

Supporting Information

Phase Equilibria and Phase Diagrams of Mn^{2+} , Mg^{2+} , $\text{NH}_4^+/\text{SO}_4^{2-}$ - H_2O system at 298.15, 323.15 and 373.15 K

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Supplementary Tables, Figures and Captions:

Table S1 Raw materials scheme for the phase equilibrium experiments at 298.15 K

298 K	MgSO ₄ •7H ₂ O	MnSO ₄ •H ₂ O	(NH ₄) ₂ SO ₄	Water
	g	g	g	g
A(1-8)	503.65	0.00 48.23 51.44 56.55 74.35 101.72 215.29 322.52	39.84	297.52
C(1-6)	0.00 122.81 225.47 329.31 423.61 522.92	447.46	49.71	505.03
D(1-5)	0.00 49.49 155.61 255.62 357.56	80.06	375.82	371.40
E(1-9)	207.29	329.84	0.00 14.00 96.57 133.38 164.50 208.82 245.40 271.75 313.31	462.87

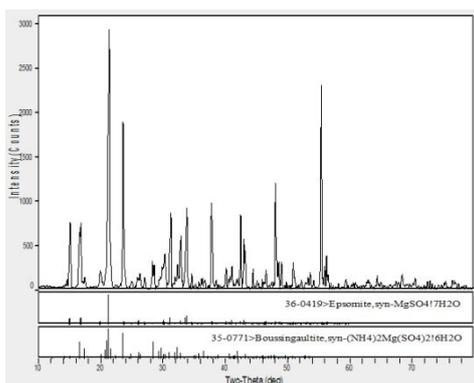
Table S2 Raw materials scheme for the phase equilibrium experiments at 323.15 K

323 K	MgSO ₄ •7H ₂ O	MnSO ₄ •H ₂ O	(NH ₄) ₂ SO ₄	Water
	g	g	g	g
A(1-5)	715.34	0.00 35.00 70.85 103.63 142.35	41.99	242.93

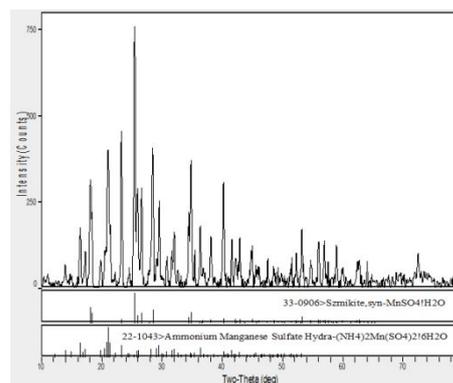
	0.00	62.29			
C(1-8)	122.29	192.29			
	282.29	392.29	401.96	41.99	391.24
	502.29	502.29			
	0.00	40.00			
D(1-13)	213.42	300.00			
	417.35	480.00			
	627.69	820.00	58.97	268.18	263.99
	833.07	1051.78			
	1150.00	1600.00			
	2600.00				

Table S3 Raw materials scheme for the phase equilibrium experiments at 373.15 K

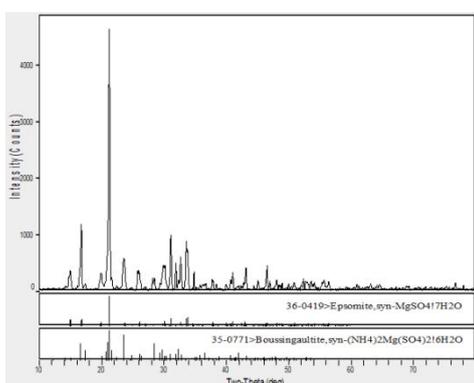
373 K	MgSO ₄ •7H ₂ O	MnSO ₄ •H ₂ O		(NH ₄) ₂ SO ₄	Water
	g	g	g	g	g
		0.00	35.28		
A(1-5)	587.68	97.67	153.23	67.18	364.64
		210.00			
B	137.12	0.00	66.98	333.05	205.90
		151.33	241.88		
C(1-8)		0.00	80.27		
	298.93	163.25	241.45	42.2	325.54
		321.95	421.22		
		547.01	703.99		
D(1-8)	0.00	72.81			
	169.06	290.15			
	393.84	592.65	31.73	277.5	225.07
	847.79	1057.11			



