Supplementary Information (SI) for Environmental Science: Water Research & Technology.

Engineered Clay Pellets Functionalized with Industrial Residuals for Phosphorus Removal from Agricultural Runoff

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Fig S1

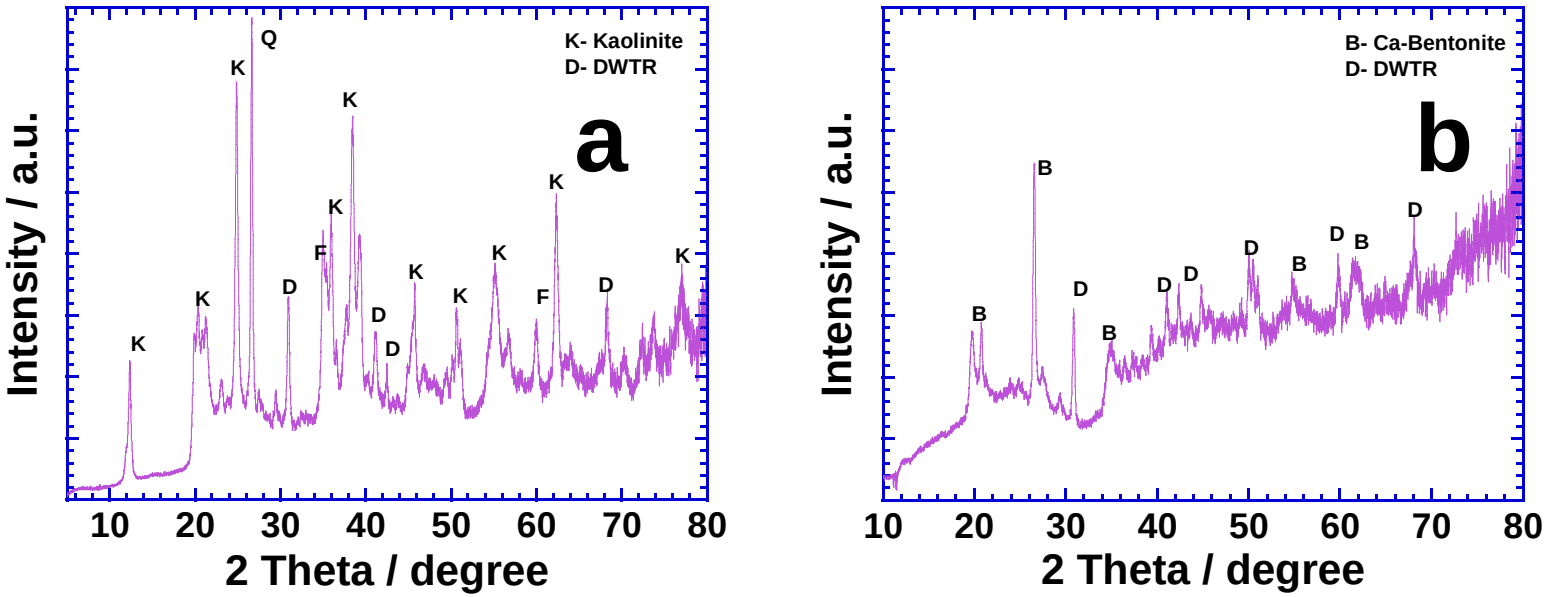

Fig S1. XRD plots of (a) kaolinite- DWTR (b) Ca-bentonite- DWTR

Fig S2a

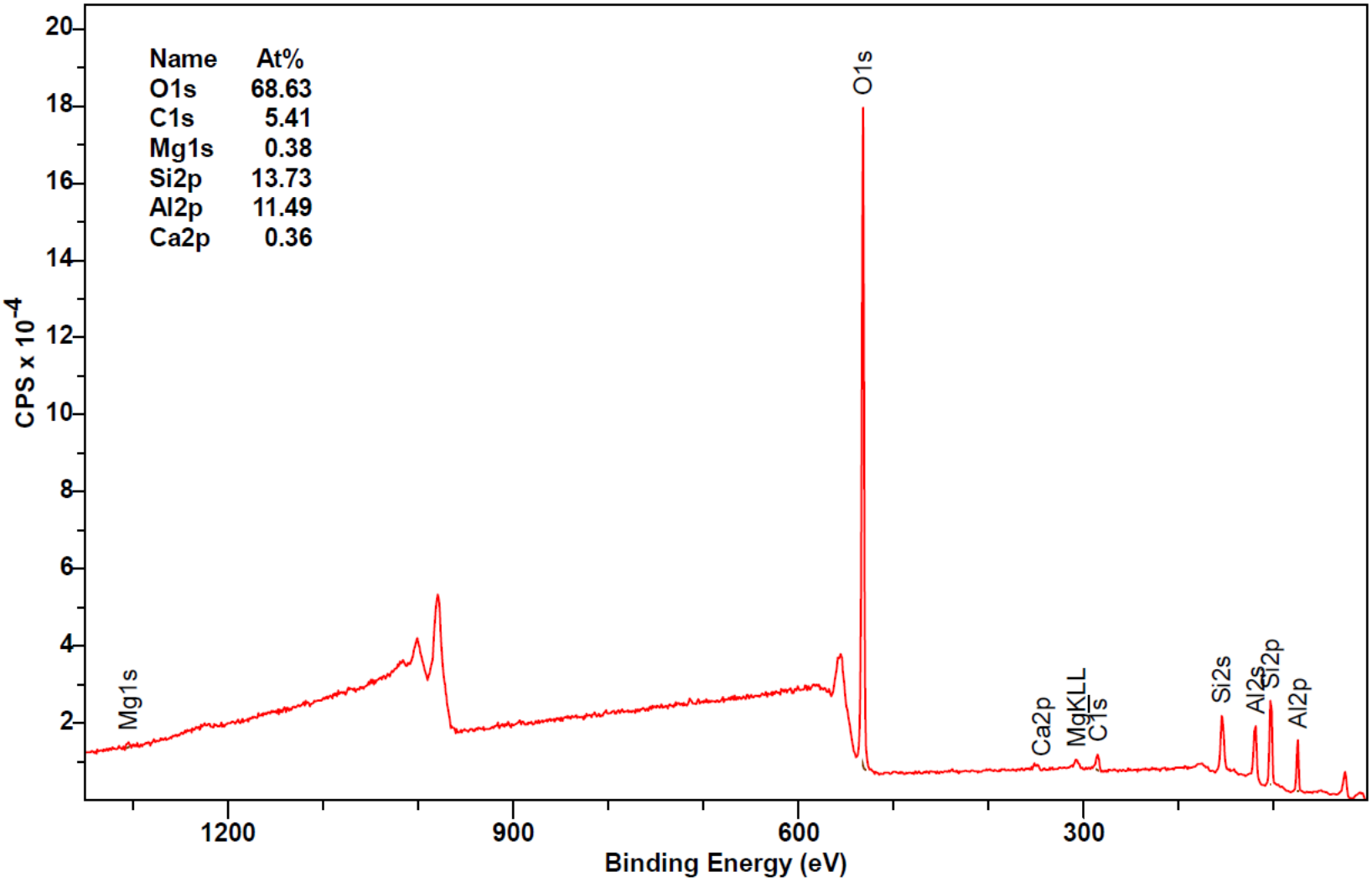

Fig S2a. XPS survey of elemental composition of pure kaolinite clay pellets.

