Supplementary Information

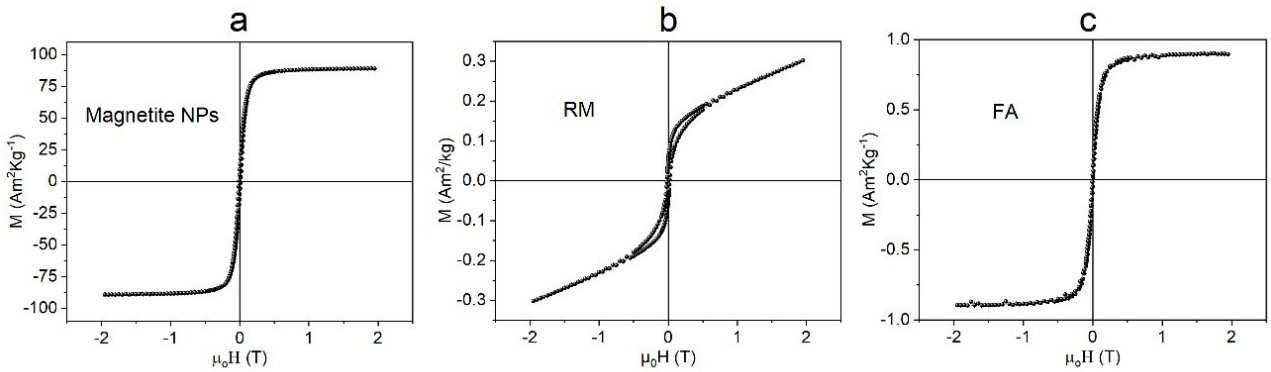


Fig. S1. Field dependence of magnetization recorded at 300K of: [a] magnetite nanoparticles, [b] red mud and [c] fly ash.

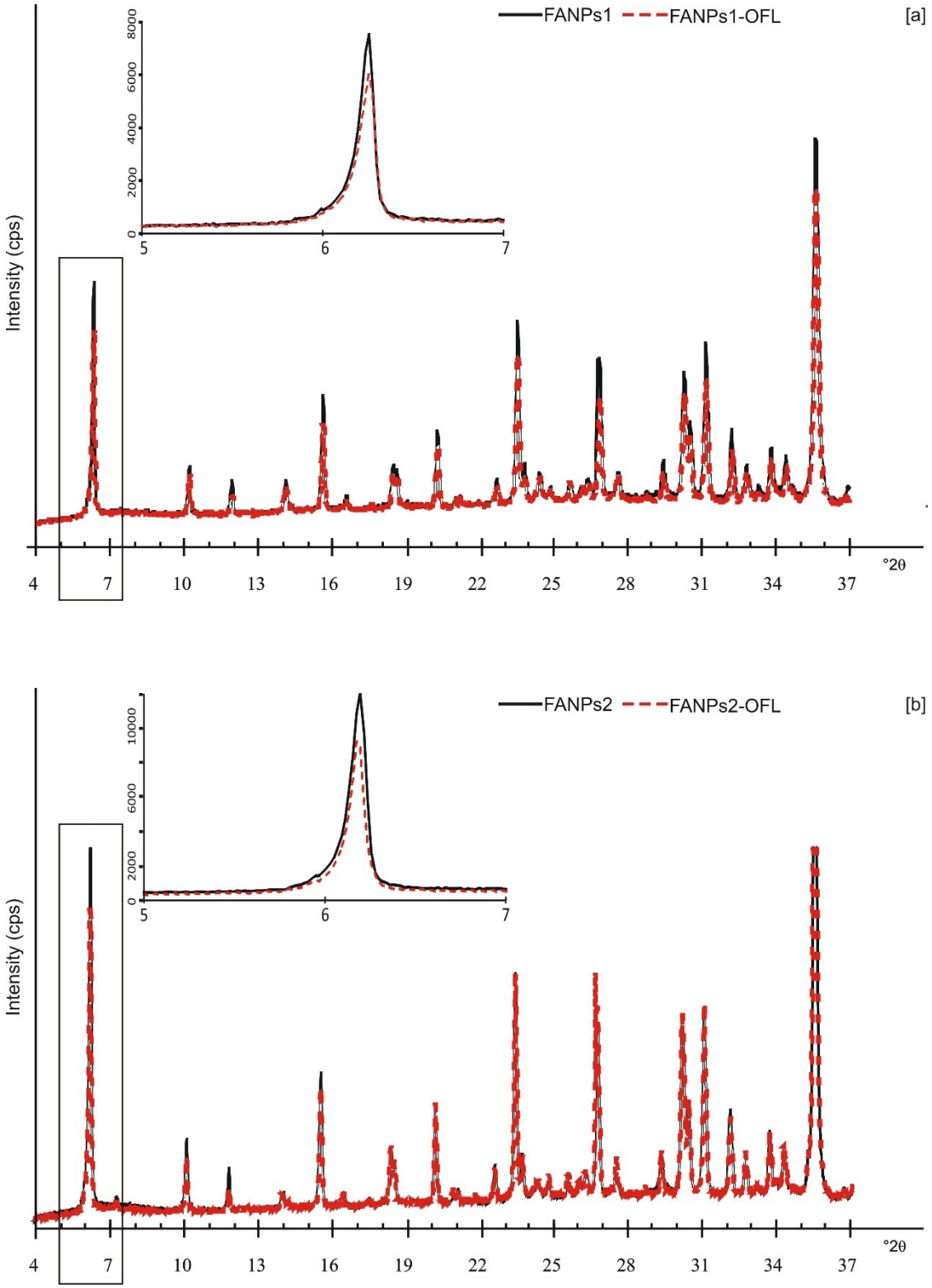


Fig. S2. XRD patterns of: [a] FANPs1 and [b] FANPs1 before and after OFL treatment (1 mg g^{-1})