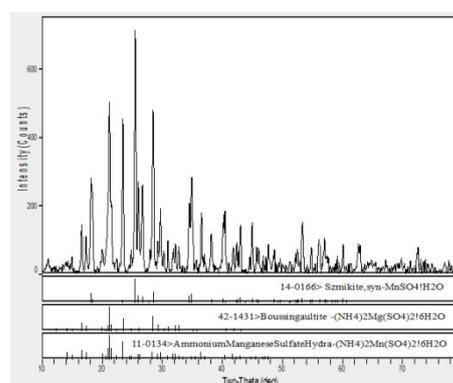
(a) $S_1 + S_5$ at A_2



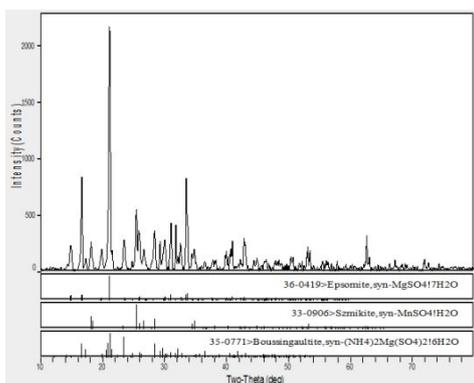
(a) $S_2 + S_4$ at C_2



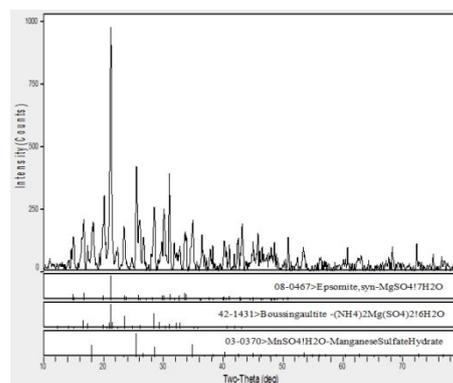
(b) $S_1 + S_5$ at A_4



(b) $S_2 + S_4 + S_5$ at C_3



(c) $S_1 + S_5 + S_2$ at A_8



(c) $S_1 + S_2 + S_5$ at C_5

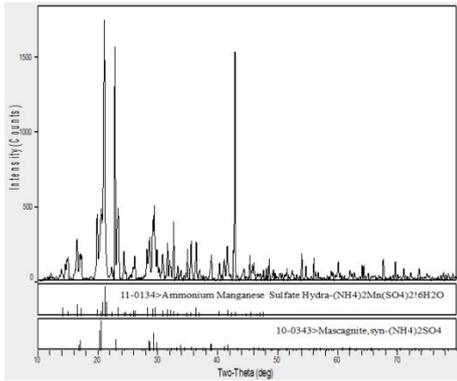
Figure S1 XRD pattern of solid phase at typical points of A_2 A_4 A_8 at 298.15 K

S_1 : $MgSO_4 \cdot 7H_2O$, S_2 : $MnSO_4 \cdot H_2O$,
 S_5 : $MgSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

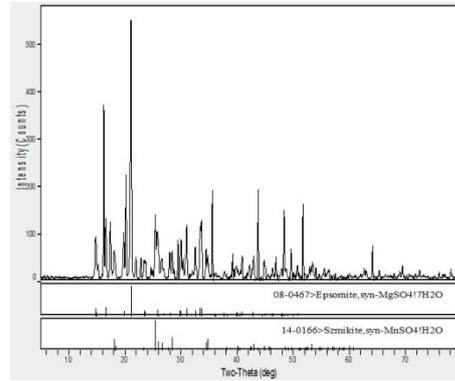
Figure S2 XRD pattern of solid phase at typical points C_2 C_3 C_5 at 298.15 K