Fig S2b

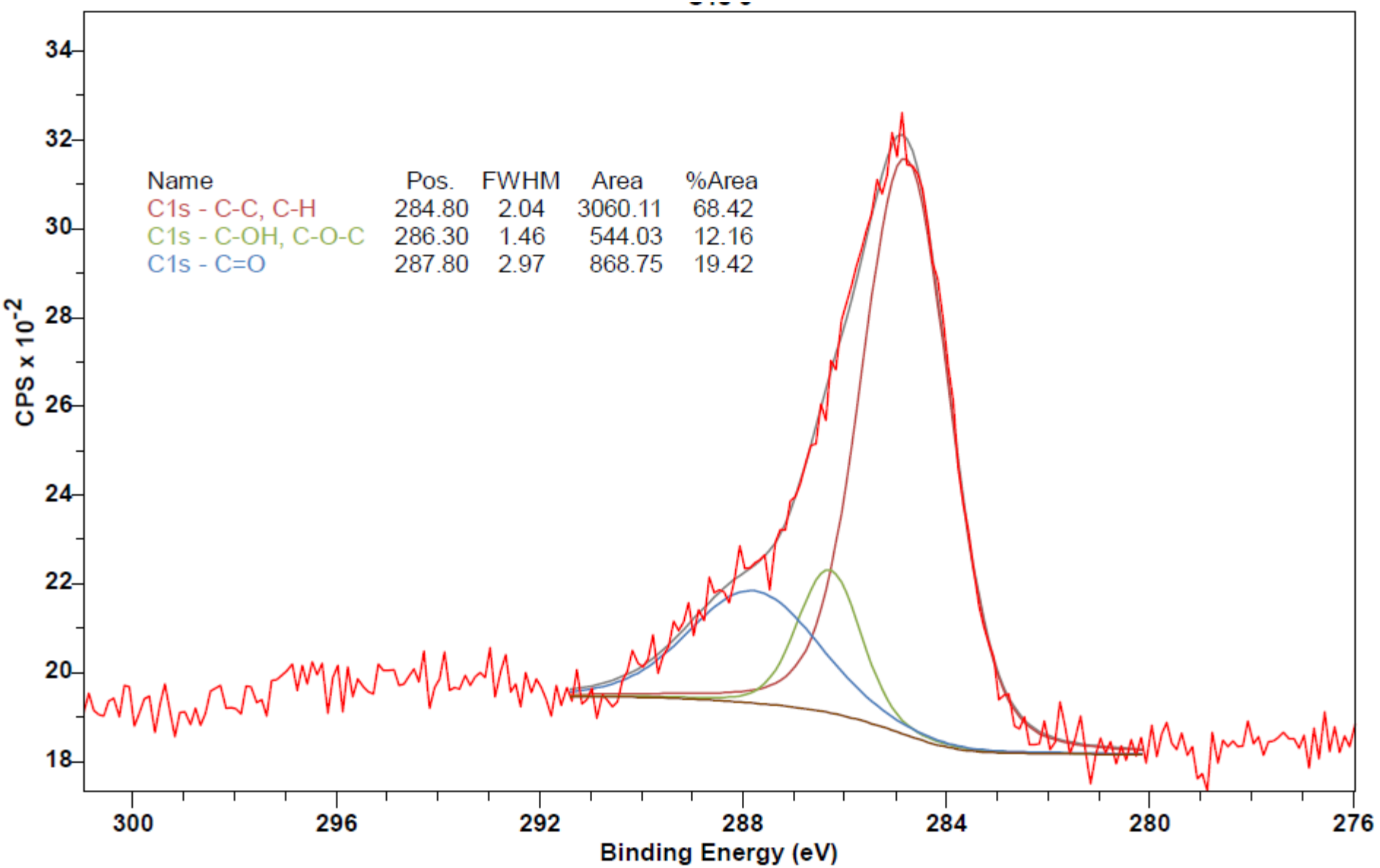

Fig S2b. High resolution XPS spectra of C-1s associated with kaolinite clay pellets.

