SUPPORTING INFORMATION

Table S1. Capture of metal ions using living and dead biomass

Microalga	Metal ion	Conditions	Typology of biomass	Adsorption efficiency (% or mg/g)	Ref
Chlorella vulgaris	Cu (II)	10 days	Living	76.5%	(4)
		2 days	Autoclaved[1]	81.9%	
	Zn (II)	10 days	Living	2,9%	
		8 days	Autoclaved	96.3%	
Spirulina Maxima	Cu (II)	10 days	Living	81.7%	
		2 days	Autoclaved	76.9%	
	Zn (II)	8 days	Autoclaved	94.9%	
Chlamydomonas reinhardtii[2]	Hg (II)	5÷35°C, 60 min, 200rpm, pH 6	Dead biomass	72.2±0.67 mg/g	(5)
	Cd (II)			42.6±0.54 mg/g	
	Pb (II)	5÷35°C, 60 min, 200rpm, pH 5		96.3±0.86 mg/g	
Chlorophyceae sp.[3]	Zn (II)	pH 5.5, 3 h	Living	91.9%	(6)
	Cu (II)	pH 7, 10 min	Living	88%	
Scenedesmus almeriensis[3]	As (III)	pH 9.5, 3 h	Living	40.7%	
Chlamydomonas sp.[4]	As (III)	25°C, 300rpm, pH 4, 60 min	Dead biomass	53.8 mg/g	(7)
Chlamydomonas reinhardti[5]	Cu (II)	30°C, pH 6, 65 min	Living	0.056 mg/g	(8)
			Dead biomass	0.109 mg/g	
	Pb (II)		Living	0.057 mg/g	
			Dead biomass	0.286 mg/g	
Chlorella vulgaris[6]	Cd (II)	5 min	Living	95.2% 16.34 mg/g	(9)
			Dead biomass	96.8% 16.65 mg/g	
Chlorella vulgaris[7]	Ag (I)	25°C, 300rpm, pH 5	Dead biomass	174.58±4.83 mg/g	(10)
	Nd (III)		Dead biomass	239.75±3.39 mg/g	

[1]The dead biomass is obtained throughout the autoclaving of the solution containing the inoculated cells.
[2]Biosorbent density = 0.8 g/L; [Met] = 100 mg/L
[3]Biosorbent density = 1g/L; [Zn] = 3mg/L, [Cu] = 3mg/L, [As] = 12mg/L
[4]Biosorbent density = 0.6 g/L; [As] = 50mg/L; biomass dried at 50°C and then grinded
[5]Biosorbent density = 0.2 g/L; metal ions concentration = 5 10^{-7} M
[6]Biosorbent density = 0.09 g/L; [Cd] = 100 mg/L
[7]Biosorbent density = 0.5 g/L; [Met] = 200 mg/L

Table S2. Metal concentration of industrial wastewater streams (BAT reference documents)

Heavy Metal Ion	**Ceramic Manufacturing (mg/L)** (1)	**Ferrous Metals Processing (mg/L)** (2)	**Surface Treatment of Metals and Plastics (mg/L)** (3)
Pb	0.3	0.042	0.5
Zn	2.0	0.2	2.0
Cd	0.07	0.015	0.2
Cr (III)	-	0.15	2.0
Cr (VI)	-	0.087	0.2
Hg	-	0.01	-
Ni	-	1.1	2.0
Cu	-	-	2.0

Table S3. Kuhl Medium composition for the algae growth.

Composition	**[mg/1000ml]**
KNO_3	1011.1
$NaH_2PO_4 \cdot H_2O$	621
$Na_2HPO_4 \cdot H_2O$	89
$MgSO_4 \cdot 7H_2O$	246.5
$CaCl_2 \cdot 2H_2O$	14.7
$FeSO_4 \cdot 7H_2O$ (Fe-EDTA complex)	6.95
Micronutrient solution*	1 ml

***Micronutrient Solution Composition**	**[mg/1000ml]**
H_3BO_3	61.0
$MnSO_4 \cdot H_2O$	169.0
$ZnSO_4 \cdot 7H_2O$	287.0
$CuSO_4 \cdot 5H_2O$	2.5
$(NH_4)_6Mo_7O_{24} \cdot 2H_2O$	12.5

Table S4. Characteristics IR bands and functional groups detected in the samples.