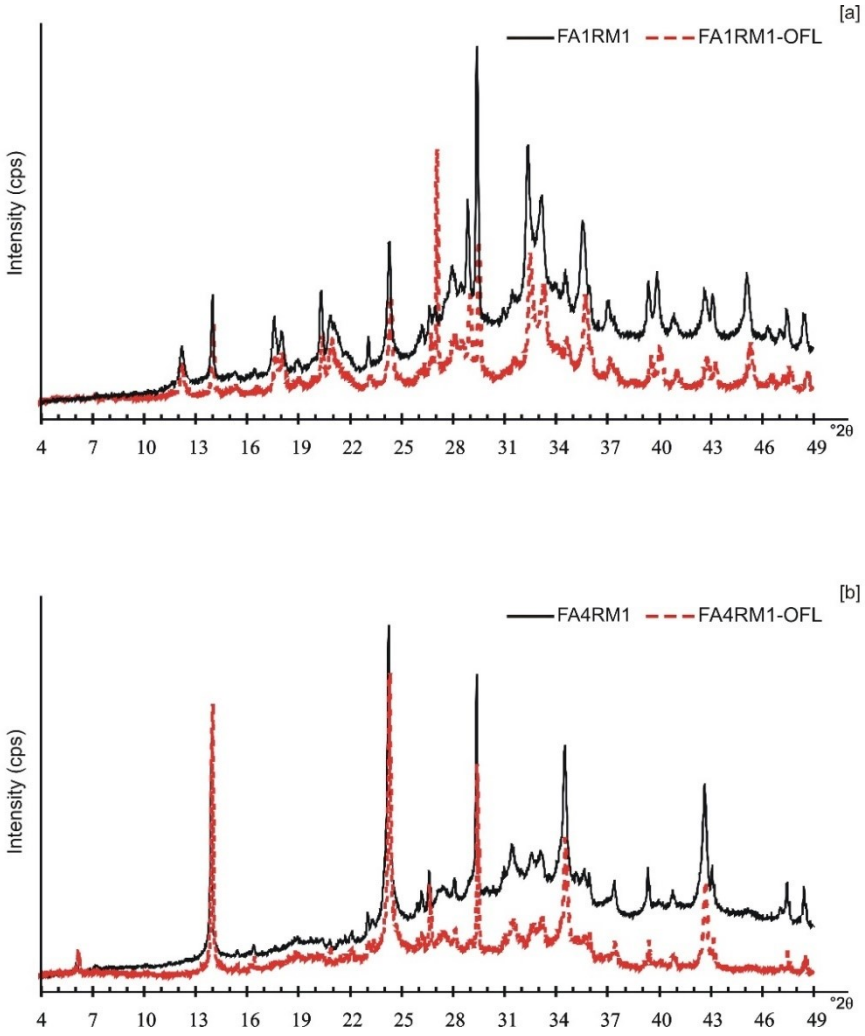
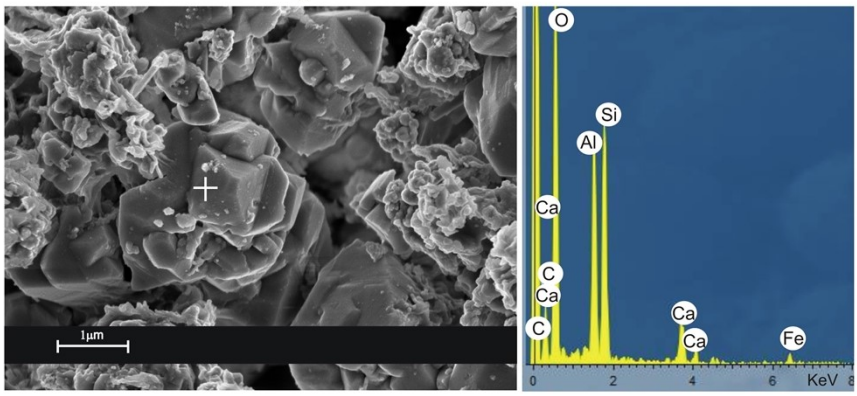


Fig. S3. XRD patterns of: [a] FA1RM1 and [b] FA4RM1 before and after OFL treatment (1 mg g^{-1}) .

