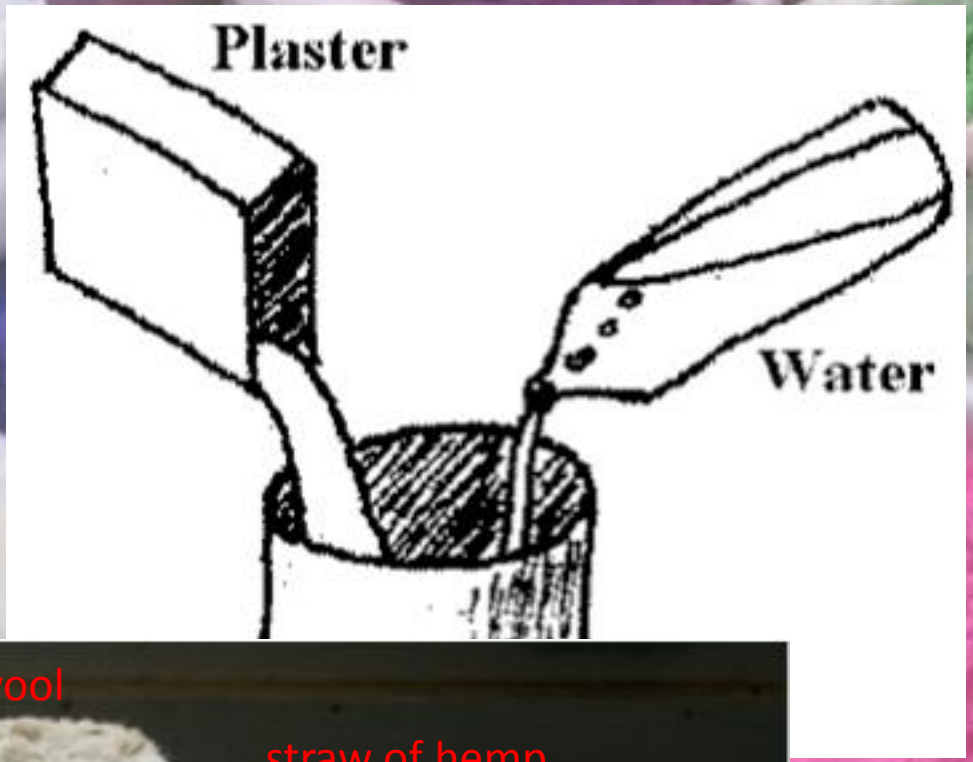




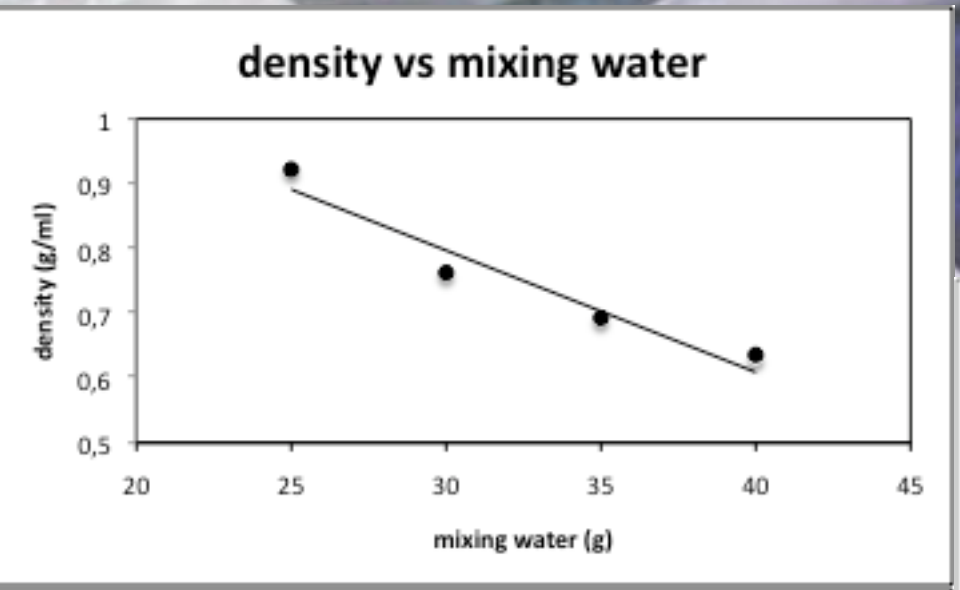
p-nitroaniline