S_2 : $MnSO_4 \cdot H_2O$, S_4 : $MnSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$, S_5 : $MgSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

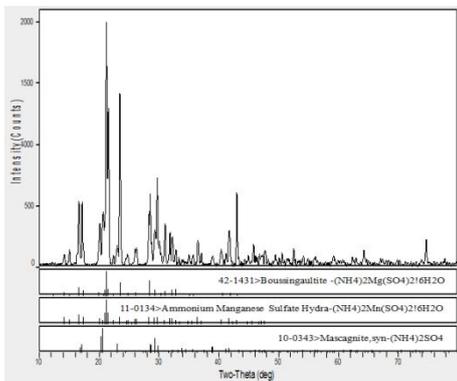
S₂: MnSO₄•H₂O, S₄: MnSO₄•
(NH₄)₂SO₄•6H₂O, S₅: MgSO₄•
(NH₄)₂SO₄•6H₂O



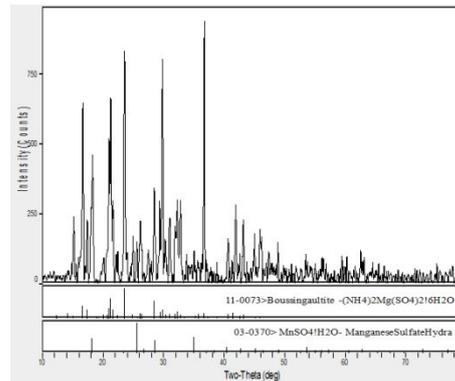
(a) S₃+S₄ at D₁



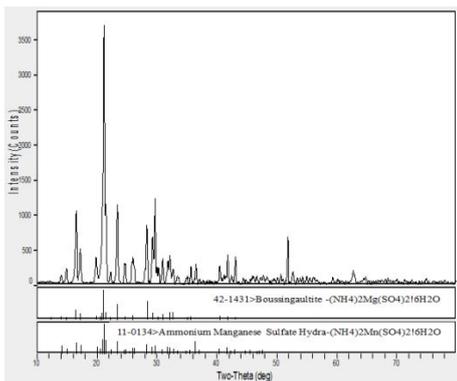
(a) S₁+S₂ at E₂



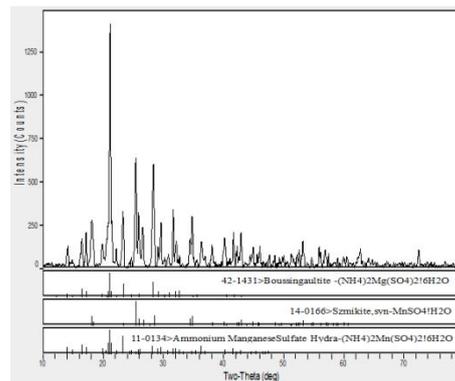
(b) S₃+S₄ at D₂



(b) S₂+S₅ at E₃



(c) S₃ +S₄ +S₅ at D₅



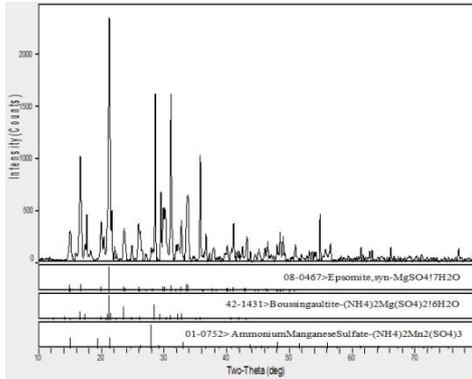