Fig S2c

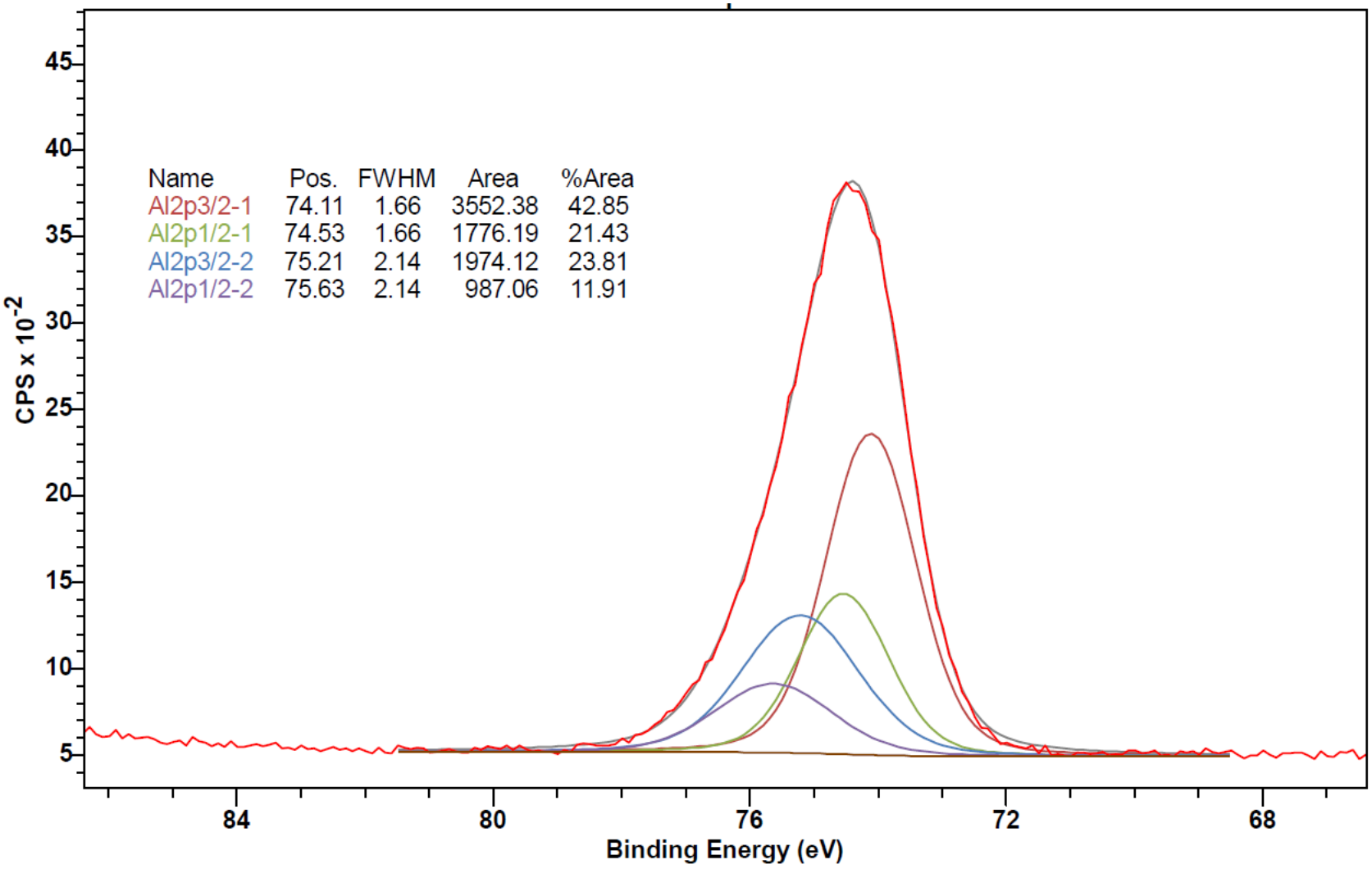

Fig S2c. High resolution XPS spectra of Al- 2p of kaolinite- DWTR modified clay pellets.

Fig S2d

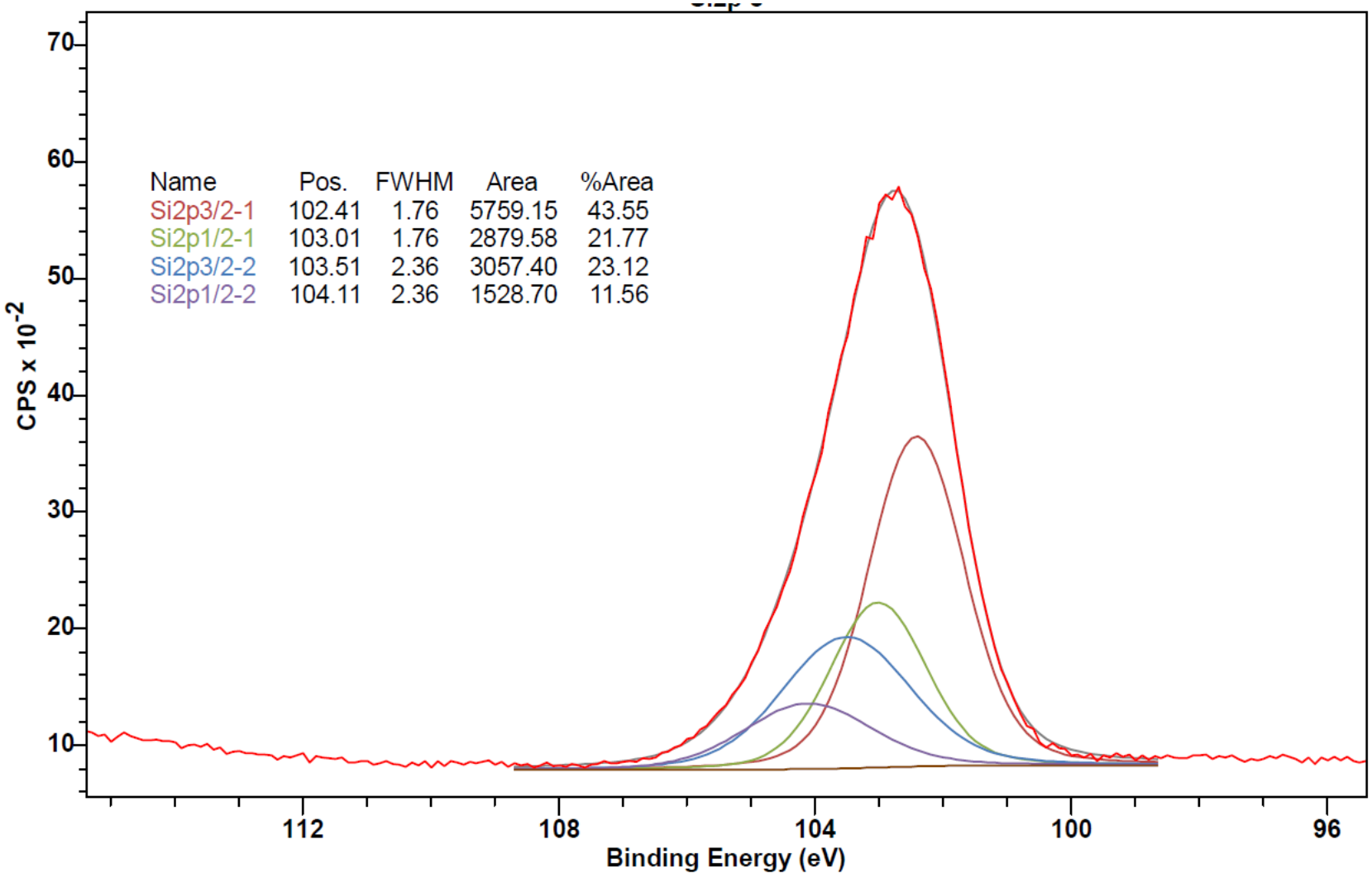

Fig S2d. High resolution XPS spectra of Si-2p kaolinite- DWTR modified clay pellets.