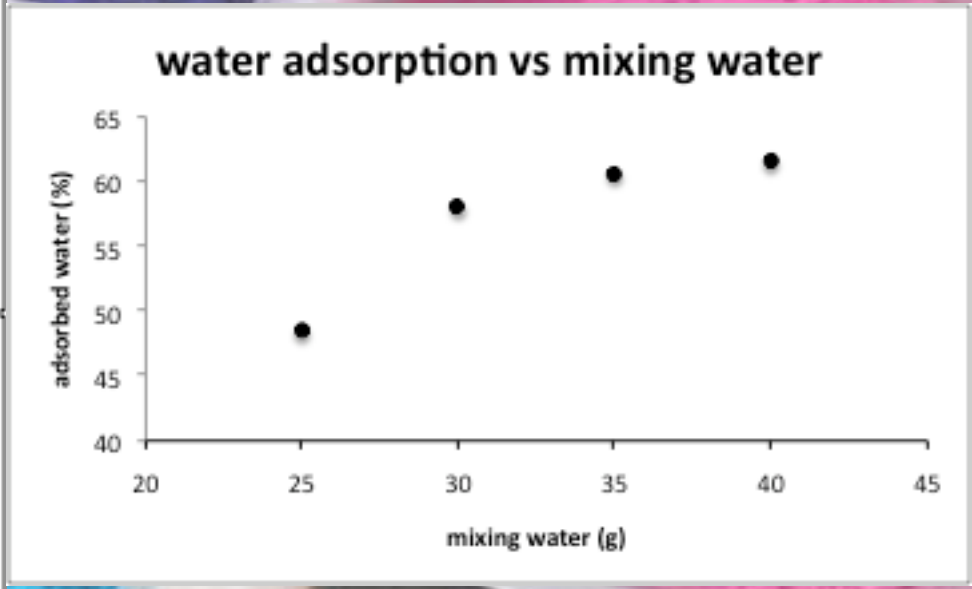
phenylenediamine

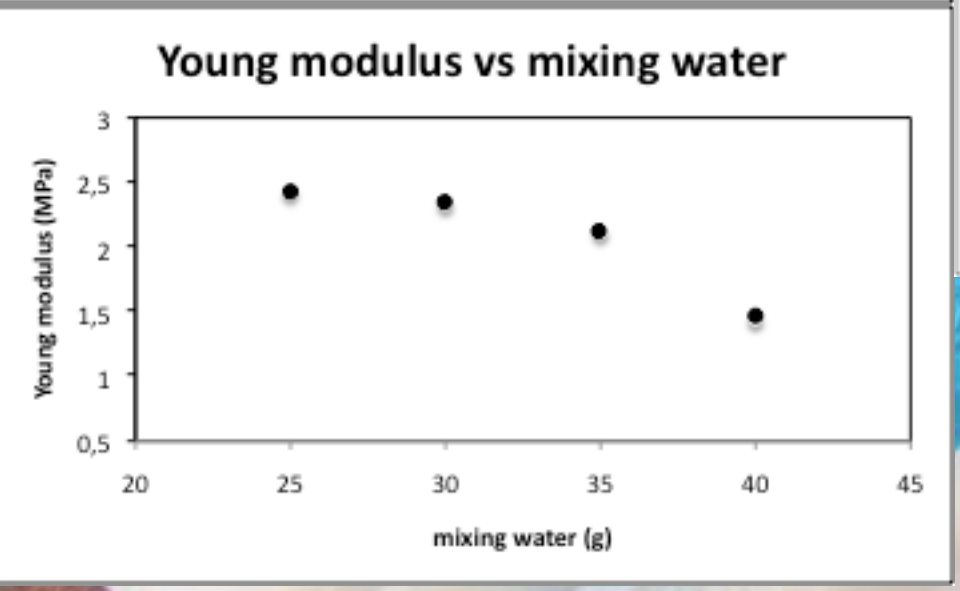