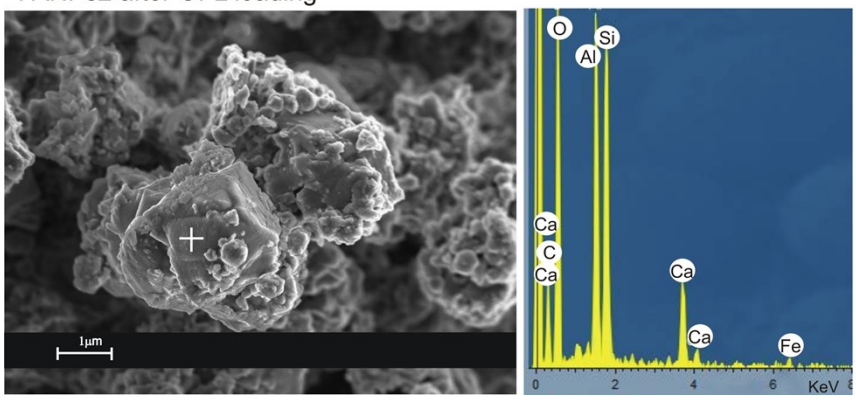
FANPs1 after OFL loading



Element	Weight %
Na	-
Al	16.99
Si	22.79
Ca	8.62
Fe	5.50
O	46.10
*Totals**	*100*

* Normalized

FANPs2 after OFL loading

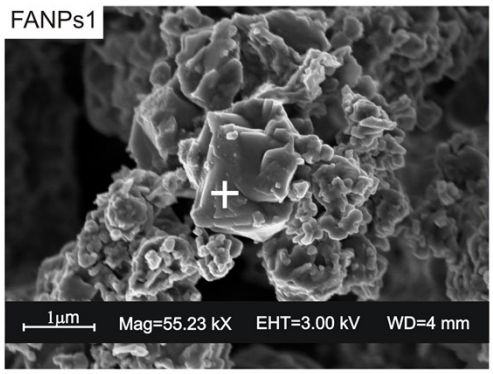


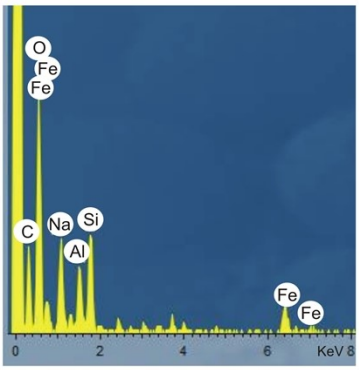
Element	Weight %
Na	1.03
Al	17.63
Si	20.99
Ca	11.24
Fe	3.63
O	45.48
*Totals**	*100*

* Normalized

Fig. S4. SEM images, EDX spectrum and quantitative elemental composition of FANPs samples after OFL loading.

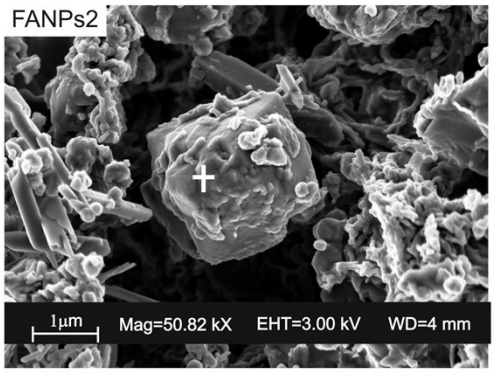
[a]

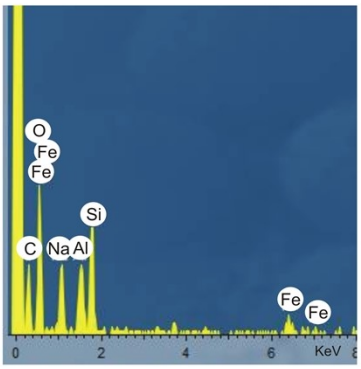




Element	Weight %
Na	16.58
Al	8.13
Si	14.70
Ca	-
Fe	23.97
O	36.62
*Totals**	*100*

* Normalized

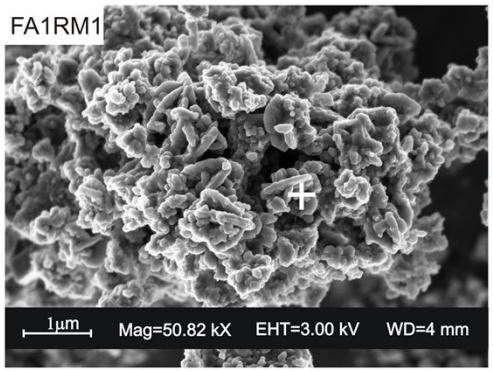


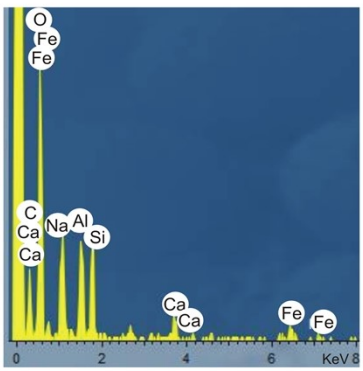


Element	Weight %
Na	15.21
Al	9.59
Si	20.74
Ca	-
Fe	13.21
O	41.24
*Totals**	*100*

* Normalized

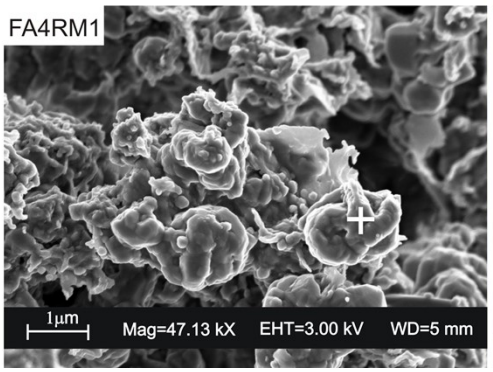
[b]