Fig S2e

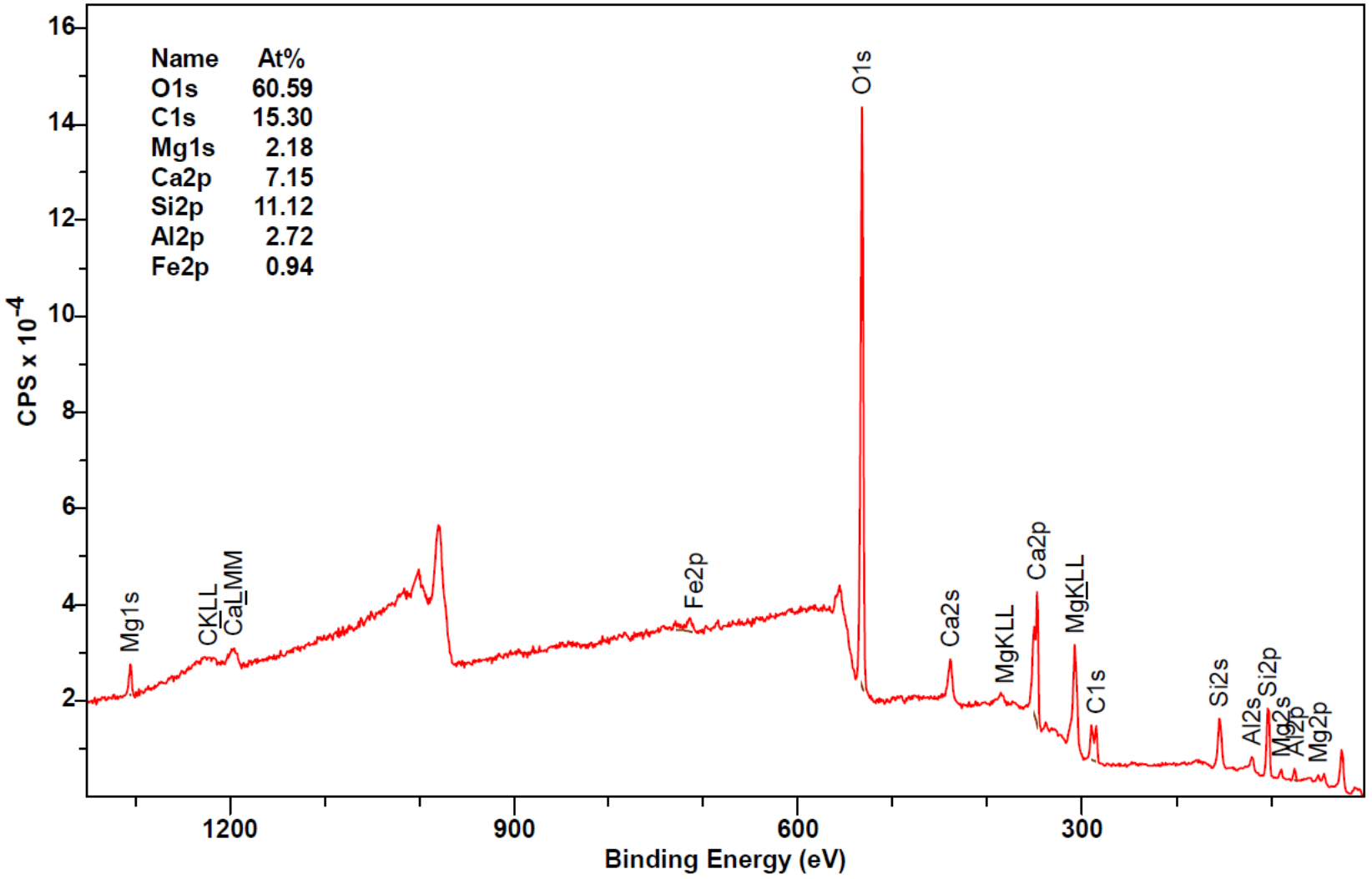

Fig S2e. XPS survey of elemental composition of Ca-bentonite- steel slag modified clay pellets.

Fig S2f

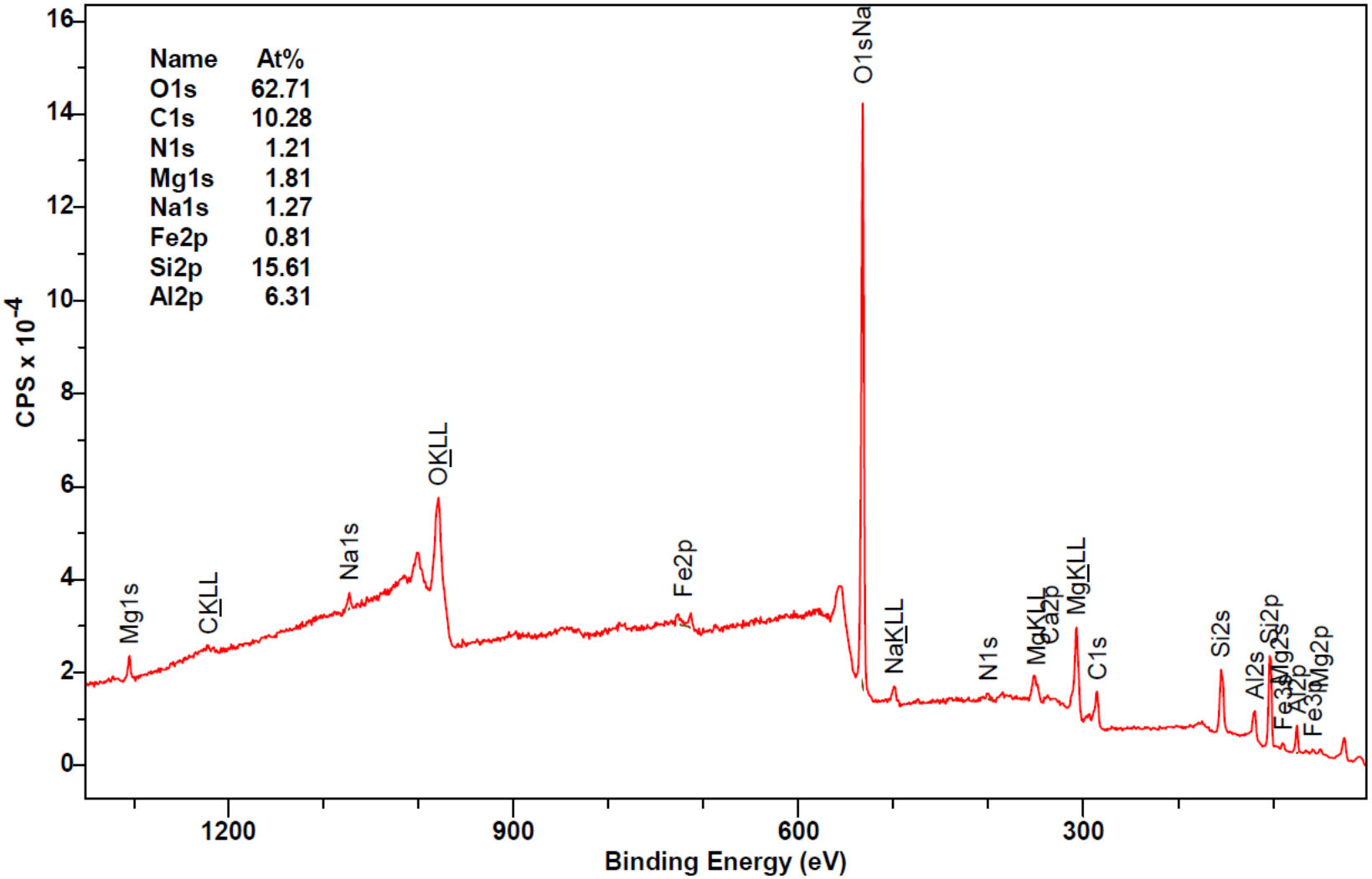

Fig S2f. XPS survey of elemental composition of Ca-bentonite- DWTR modified clay pellets.