Why plaster



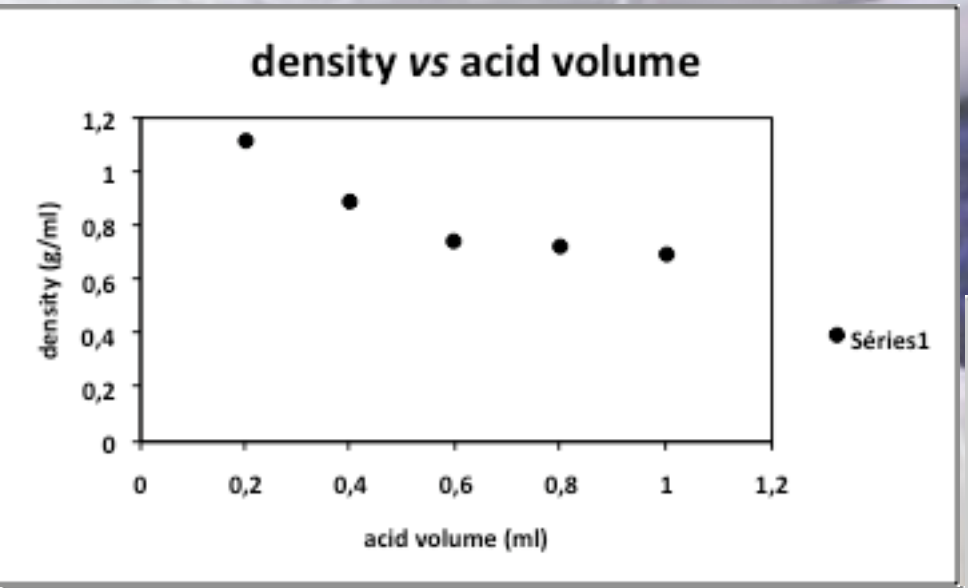
PLASTER cylinder (50 g)