Region	Characteristic bands (cm^{-1})	Vibration mode	Functional group	Fraction	Ref.
Region I	3400 - 3200 cm^{-1}	-OH stretching mode -NH stretching mode	Hydroxyl Amine	-	(5,7,11)
	2955-2855 cm^{-1}	-CH stretching mode	alkyl	-	
	3010 cm^{-1}	=C-H stretching mode	alkenyl	-	(11)
Region II	1645 cm^{-1}	C=O stretching mode	amide I	Peptide linkage in proteins	(5,7,12, 13)
	1539 cm^{-1}	N-H in plane bending and CN stretching vibration	amide II		
	1320-1230 cm^{-1}		amide III		
	1720 cm^{-1}	C=O stretching bonds	carboxylic in ester groups	Lipid fraction	(11–13)
	1244 cm^{-1}	OCO vibrational mode			(11,13)
		P=O vibrational mode	phosphate	-	
	1454 cm^{-1}	CH_2 and CH_3 bending	alkyl	-	(5,13)
Region III	1030/1000 cm^{-1}	C-O and C-C stretching modes	-	polysaccaride	(5,11)
	881 cm^{-1}	OH out-of-plane bending	hydroxyl	-	

Table S5. Dried algae metal adsorption at different contact times at pH 6.

Ion	Initial metal concentration (mg/L)	pH	Adsorption after 2 days		Adsorption after 4 days	
			mg/L	% (w/w)	mg/L	% (w/w)
Pb (II)	0.5 ± 0.005	6	0.401 ± 0.004	80	0.402 ± 0.004	80
		7	0.428 ± 0.004	86	-	-
Cr (III)	0.2 ± 0.002	6	0.129 ± 0.001	65	0.124 ±0.001	62
		7	0.046 ± 0,0005	23	-	-
Cd (II)	0.2 ± 0.002	6	0.151 ± 0.001	76	0.125 ± 0.001	63
		7	0,129 ± 0,001	65	-	-

Table S6. Nominal results of dried algae metal adsorption at pH 6 in single and in multi-ions solution.

Ion	C_i (mg/L)	pH	Adsorption in single ion system		Adsorption in multi-metal system	
			mg/L	% (w/w)	mg/L	% (w/w)
Pb (II)	0.5 ± 0.005	6	0.401 ± 0.004	80	0.453 ± 0.005	91
Cr (III)	0.2 ± 0.002		0.129 ± 0.001	65	0.169 ± 0.002	85
Cd (II)	0.2 ± 0.002		0.151 ± 0.002	76	0.117 ± 0.001	59

Table S7. Nominal results ($\mu mol_{ion}/g_{algae}$) of dried algae metal adsorption at pH 6 in single and in multi-ions solution after 2 days of contact time.

Metal ions	C_i (µmol/g)	C_a in single-metal system		C_a in multi-metal system	
		$\mu mol_{ion}/g_{algae}$	%(w/w)	$\mu mol_{ion}/g_{algae}$	%(w/w)
Pb (II)	8.0	6.5	80	7.3	91
Cr (III)	12.8	8.3	65	10.8	85
Cd (II)	5.9	4.5	76	3.5	59