Fig S3a

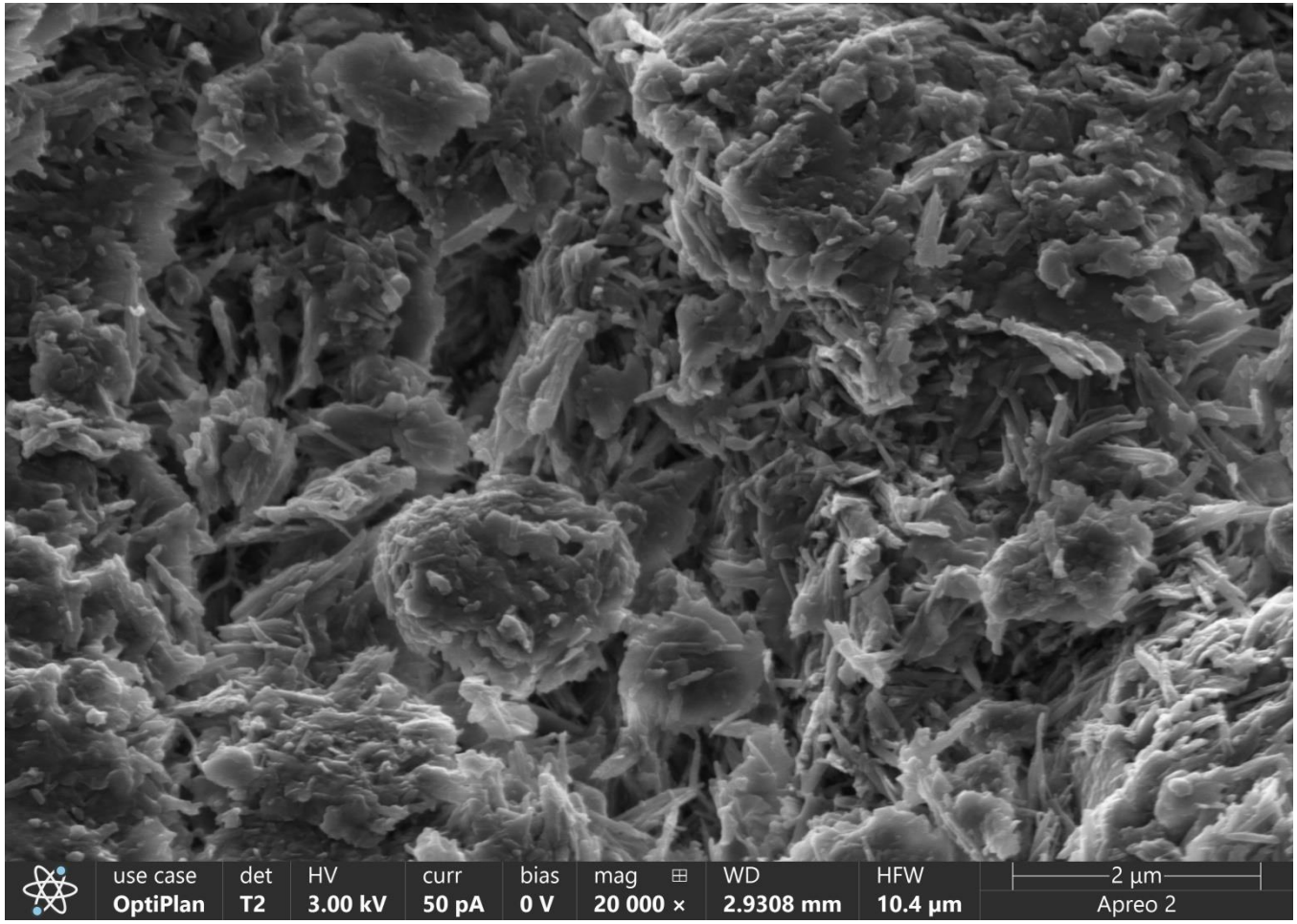

Fig S3a. High resolution FESEM image of pure Ca-bentonite clay pellets.

Fig S3b

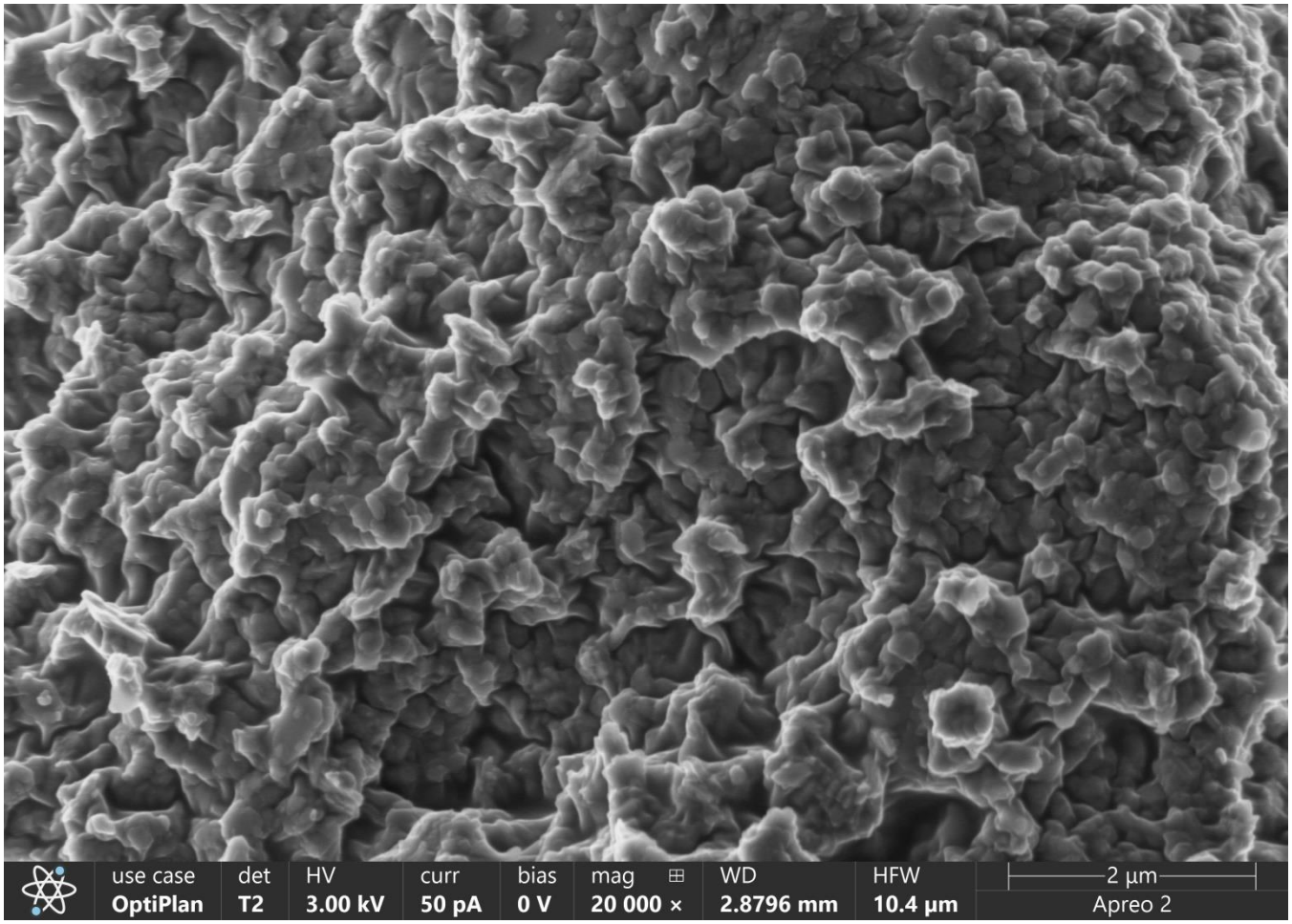

Fig S3b. High resolution FESEM image of pure kaolinite clay pellets.