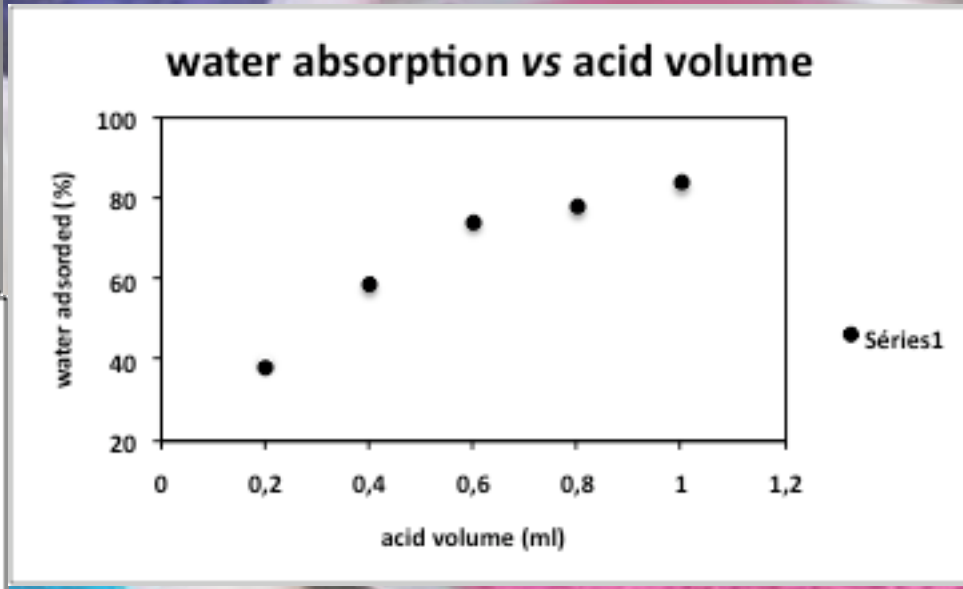


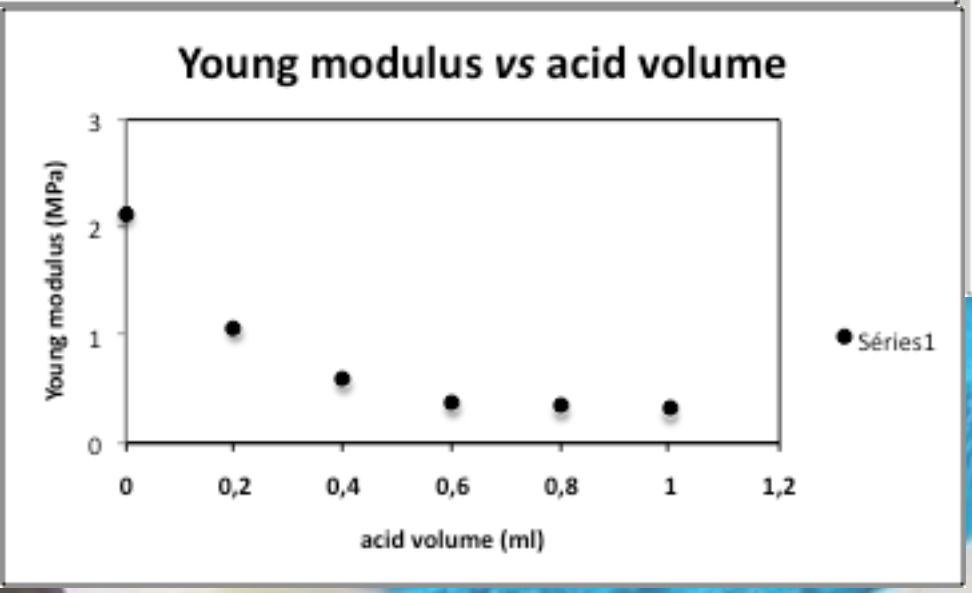




POROUS PLASTER = $CaCO_3 + H_3O^+$