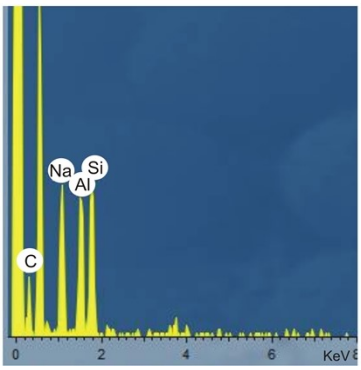




Element	Weight %
Na	16.95
Al	13.70
Si	14.40
Ca	6.53
Fe	8.80
O	39.62
*Totals**	*100*

* Normalized





Element	Weight %
Na	18.54
Al	16.00
Si	20.93
Ca	-
Fe	-
O	44.53
*Totals**	*100*

* Normalized

Fig. S5. SEM images and EDX spectrum of: [a] FANPs1 and FANPs2; [b] FA1RM1 and FA4RM1 samples before OFL loading.

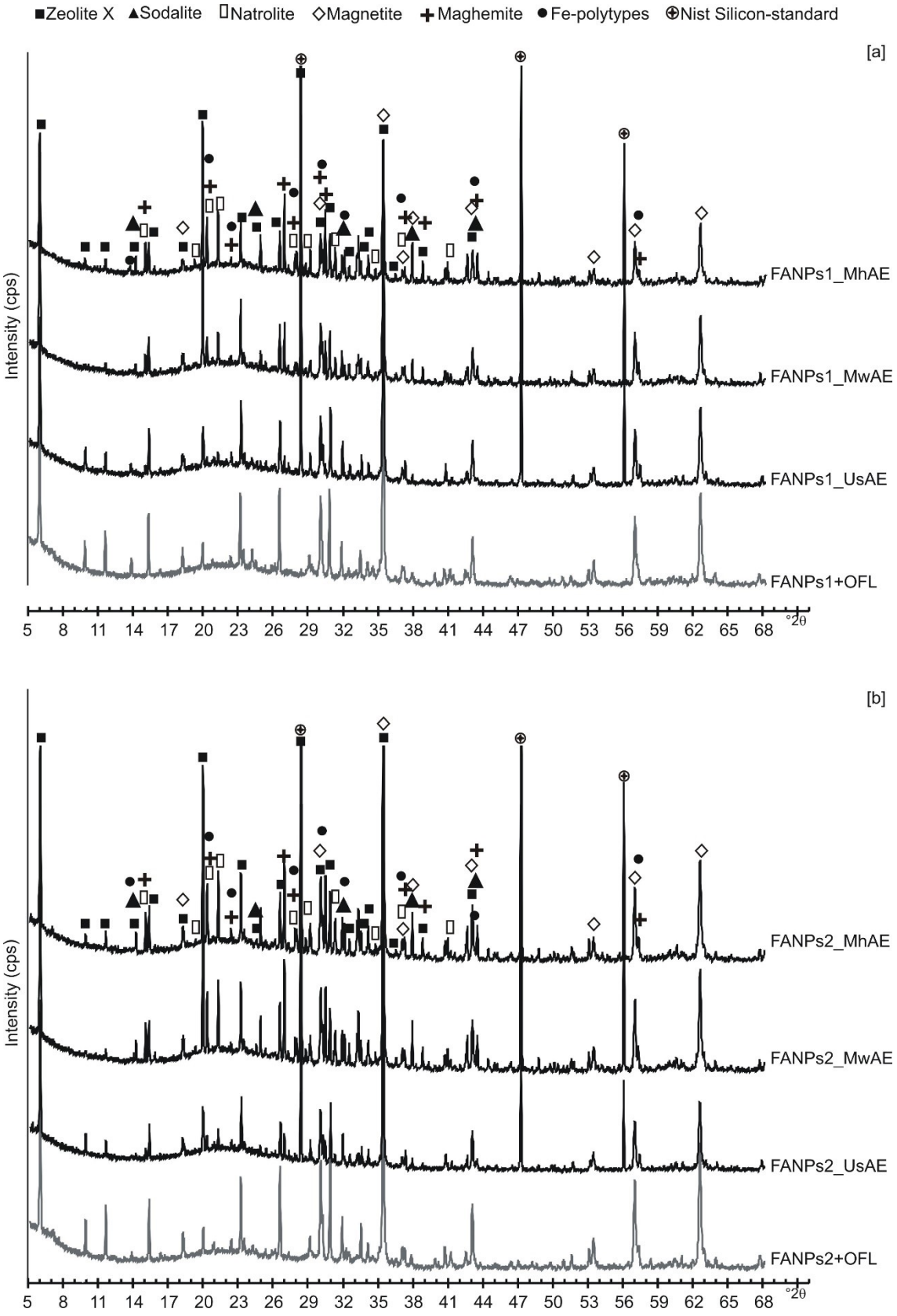


Fig. S6. X-ray profiles of: [a] FANPs1 and [b] FANPs2 plus OFL before and after ultrasonic (UsAE), microwaves (MwAE) and magnetic hyperthermia (MhAE) treatments.