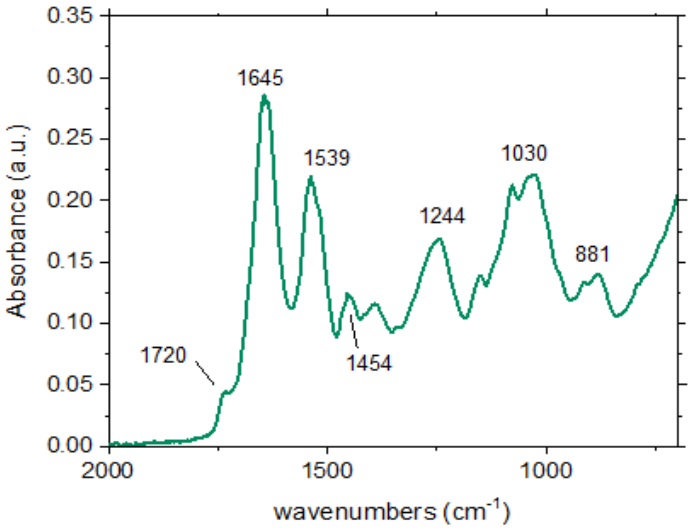


Figure S1. FTIR in ATR mode low frequency region spectrum of pristine *C.reinhardtii*

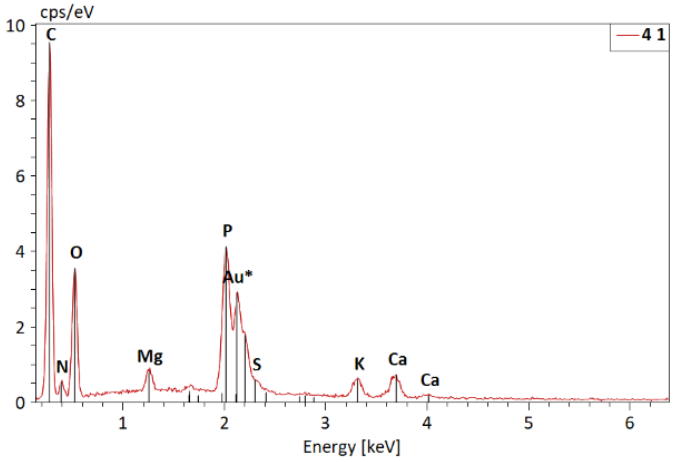


Figure S2. EDX analysis of pristine dried *C.reinhardtii*. Au* peak is related to gold plating of samples to make them conductive.

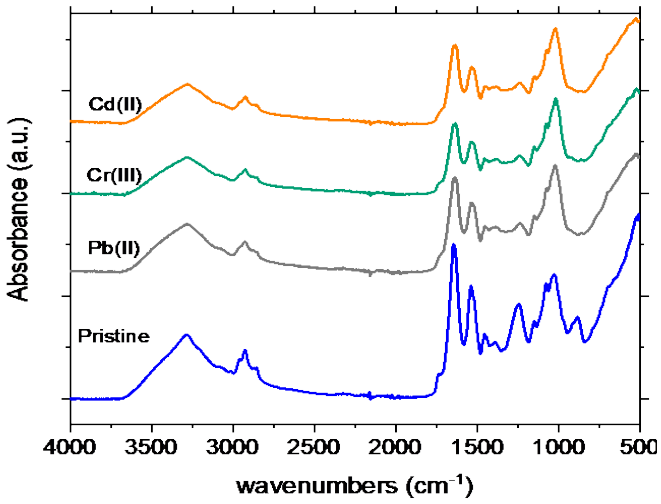
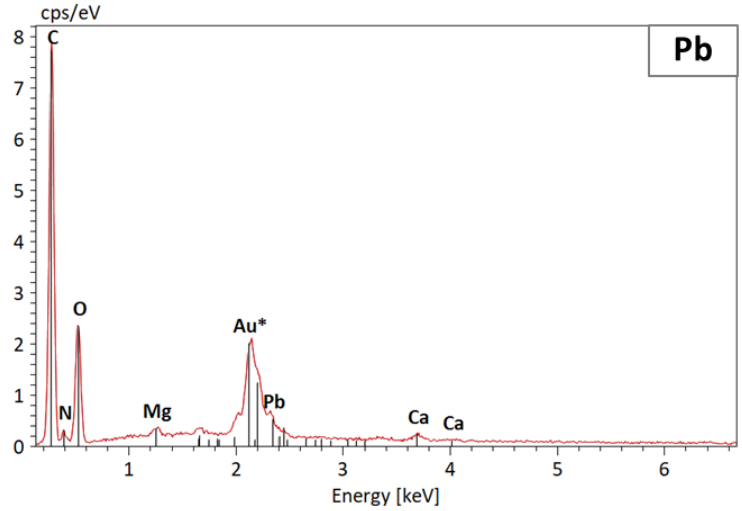
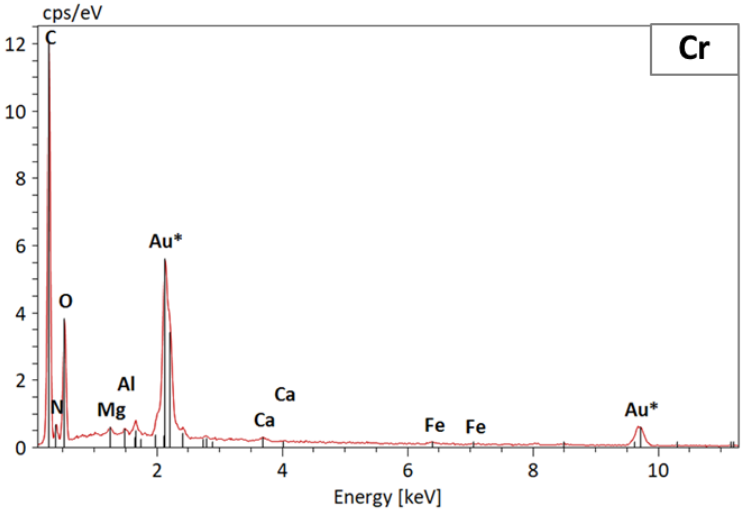