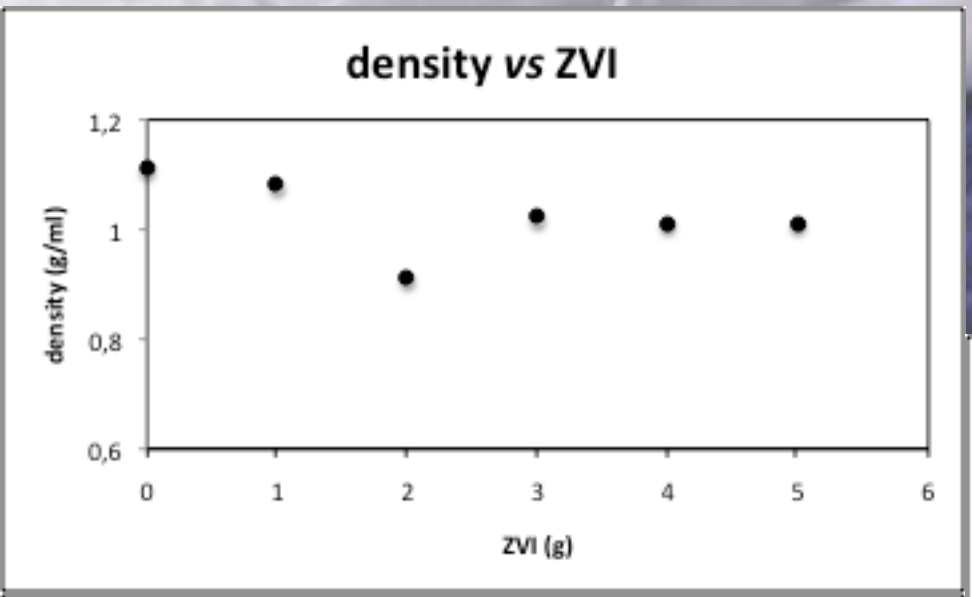


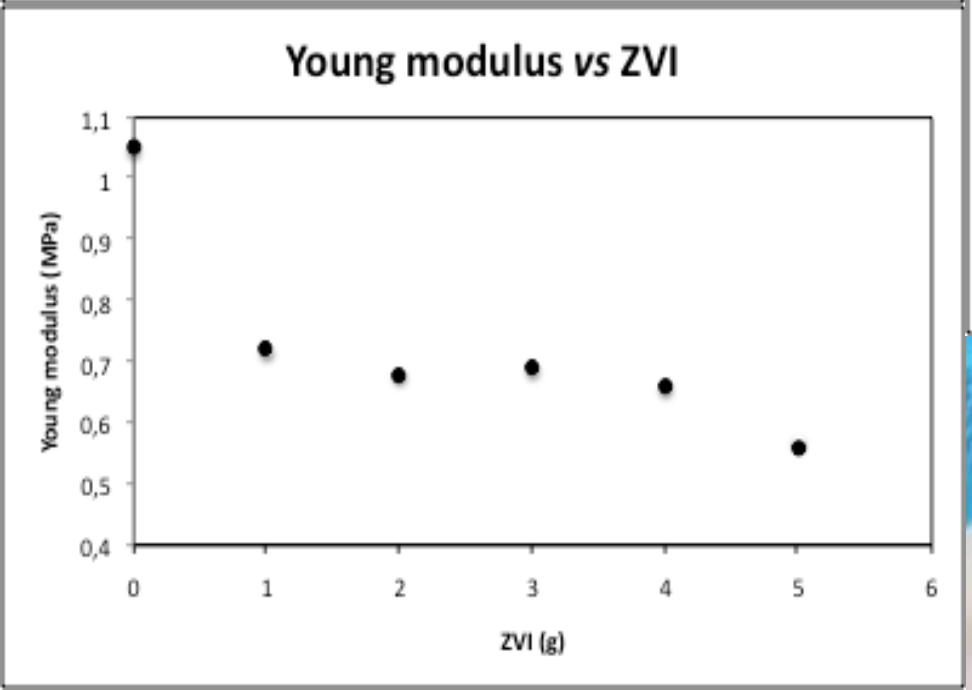


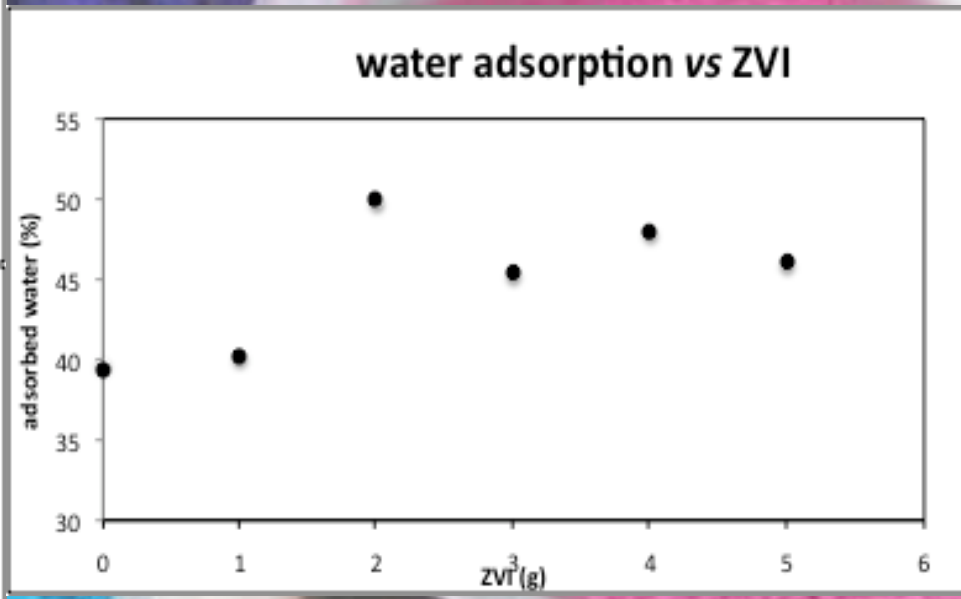


Plaster/water 50/35 (w:w)