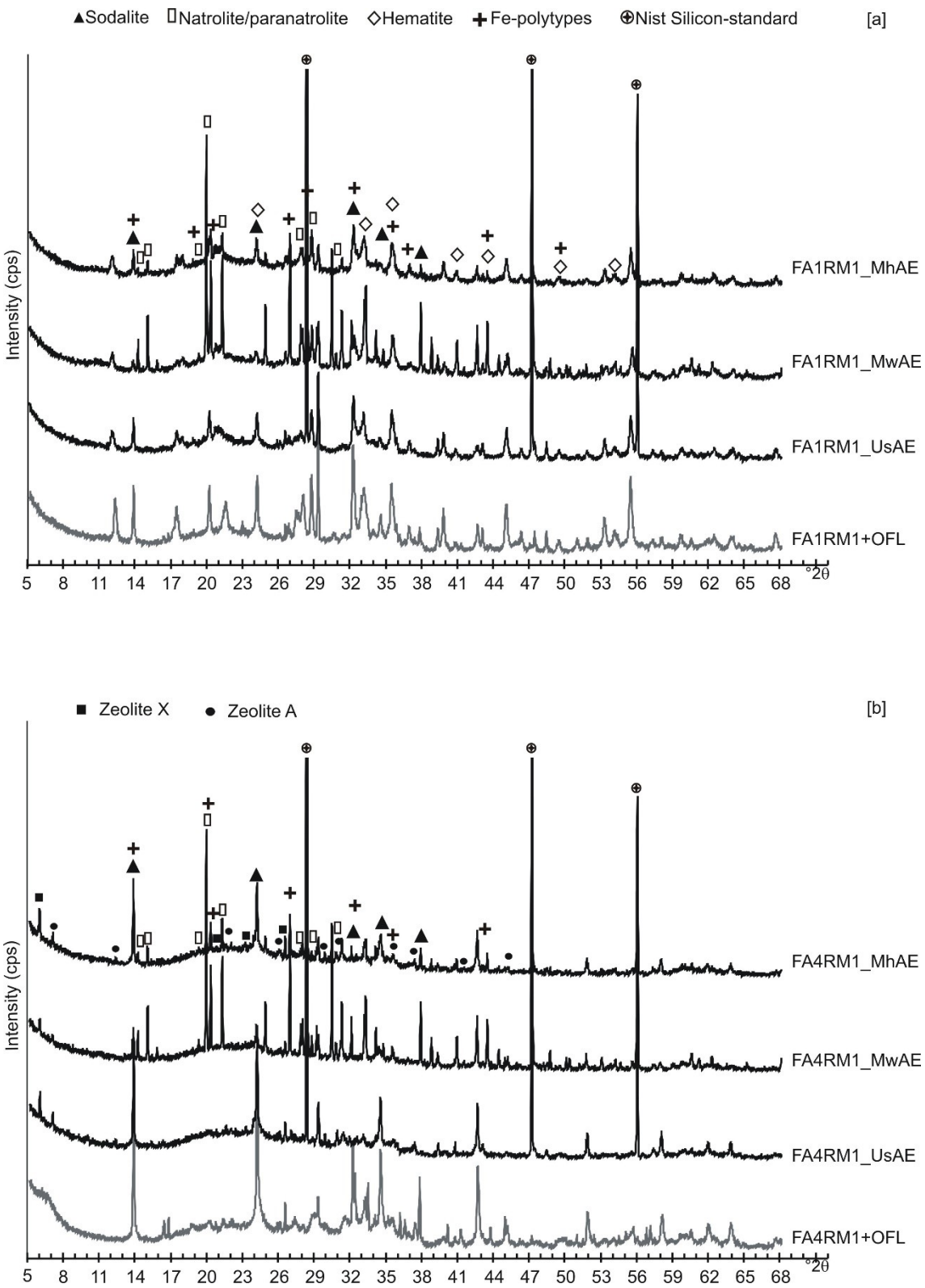


Fig. S7. XRD patterns of: [a] FA1RM1 and [b] FA4RM1 plus OFL and ultrasonic (UsAE), microwaves (MwAE) and magnetic hyperthermia (MhAE) treatments.

Table S1. Chemical composition of fly ash and red mud. Major costituents (wt.%)

Sample	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5
Fly ash	46.8	28.21	5.23	1.49	0.06	1.43	5.57	0.54	1.26	0.78
Red mud	7.89	11.46	36.8	4.82	0.21	0.21	3.53	4.03	0.45	0.09

Table S2. ESI source parameters for ofloxacin and hormones.

ESI source parameters	**ofloxacin**	**hormones**
Drying gas (N_2) temperature	300 °C	350 °C
Drying gas flow	7 L min^{-1}	12 L min^{-1}
Nebulizer	45 psi	50 psi
Sheath gas temperature	350 °C	400 °C
Sheath gas flow	7 L min^{-1}	12 L min^{-1}
Capillary voltage	3500 V positive	4000 V positive 3000 V negative
Nozzle voltage	500 V positive	0 V positive 1500 V negative
Cell accelerated voltage (CAV)	4 V positive	4 V positive 1 V negative

Table S3. MRM conditions for the HPLC-ESI-MS/MS analysis of ofloxacin and hormones.