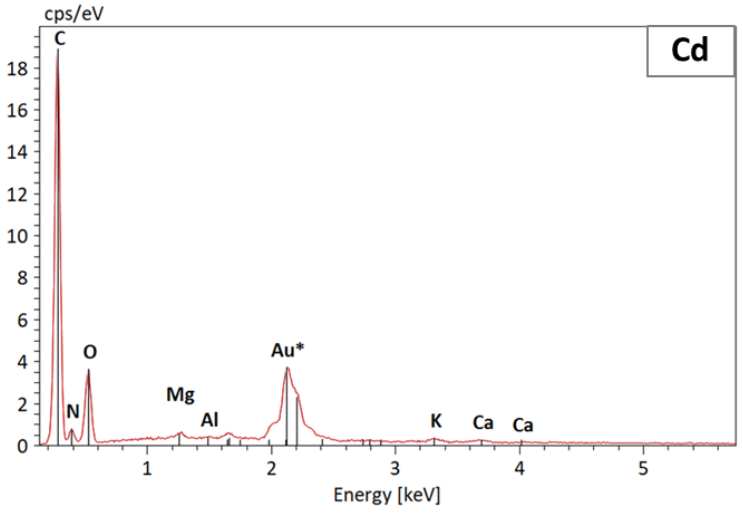
Figure S3. FTIR in ATR mode of the microalga before (namely, pristine) and after the adsorption of the HMs at pH 6 full spectra



a)



b)



c)

Figure S4. EDX analysis of the microalga after single metal adsorption at pH6

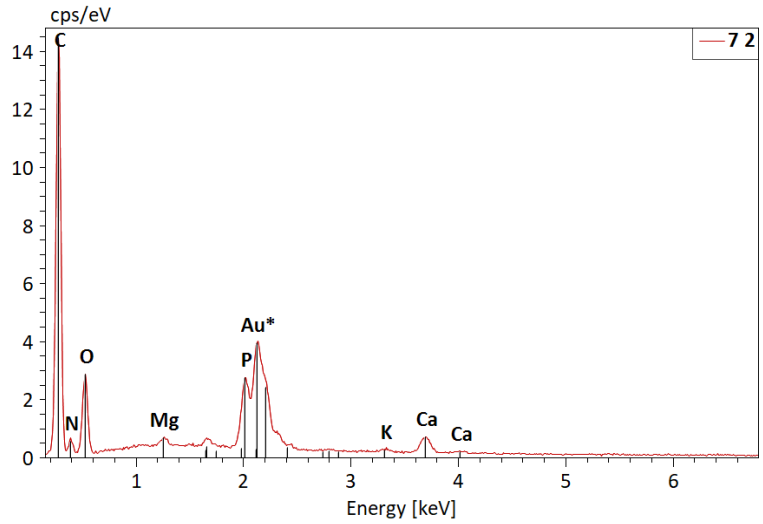


Figure S5. EDX analysis of the microalga after multi-metal adsorption at pH6. Au* peak is related to gold plating of samples to make them conductive.