Fig S3c

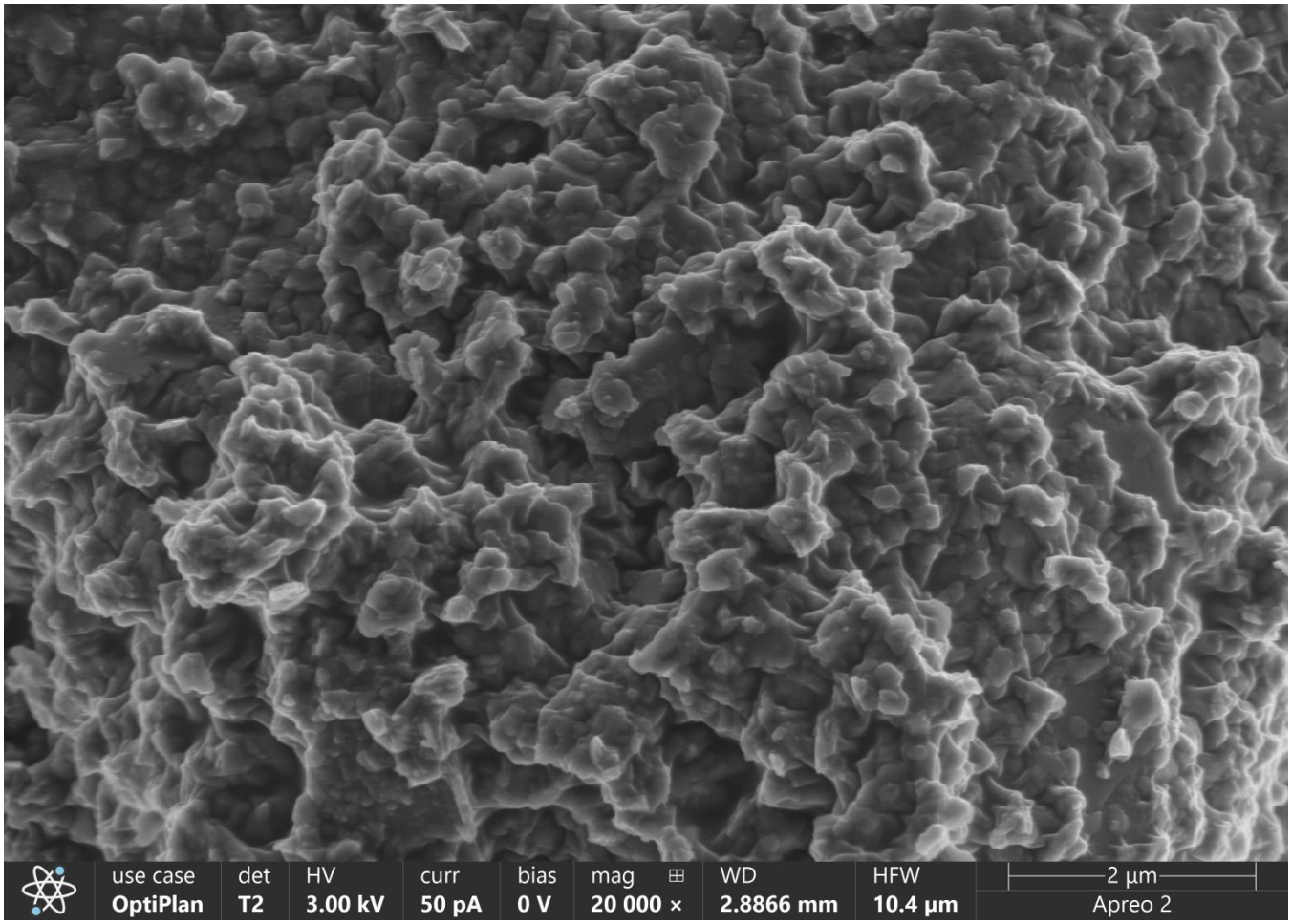

Fig S3c. High resolution FESEM image of kaolinite- steel slag modified clay pellets.

Fig S4

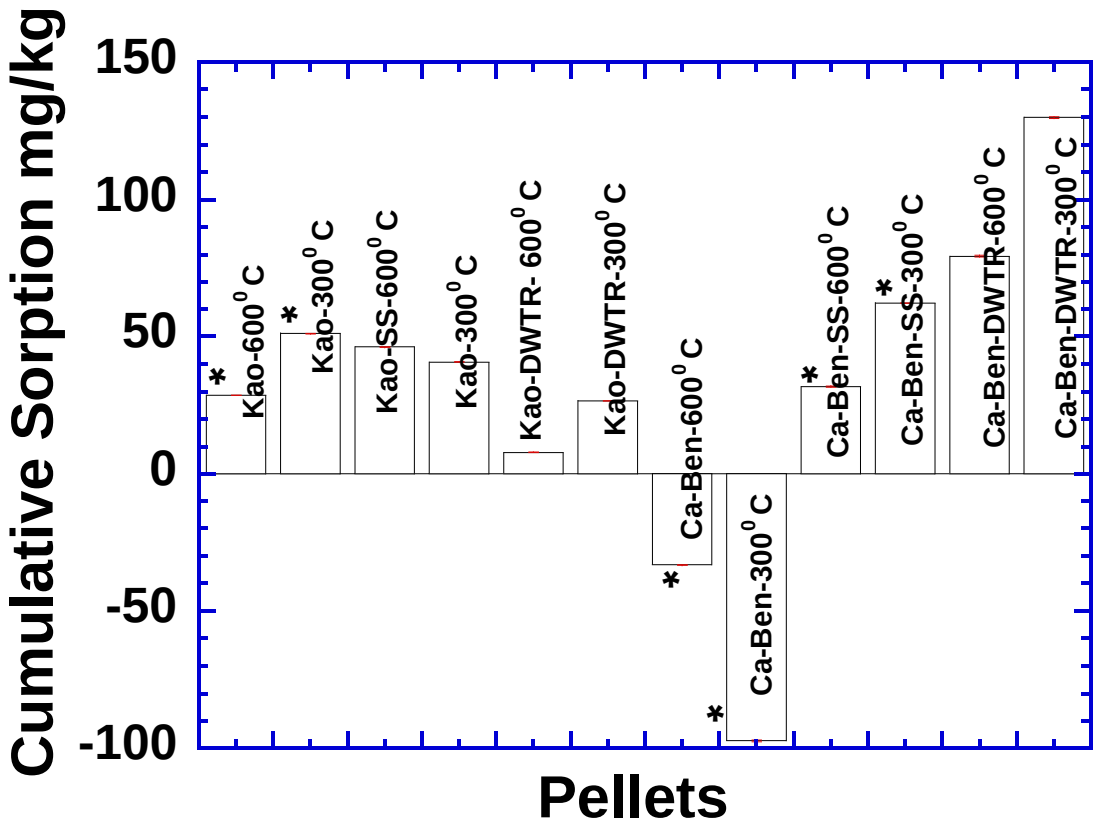

Fig S4. Bar graph of unmodified and modified clays media pellet treated at 600°C and 300°C. Media marked with * are statistically different between 600°C and 300°C temperature at α=0.05.