Analyte	Precursor Ion (m/z)	Product Ion (m/z)	Fragmentor (V)	Collision Energy (V)	Dwell Time (ms)	Polarity
OFL	362	318.1	140	21	75	positive
		261.0		29		
E2	271	183.3	166	50	100	negative
		143.1	166	64	100	
E1	269	145.1	148	44	75	negative
		143.1	148	60	75	
EE2	295	145.1	154	44	100	negative
		143.1	154	68	100	
PROG	315	109	94	24	50	positive
		97	94	20	50	
TST	289	109	76	24	50	positive
		97.1	76	20	50	

Table S4. OFL loading efficiency (LE%). Experimental conditions: 50 mg adsorbent, 10 mL tap water, 10 μg L^{-1}, *n*=4 (standard deviation in parentheses)

Sample	pH	LE%
FANPs1	pH 8-8.3	93(5)
	pH 6.7-7	95(3)
FANPs2	pH 8-8.3	90(5)
	pH 6.7-7	94(4)
FA4RM1	pH 8-8.3	85(8)
	pH 6.7-7	91(6)
FA1RM1	pH 8-8.3	40(11)
	pH 6.7-7	80(9)

Table S5. Framework oxygen bond distances (Å), crystallographic free area (CFA = π·(mean radius)2; Å2), and channel ellipticity (ε = largest/shortest oxygen–oxygen distance). The ionic radius for oxygen atoms is assumed to be 1.35 Å

	FANPs1	FANPs1-OFL	FANPs2	FANPs2-OFL
O1-O1	7.56(3)	7.70(2)	7.43(3)	6.78(2)
O4-O4	7.40(5)	7.36(3)	7.50(3)	7.38(3)
CFA	43.87	44.56	43.95	39.34
ε	1.02	1.05	1.01	1.09

Table S6. Framework atomic coordinates, site occupancy, and atomic displacement parameters, ADPs (U_{iso}* = U_i/U_e*100 [$Å^{-2}$]). Samples FANPs1 and FANPs2.

FANPs1							
Site	**Type**	**Multiplicity**	**x/a**	**y/b**	**z/c**	**Fraction**	**Ui/Ue*100**
T1	Si	96	-0.0467(8)	0.1259(13)	0.0344(10)	1.00	0.61(2)
T2	Al	96	-0.0583(8)	0.0403(11)	0.1244(12)	1.00	0.61(2)
O1	O	96	-0.1109(11)	0.0032(13)	0.0999(15)	1.00	1.53(2)
O2	O	96	-0.0001(10)	0.0078(11)	0.1415(11)	1.00	1.53(2)
O3	O	96	-0.0294(10)	0.0733(12)	0.0713(10)	1.00	1.53(2)
O4	O	96	-0.0721(10)	0.0698(13)	0.1862(12)	1.00	1.53(2)
Na(I)	Na	16	0.0000	0.0000	0.0000	0.42(3)	2.54(2)
Na(II)	Na	32	0.2406(7)	0.2406(7)	0.2406(7)	1.00(4)	3.95(2)
Na(IV)	Na	96	0.0863(16)	0.1005(17)	0.5401(11)	0.62(5)	16.21(2)
Fe(III)	Fe	32	0.0594(10)	0.0594(10)	0.0594(10)	0.33(7)	4.26(2)
W1	O	32	0.1590(13)	0.1590(13)	0.1590(13)	0.65(5)	8.50(2)
W2	O	96	0.0920(24)	0.0462(25)	0.7661(26)	1.00(2)	8.50(2)
W4	O	96	0.0015(27)	0.0346(22)	0.4202(17)	0.90(9)	8.50(2)
W5	O	96	0.0630(31)	0.1572(28)	0.8270(25)	0.85(7)	8.50(2)
W6	O	96	0.9024(15)	0.3488(17)	0.0798(6)	0.20(3)	8.50(2)
W7	O	96	0.6193(11)	-0.0315(11)	0.0259(13)	0.18(4)	8.50(2)

W8	O	32	0.5884(11)	0.0884(11)	0.0884(11)	0.13(4)	8.50(2)