(c) S₂+S₄+S₅ at E₄

Figure S3 XRD pattern of solid phase at typical points D₁, D₂ and D₃ at 298.15 K

Figure S4 XRD pattern of solid phase at

typical points E₂, E₃ and E₄ at 298.15 K

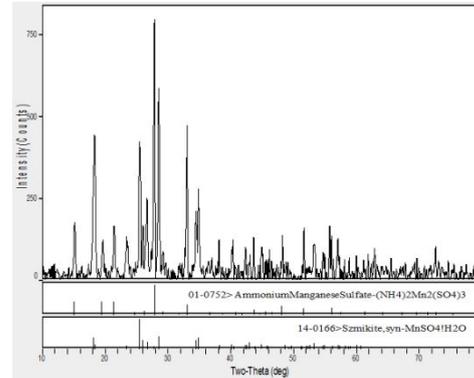
S₂: MnSO₄•H₂O, S₄: MnSO₄•
(NH₄)₂SO₄•6H₂O, S₅:MgSO₄•
(NH₄)₂SO₄•6H₂O



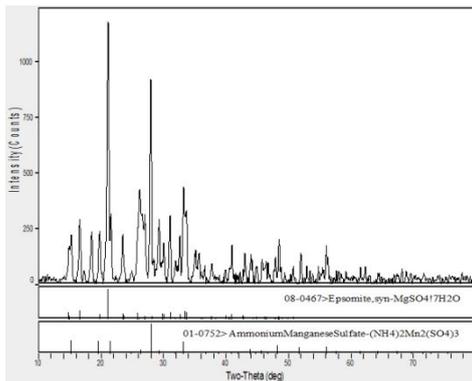
(a) S₁+S₅+S₆ at A₂

typical points A₂, A₃ and A₅ at 323.15 K

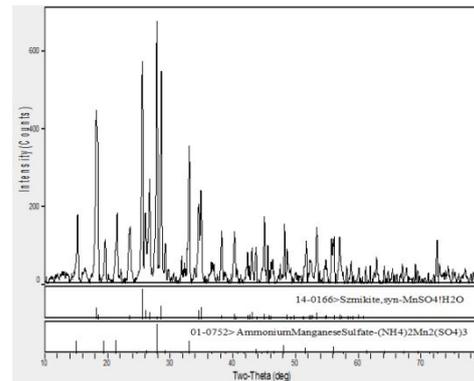
S₁:MgSO₄•7H₂O, S₂: MnSO₄•H₂O,
S₅: gSO₄•(NH₄)₂SO₄•6H₂O, S₆: 2MnSO₄•
(NH₄)₂SO₄