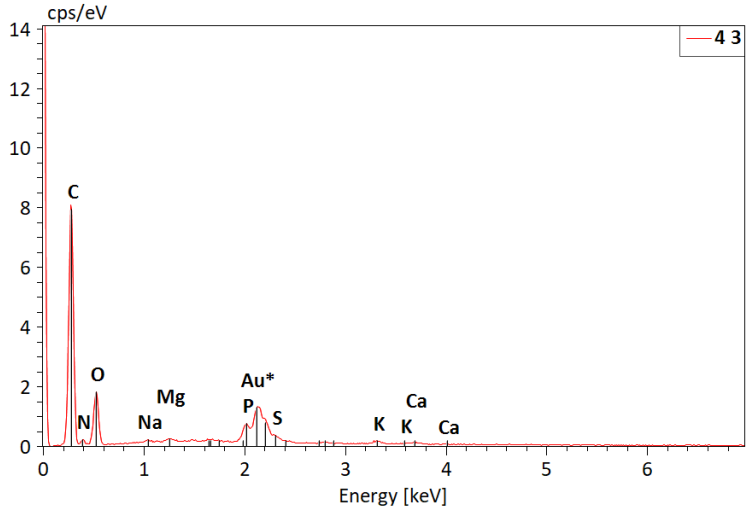
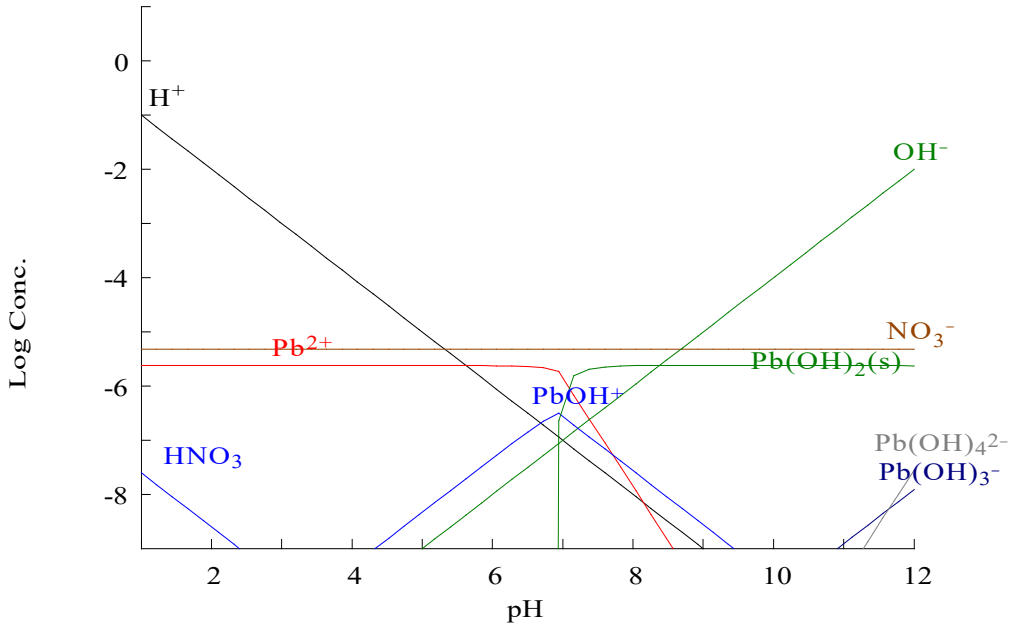