POROUS PLASTER + ZVI



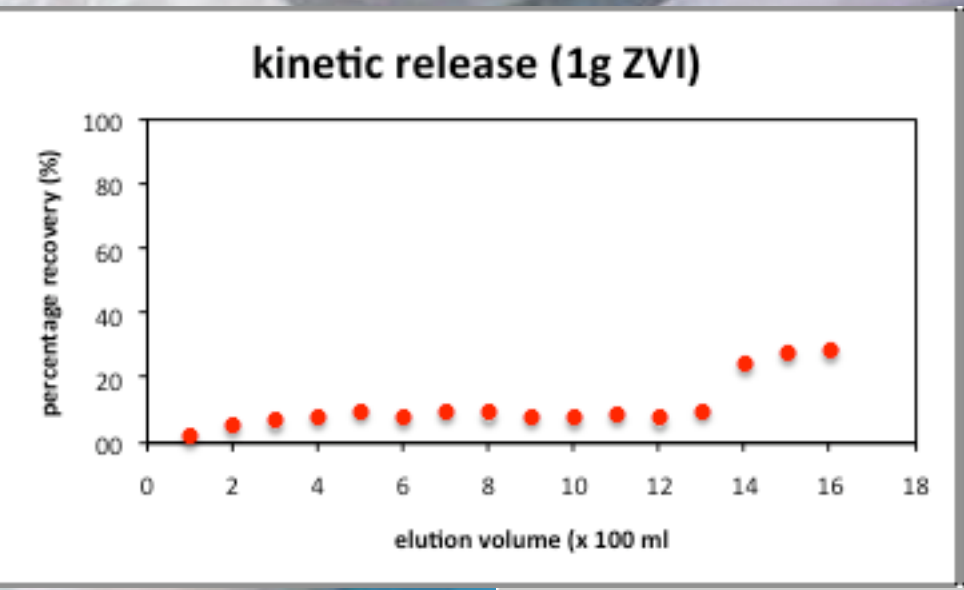


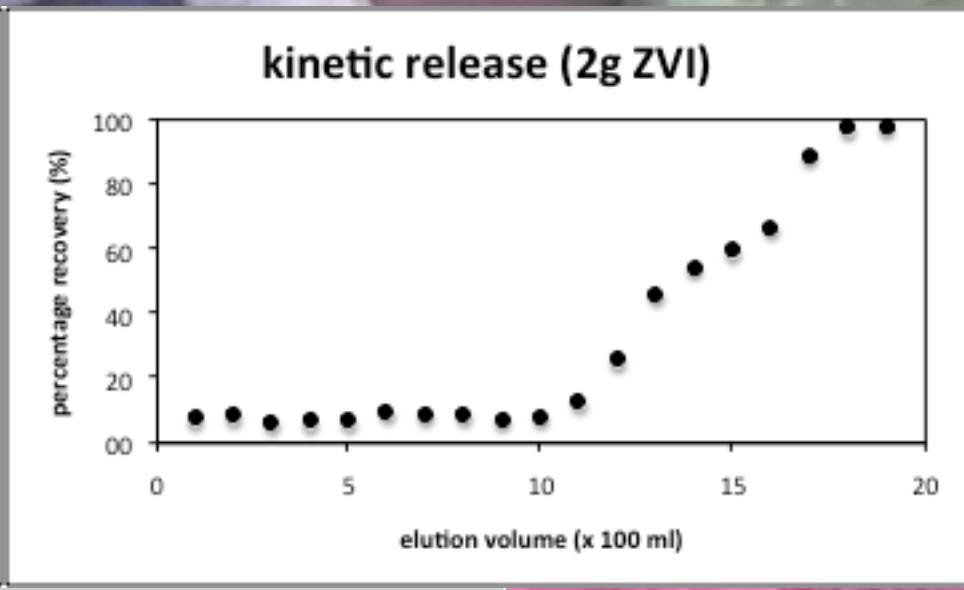



+ ZVI
plaster
+ charcoal
4µ

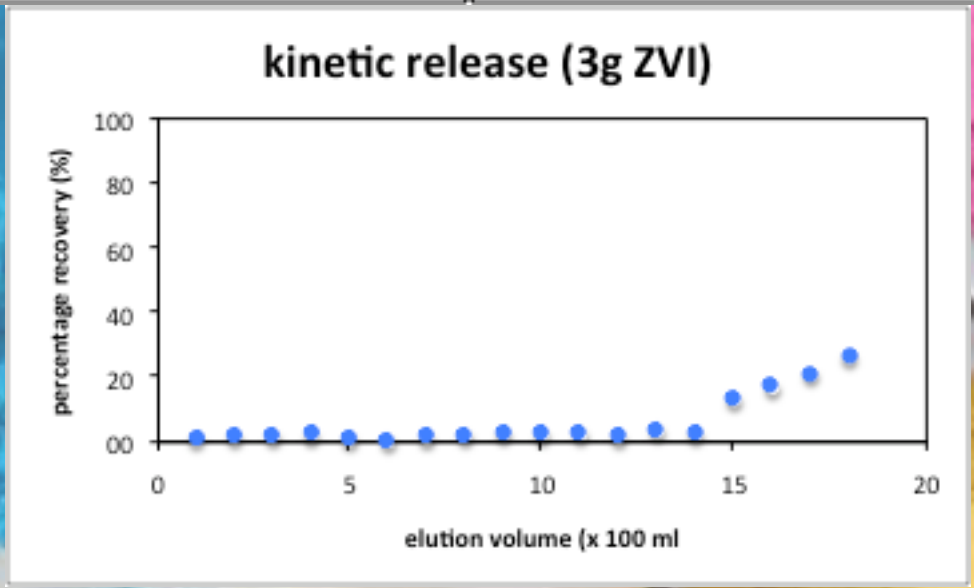
Treatement of an aqueous solution of p-nitroanilina