Fig S5

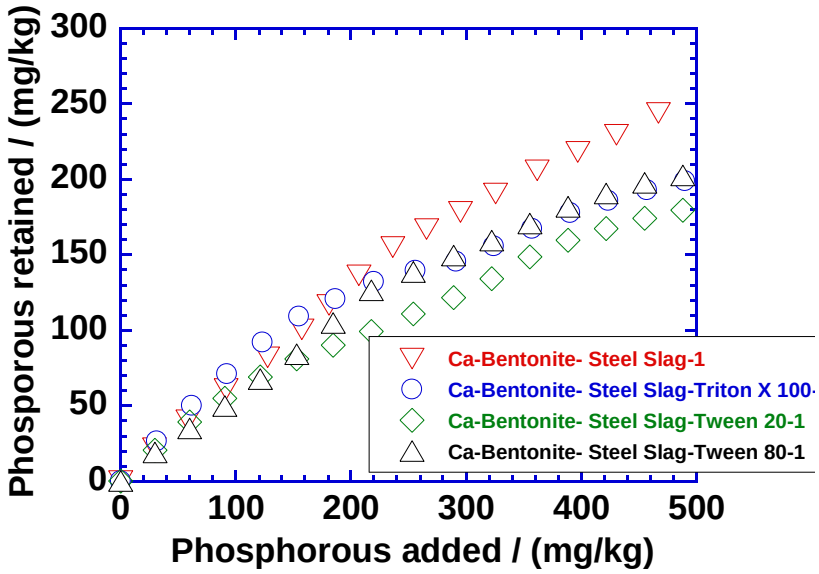

Fig S5. Phosphorous retained (mg/kg) vs phosphorous added (mg/kg) plot of steel slag modified Ca- bentonite and surfactant functionalized Ca- bentonite- steel slag clay media pellets.

Fig S6

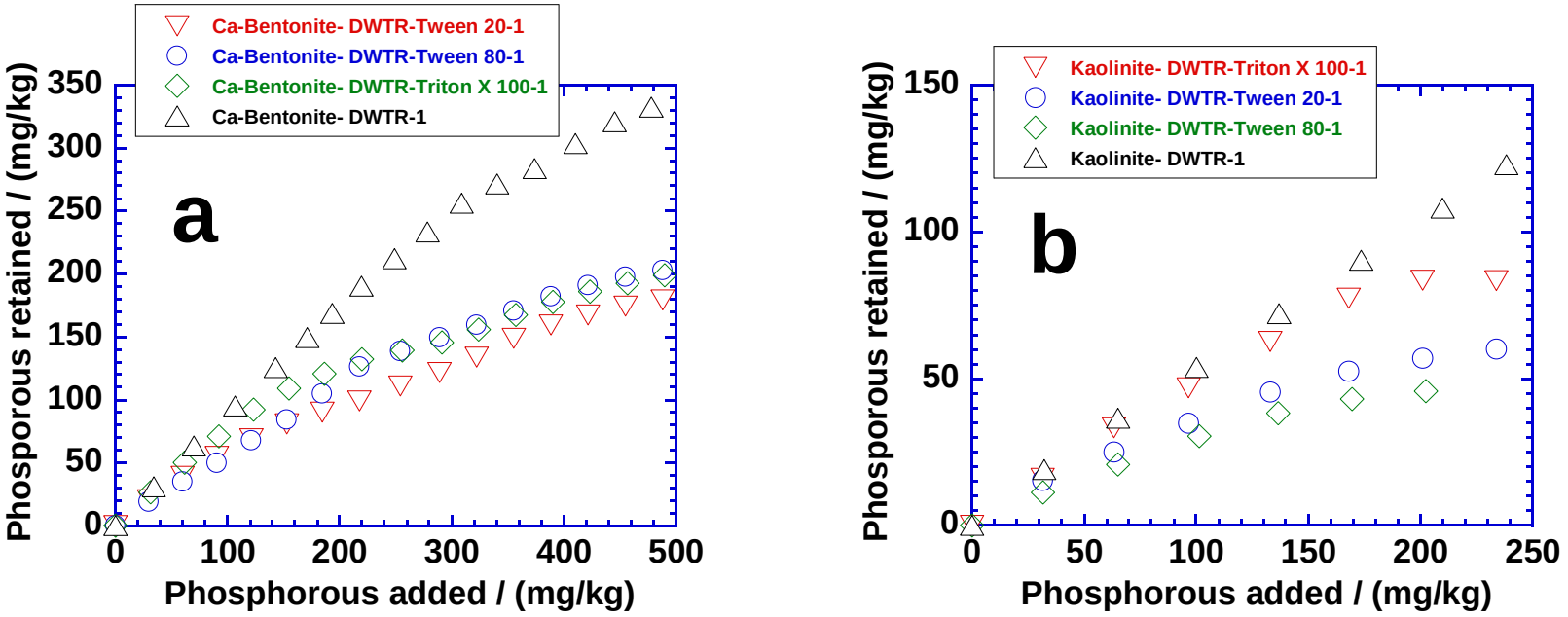

Fig S6. (a) Phosphorous retained (mg/kg) vs phosphorous added (mg/kg) plot of DWTR modified Ca- bentonite and surfactant functionalized Ca- bentonite- DWTR clay media pellets. (b) DWTR modified kaolinite and surfactant functionalized kaolinite- DWTR clay media pellets