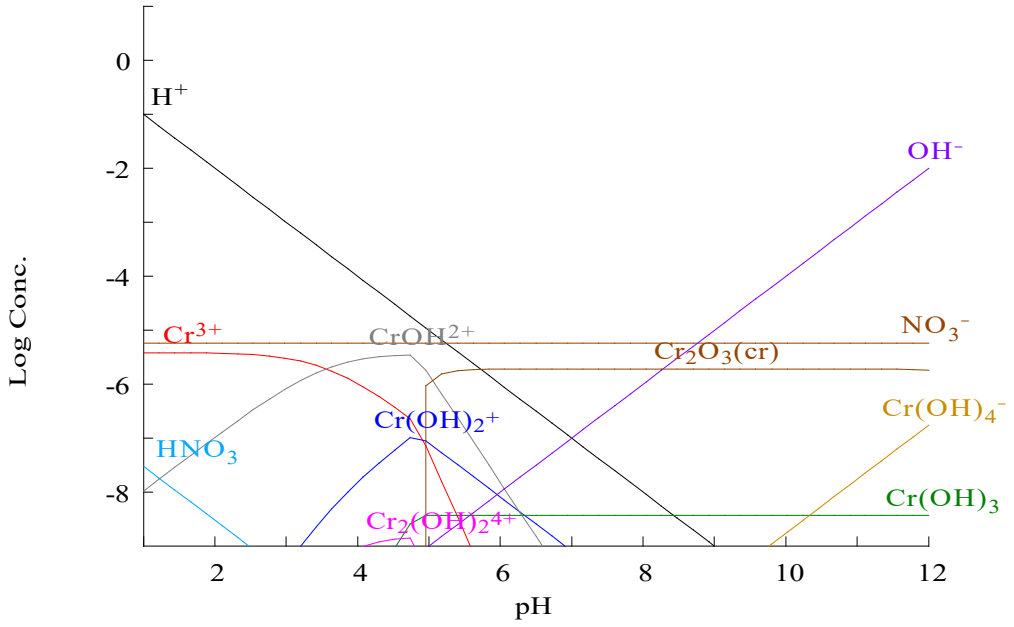
Figure S6. EDX analysis of the living microalga after Cd adsorption. Au* peak is related to gold plating of samples to make them conductive.

$[Pb^{2+}]_{TOT}$ = 2.41 µM $[NO_3^-]_{TOT}$ = 4.82 µM



a)

$[Cr^{3+}]_{TOT}$ = 3.85 µM $[NO_3^-]_{TOT}$ = 5.78 µM



b)