FANPs2

Site	Type	Multiplicity	x/a	y/b	z/c	Fraction	Ui/Ue*100
T1	Si	96	-0.0562(8)	0.1225(9)	0.0390(8)	1.00	0.61(2)
T2	Al	96	-0.0495(6)	0.0328(9)	0.1252(8)	1.00	0.61(2)
O1	O	96	-0.10916)	0.0047(7)	0.1049(8)	1.00	1.53(2)
O2	O	96	0.0022(9)	-0.0065(10)	0.1483(13)	1.00	1.53(2)
O3	O	96	-0.0296(8)	0.0702(9)	0.0708(9)	1.00	1.53(2)
O4	O	96	-0.0708(9)	0.0700(8)	0.1804(8)	1.00	1.53(2)
Na(I)	Na	16	0.0000	0.0000	0.0000	0.80(5)	2.54(2)
Na(II)	Na	32	0.2435(6)	0.2435(6)	0.2435(6)	0.97(4)	3.95(2)
Na(IV)	Na	96	0.0957(15)	0.0842(16)	0.5404(12)	0.60(2)	8.62(2)
Fe(III)	Fe	32	0.0615(9)	0.0616(8)	0.0616(8)	0.31(1)	4.30(2)
W1	O	32	0.1557(14)	0.1557(14)	0.1557(14)	0.77(4)	10.08(2)
W2	O	96	0.0964(14)	0.0493(14)	0.7706(11)	0.85(5)	8.72(2)
W3	O	32	0.6524(13)	0.0977(15)	0.0977(15)	0.10(6)	6.00(2)
W4	O	96	-0.0081(25)	0.0309(16)	0.4214(13)	0.88(4)	12.94(2)
W5	O	96	0.0580(23)	0.1580(21)	0.8288(16)	0.80(6)	15.29(2)
W6	O	96	0.9168(18)	0.3527(17)	0.0744(5)	0.21(3)	6.27(2)
W7	O	96	0.6355(11)	-0.0002(10)	0.0205(10)	0.20(6)	12.64(2)
W8	O	32	0.5937(16)	0.0937(16)	0.0937(16)	0.12(6)	7.23(2)

Table S7. Extra-framework atomic bond distances of FANPs1 and FANps2 samples.

FANPs1		**FANPs2**	
Distance	Value(Å)	Distance	Value(Å)
O1_W5	2.592(28)	O2_Na(II)[x3]	2.406(28)
O2_Na(II)[x3]	2.494(28)	O3_Fe(III)[x3]	2.303(24)
O2_Fe(III) [x3]	2.853(26)	O3_Na(I)[x6]	2.603(26)
O3_Fe(III)[x3]	2.273(30)	O4_Na(II)[x3]	2.959(33)
O3_Na(I)[x6]	2.667(25)	Fe(III)_W1 [x3]	2.633(28)
O4_Na(II)[x3]	2.885(29)	Fe(III)_Na(I)[x2]	2.669(8)
Fe(III)_W1 [x3]	2.741(14)	Na(II)_W2[x3]	2.950(6)
Fe(III)_Na(I)[x2]	2.578(4)	Na(II)_W7[x3]	3.104(28)
Na(II)_W2[x3]	2.902(22)	Na(IV)_W2	2.278(6)
Na(IV)_W2	2.657(33)	Na(IV)_W3	2.828(40)
Na(IV)_W5	2.998(25)	Na(IV)_W4	2.646(5)
Na(IV)_W7	2.395(29)	Na(IV)_W5	3.135(7)
Na(IV)_W8 [X3]	2.714(27)	Na(IV)_W7	2.496(24)
Na(IV)_Na(IV)	1.938(6)	Na(IV)_W8[X3]	2.705(33)
W2_W4	2.343(7)	W1_W1[x3]	2.170(10)
W2_W6	2.076(25)	W2_W4	2.158(26)
W2_W7	2.419(6)	W4_W7	2.253(9)
W4_W5	2.122(22)	W6_W6	2.372(9)
W4_W7	2.516(9)	W8_W8	2.212(6)
W5_W6	2.247(8)		
W6_W7	2.306(8)		
W8_W8	2.596(12)		

Table S8. OFL UsAE recovery (R%). Experimental conditions: 20 mg adsorbent, 10 mL tap water, 10 μg L^{-1}, *n*=3 (standard deviation in parentheses)

Sample	time (min)	R_UsAE%
FANPs1_UsAE	20	49(2)
	30	47(1)
	10	48(2)
FANPs2_UsAE	20	51(1)
	30	50(2)
	10	50(1)
FA4RM1_UsAE	20	46(9)
	30	48(8)
	10	47(10)
FA1RM1_UsAE	30	48(9)
	20	47(8)
	10	49(7)

Table 9. OFL MwAE recovery (R%). Experimental conditions: 20 mg adsorbent, 10 mL tap water, 10 μg L^{-1}, *n=3* (standard deviation in parentheses)

Sample	Temperature (°C)	R_MwAE%
FANPs1_MwAE	60	54(2)
	120	71(2)
FANPs2_MwAE	60	57(2)
	120	102(3)
FA4RM1_MwAE	60	57(5)
	120	88(8)
FA1RM1_MwAE	60	53(4)
	120	71(2)

Table S10. OFL MhAE recovery (R%). Experimental conditions: 20 mg adsorbent, 10 mL tap water, 10 μg L^{-1}, *n*=3 (standard deviation in parentheses)

Sample	time (min)	R_MhAE%
FANPs1_MhAE	7	37(2)
	15	37(6)
FANPs2_MhAE	7	52(6)
	15	52(5)
FA4RM1_MhAE	7	62(5)
	15	58(1)
FA1RM1_MhAE	7	60(19)
	15	57(14)

Table S11. Crystallite size (Å).

Samples	Crystallite size (Å)
FANPs1	1502.7
FANPs1_UsAE	1603.4
FANPs1_MwAE	1549.3
FANPs1_MhAE	1589.9
FANPs2	1551.2
FANPs2_UsAE	1743.8
FANPs2_MwAE	1614.4
FANPs2_MhAE	1488.4
FA1RM1	1613.2
FA1RM1_UsAE	2054.7
FA1RM1_MwAE	1884.9
FA1RM1-C.M.	2097.1
FA4RM1	1185.9
FA4RM1_UsAE	2089.2
FA4RM1_MwAE	1981.0
FA4RM1-C.M.	2040.9

Table S12. Unit cell parameters.