Fig S7

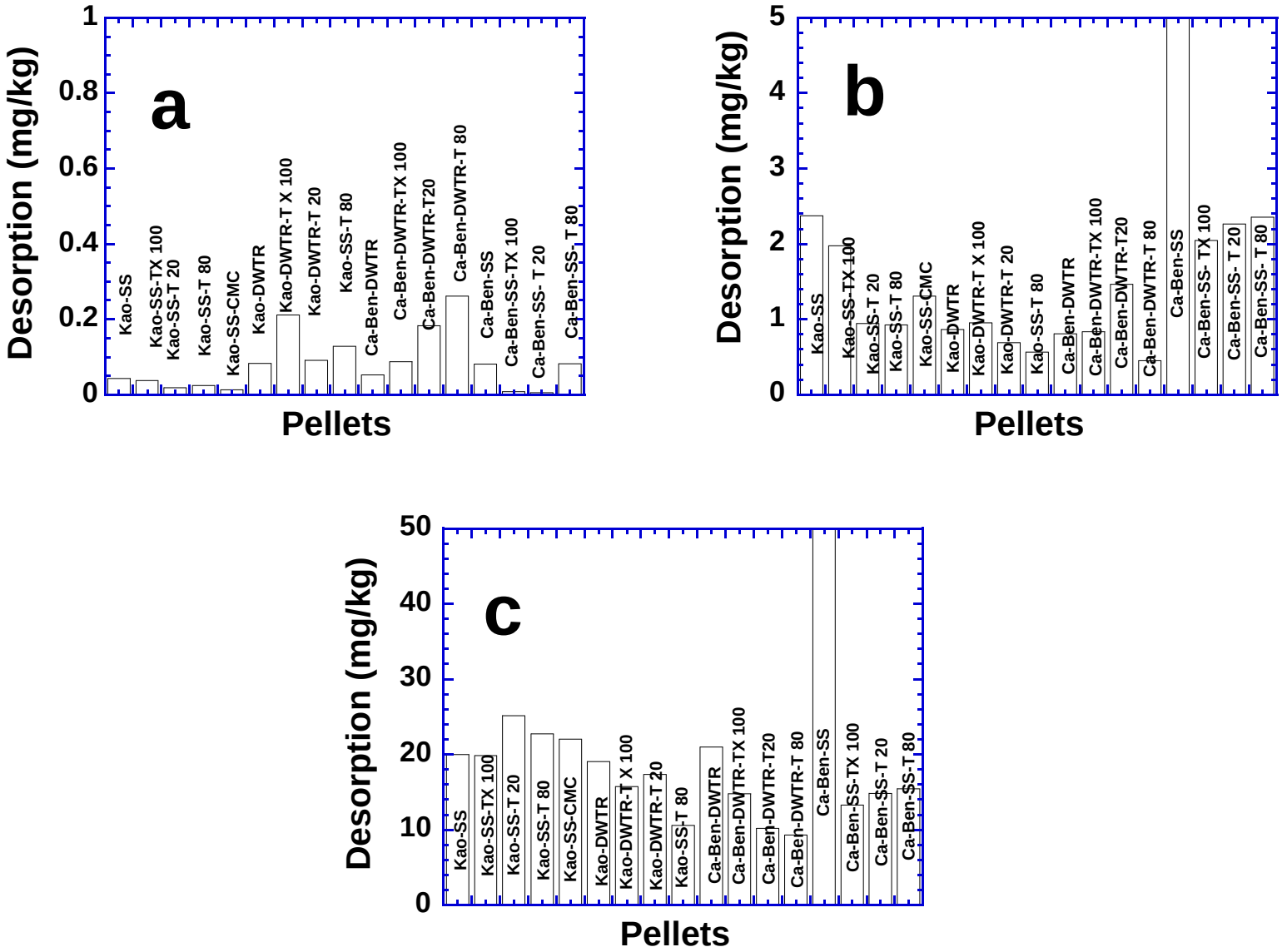

Fig S7. Bar graphs show the desorption (mg/kg) of modified clays media pellets treated with DI water for 1 hour (a), 0.5M NaHCO3 for 1 hours (b), and 3M KOH for 24 hours (c).

Table S1: Composition of modified/functionalized clay pellets

Sample Code	Media	Composition
215DB	Ca-Bentonite	500 g
215DB- TX 100	Ca-Bentonite / Triton X 100 (coating)	500 g / 0.5 g
215DB- T 20	Ca-Bentonite / Tween 80 (coating)	500 g / 0.5 g
215DB- T 80	Ca-Bentonite / Tween 20 (coating)	500 g / 0.5 g
216DB	Ca-Bentonite / Steel Slag (additive)	250 g / 250 g
216DB- TX 100	Ca-Bentonite / Steel Slag / Triton X 100 (coating)	250 g / 250 g / 0.5 g
216DB- T 20	Ca-Bentonite / Steel Slag / Tween 80 (coating)	250 g / 250 g / 0.5 g
216DB- T 80	Ca-Bentonite / Steel Slag / Tween 20 (coating)	250 g / 250 g / 0.5 g
217DB	Ca-Bentonite / DWTR (additive)	250 g / 250 g
217DB- TX 100	Ca-Bentonite / DWTR / Triton X 100 (coating)	250 g / 250 g / 0.5 g
217DB- T 20	Ca-Bentonite / DWTR / Tween 80 (coating)	250 g / 250 g / 0.5 g
217DB- T 80	Ca-Bentonite / DWTR / Tween 20 (coating)	250 g / 250 g / 0.5 g
209DB	Kaolinite	500g
209DB- TX 100	Kaolinite / Triton X 100 (coating)	500g / 0.5 g
209DB- T 20	Kaolinite / Tween 80 (coating)	500g / 0.5 g
209DB- T 80	Kaolinite / Tween 20 (coating)	500g / 0.5 g
210DB	Kaolinite / Steel Slag (additive)	333g / 166 g / 0.5 g
210DB- TX 100	Kaolinite / Steel Slag / Triton X 100 (coating)	333g / 166 g / 0.5 g
210DB- T 20	Kaolinite / Steel Slag / Tween 20 (coating)	333g / 166 g / 0.5 g
210DB- T 80	Kaolinite / Steel Slag / Tween 80 (coating)	333g / 166 g / 0.5 g
211DB	Kaolinite / DWTR (additive)	333g / 0.5 g
211DB- TX 100	Kaolinite / DWTR / Triton X 100 (coating)	333g / 166g / 0.5 g
211DB- T 20	Kaolinite / DWTR / Tween 80 (coating)	333g / 166 g / 0.5 g
211DB- T 80	Kaolinite / DWTR / Tween 20 (coating)	333g / 166 g / 0.5 g

Table S2. shows the cumulative P sorption (mg/kg) and % P removal of each modified and unmodified clays media pellets. Data is reported until saturation is reached at 20%. Alphabets here predict the statistical analysis of clays media pellets (p≥ 0.05). Pellets with same alphabets are grouped statistically similar and statistically different from media pellets marked with different alphabets.

S.No.	Media pellets	Cumulative P Sorption (mg/kg)	Time / Hour	% P Removal
1	Pure- Ca-Bentonite	-2 (1) h	48	
2	Ca-Bentonite-Triton X 100	26(1) g	168	16 g
3	Ca-Bentonite-Tween 20	34 (1) f	168	23 f
4	Ca-Bentonite-Tween 80	28 (2) g	168	19 g
5	Ca-Bentonite-CMC	29 (6) f	168	22 f
6	Pure-Kaolinite	30 (10) f	144	24 f
7	Kaolinite-Triton X 100	20 (8) g	144	17 g
8	Kaolinite-Tween 20	21 (1) g	144	17 g
9	Kaolinite-Tween 80	12 (0.4) f	72	22 f
10	Kaolinite-CMC	7 (4) g	72	14 g
11	Kaolinite-steel slag	49 (26) c	144	41 c
12	Kaolinite-steel slag-Triton X 100	86 (3) b	192	53 b
13	Kaolinite-steel slag-Tween 20	71 (11) c	192	43 c
14	Kaolinite-steel slag-Tween 80	70 (4) c	192	42 c
15	Kaolinite-steel slag-CMC	19 (0.5) h	96	8 h
16	Ca-Bentonite-Steel Slag	263 (13) b	480	53 b
17	Ca-Bentonite-Steel Slag-Triton X 100	187 (3) c	384	47 c
18	Ca-Bentonite-Steel Slag-Tween 20	157 (36) d	384	38 d
19	Ca-Bentonite-Steel Slag-Tween 80	168 (23) c	384	44 c
20	Kaolinite- DWTR	274 (24) d	648	39 d
21	Kaolinite- DWTR-Triton X 100	63 (16) e	192	34 e
22	Kaolinite-DWTR-Tween 20	55 (3) f	192	29 f
23	Kaolinite-DWTR-Tween 80	40 (1) f	168	24 f
24	Ca-Bentonite- DWTR	293 (39) a	432	64 a
25	Ca-Bentonite-DWTR-Triton X 100	66 (18) e	240	26 e
26	Ca-Bentonite-DWTR-Tween 20	93 (13) f	288	34 f
27	Ca-Bentonite-DWTR-Tween 80	65 (9) f	288	24 f