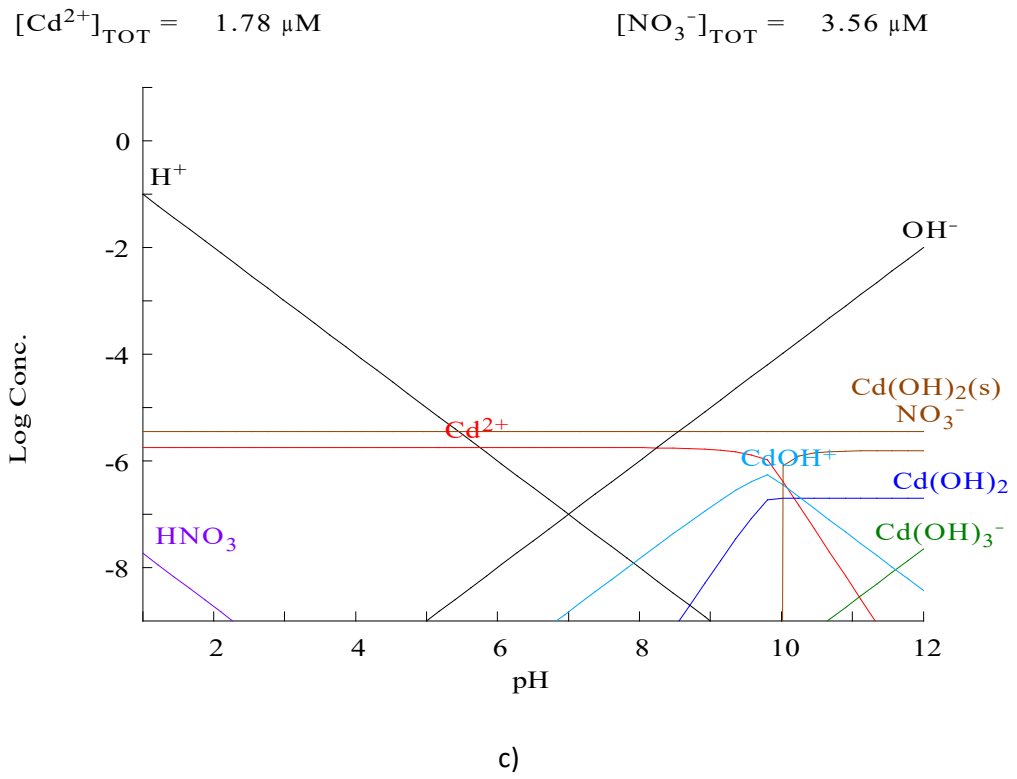


Figure S7. *Hydra-Medusa* plots for: a) Pb(II), b) Cr(III) and d) Cd(II), single ion solution.

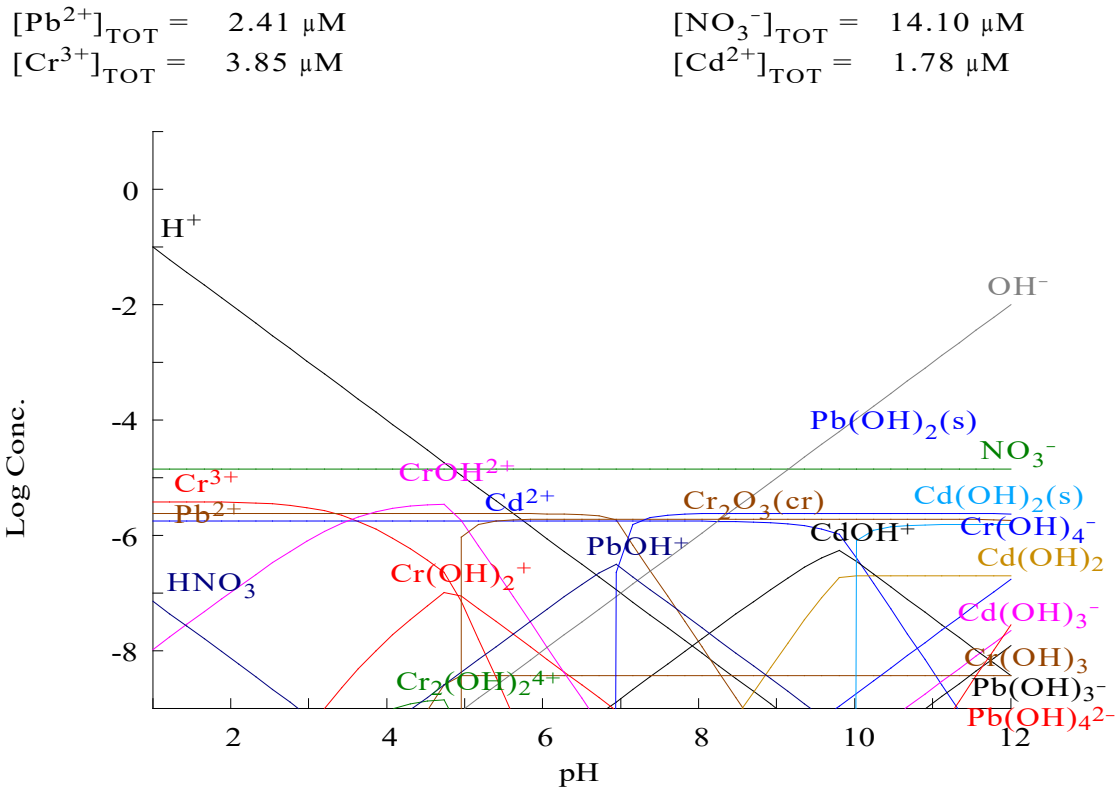


Figure S8. *Hydra-Medusa* plots of the multi-ionic solution

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