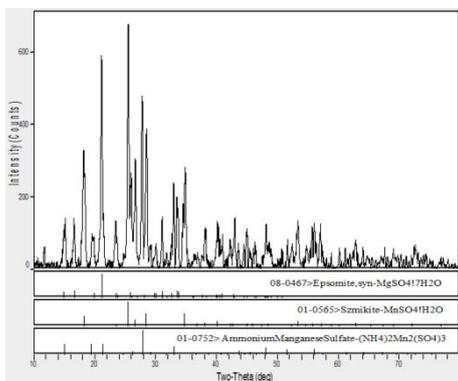
(a) S₂+S₆ at C₂



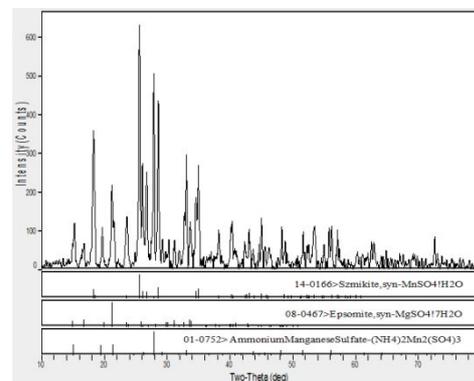
(b) S₁+S₆ at A₃



(b) S₂+S₆ at C₄



(c) S₁+S₆+S₂ at A₅



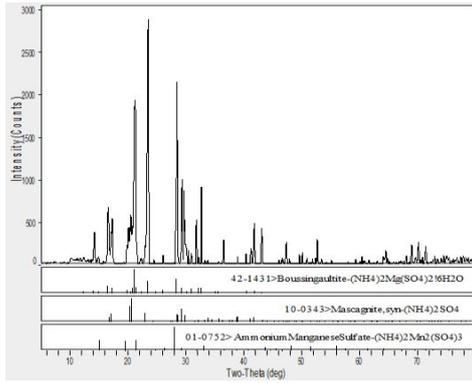
(c) S₁+S₂+S₆ at C₇

Figure S5 XRD pattern of solid phase at

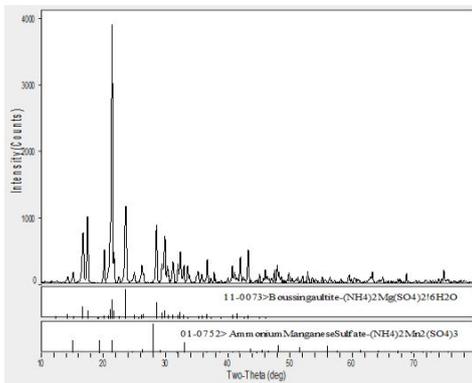
Figure S6 XRD pattern of C series solid
phase sample at 323.15 K

S₁: MgSO₄•7H₂O, S₂: MnSO₄•H₂O,

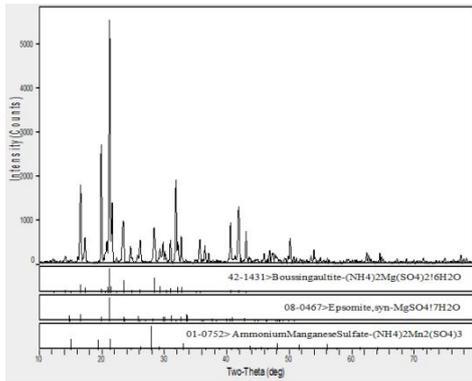
S₆: 2MnSO₄•(NH₄)₂SO₄



(a) $S_3+S_5+S_6$ at D_2



(b) S_5+S_6 at D_9



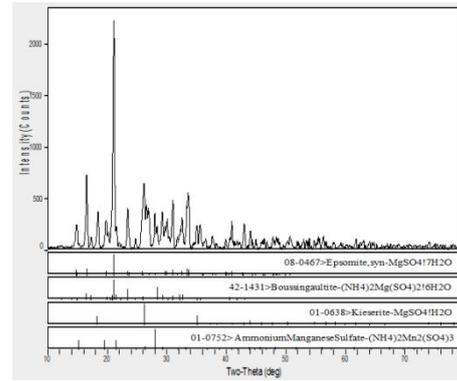
(c) $S_5+S_6+S_1$ at D_{12}

Figure S7 XRD pattern of D series solid phase sample at 323.15 K

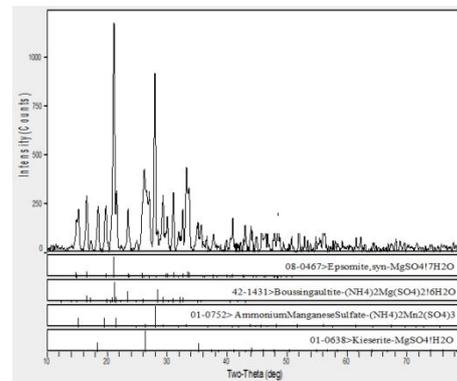
S_1 : $MgSO_4 \cdot 7H_2O$; S_3 $(NH_4)_2SO_4$,