Zeolite X	**a (Å)**	**V (A^3)**
FANPs1	25.056(1)	15729.4(1)
FANPs1-OFL	25.037(1)	15694.5(1)
FANPs1_UsAE	24.984(1)	15595.6(3)
FANPs1_MwAE	25.030(4)	15682.7(1)
FANPs1_MhAE	25.007(7)	15638.5(7)
FANPs2	25.023(1)	15667.8(1)
FANPs2-OFL	25.007(1)	15638.3(1)
FANPs2_UsAE	24.971(2)	15569.8(2)
FANPs2_MwAE	25.027(4)	15676.1(4)
FANPs2_MhAE	25.019(4)	15660.0(4)

Table S13. Framework atomic bond distances and angles.

	FANPs1	**FANPs2**
Distance		Value (Å)
T1-O1	1.670(27)	1.700(29)
T1-O2	1.668(31)	1.678(30)
T1-O3	1.700(8)	1.670(8)
T1-O4	1.700(9)	1.670(10)
Av.	1.670	1.672
Angle		Value (Å)
T2-O1	1.725(8)	1.725(1)
T2-O2	1.725(8)	1.725(1)
T2-O3	1.725(8)	1.725(1)
T2-O4	1.725(8)	1.725(1)
Av.	1.725	1.725
T1-O1-*T2*	139.4(2)	130.1(2)
T1-O2-*T2*	140.2(2)	134.8(2)
T1-O3-*T2*	134.1(2)	133.3(2)
T1-O4-*T2*	131.3(2)	139.0(2)
Av.	136.2	134.5

Table S14. Elemental composition (weight %) by EDX analysis of all the samples after the treatments.

Sample	Na	Mg	Al	Si	Ca	Fe	O	Total*
FANPs1 - MhAE	0.87 (±0.91)	5.82 (±1.02)	9.52 (±1.22)	16.90 (±1.45)	4.50 (±0.94)	22.35 (±2.62)	40.05 (±2.36)	100
FANPs1 - MwAE	0.54 (±1.08)	18.33 (±1.78)	7.07 (±1.27)	11.38 (±1.37)	1.79 (±0.78)	22.27 (±2.82)	38.61 (±2.60)	100
FANPs1 - UsAE	2.70 (±1.00)	7.50 (±1.19)	13.20 (±1.33)	19.03 (±1.66)	6.27 (±1.12)	7.40 (±1.97)	43.91 (±2.29)	100
FANPs2 - MhAE	1.74 (±0.89)	8.22 (±1.18)	15.56 (±1.40)	19.58 (±1.60)	4.21 (±0.99)	5.32 (±1.80)	45.37 (±2.201)	100
FANPs2 - MwAE	1.29 (±0.75)	4.59 (±0.85)	15.43 (±1.18)	19.75 (±1.36)	4.70 (±0.84)	9.84 (±1.82)	44.39 (±1.92)	100
FANPs2 - UsAE	3.44 (±0.99)	6.01 (±1.03)	15.00 (±1.34)	17.98 (±1.51)	6.43 (±0.96)	7.45 (±1.78)	43.68 (±2.11)	100
FA1RM1 - MhAE	3.43 (±1.06)	10.14 (±1.24)	14.69 (±1.38)	16.35 (±1.52)	8.26 (±1.19)	3.32 (±1.67)	43.81 (±2.19)	100
FA1RM1 - MwAE	0.88 (±1.09)	22.75 (±2.04)	12.01 (±1.69)	12.84 (±1.77)	5.98 (±1.31)	2.01 (±2.09)	43.54 (±2.74)	100
FA1RM1 - UsAE	4.29 (±1.13)	5.21 (±1.16)	13.45 (±1.42)	15.57 (±1.59)	8.69 (±1.41)	11.42 (±2.53)	41.37 (±2.50)	100
FA4RM1 - MhAE	7.07 (±1.37)	11.46 (±1.39)	15.02 (±1.54)	18.80 (±1.70)	2.05 (±1.01)	-	45.60 (±2.25)	100
FA4RM1 - MwAE	6.18 (±1.29)	11.75 (±1.50)	16.20 (±1.59)	17.23 (±1.73)	3.38 (±1.11)	-	45.27 (±2.31)	100
FA4RM1 - UsAE	5.07 (±1.28)	4.50 (±1.12)	14.51 (±1.57)	22.38 (±1.84)	7.43 (±1.39)	-	46,10 (±2.32)	100

*Normalized

Table S15. Batch-to-batch reproducibility: OFL recovery (R%) by UsAE, MwAE, MhAE. Experimental conditions: 20 mg adsorbent, 10 mL tap water, 10 μg L^{-1}, *n*=3 (standard deviation in parentheses).

	R%_UsAE		**R%_MwAE**		**R%_MhAE**	
Sample	batch 1	batch 2	batch 1	batch 2	batch 1	batch 2
FANPs1	48(2)	41(5)	71(2)	77(7)	37(6)	44(8)
FA4RM1	47(7)	39(5)	88(8)	86(8)	58(1)	50(8)