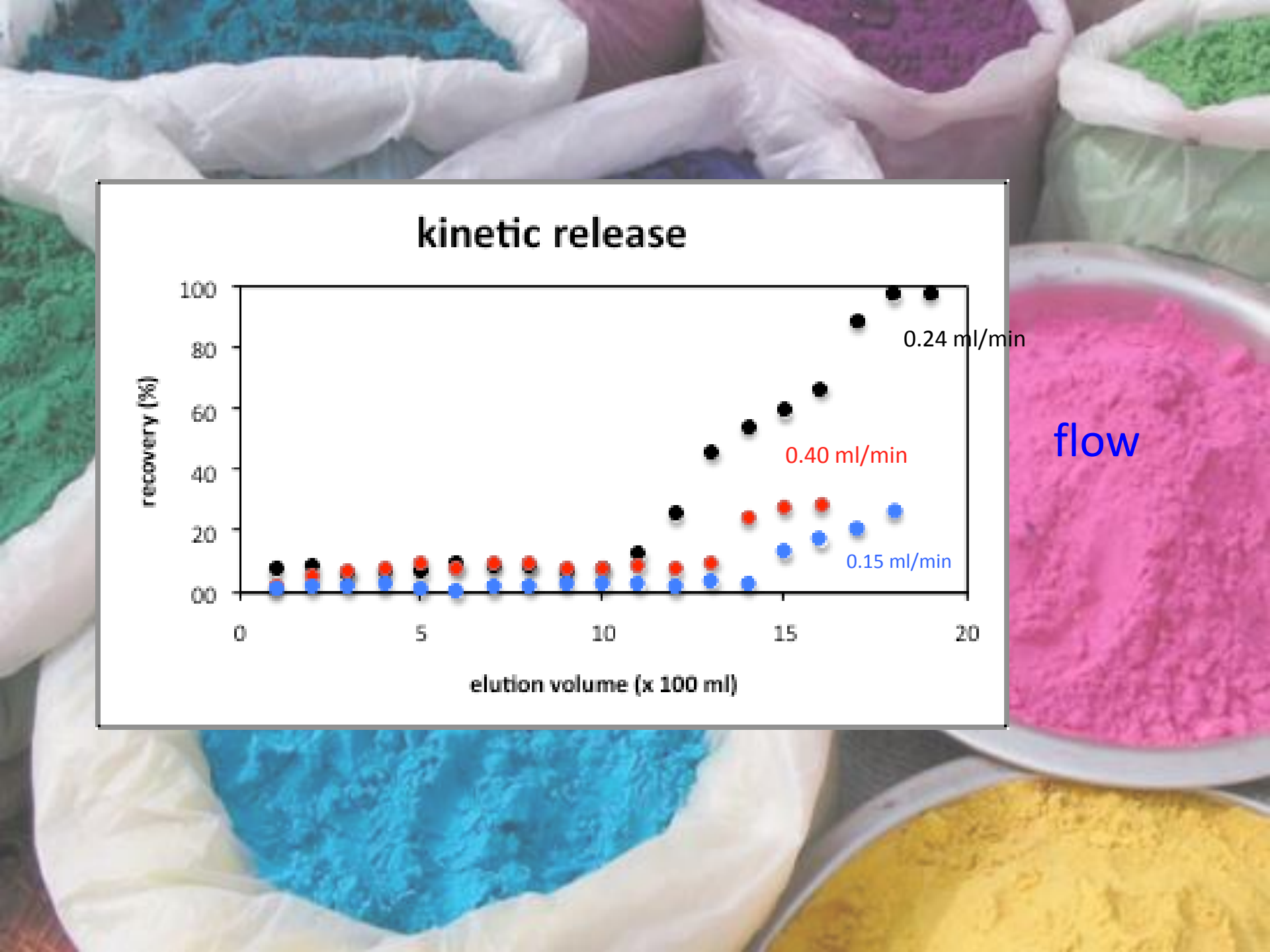
Recovery of phenylenediamine





column




kinetic release
recovery (%)
100
80
60
40
20
00
0
5
10
15
20
elution volume (x 100 ml)
0.24 ml/min
0.40 ml/min
0.15 ml/min
flow


Salsigne


Carcassonne