S_5 : $MgSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

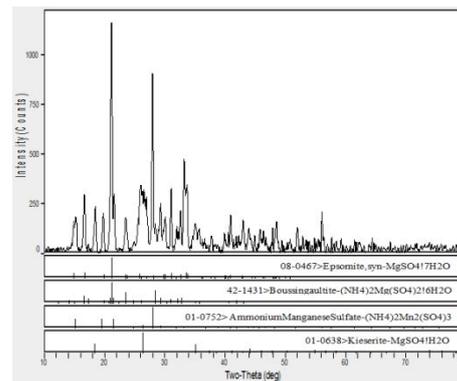
S_6 : $2MnSO_4 \cdot (NH_4)_2SO_4$



(a) S_5+S_7 at A_2



(b) $S_5+S_6+S_7$ at A_3

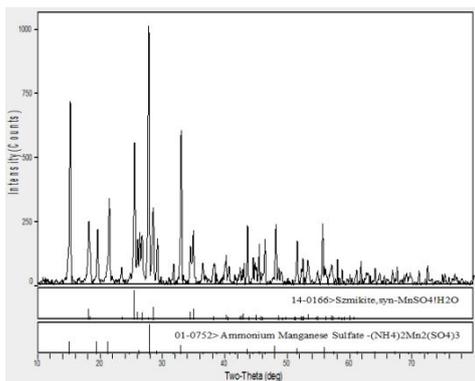


(c) $S_2+S_6+S_7$ at A_4

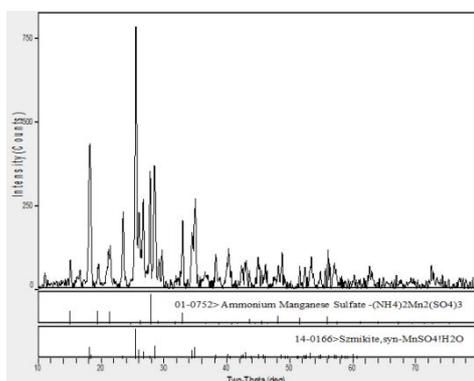
Figure S8 XRD pattern of A series solid phase sample at 373.15 K

S_2 : $MnSO_4 \cdot H_2O$, S_5 : $MgSO_4 \cdot$

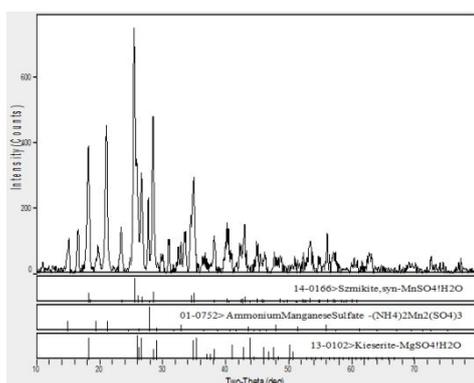
$(NH_4)_2SO_4 \cdot 6H_2O$, S_6 : $2MnSO_4 \cdot (NH_4)_2SO_4$, S_7 :



(a) S_2+S_6 at C_2



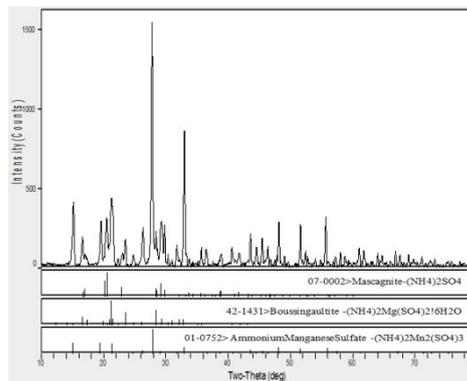
(b) S_2+S_6 at C_4



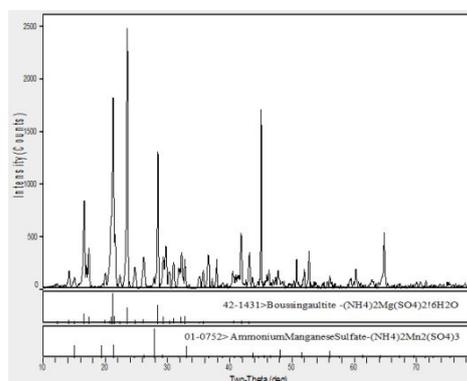
(c) $S_2+S_6+S_7$ at C_6

Figure S9 XRD pattern of C series solid phase sample at 373.15 K

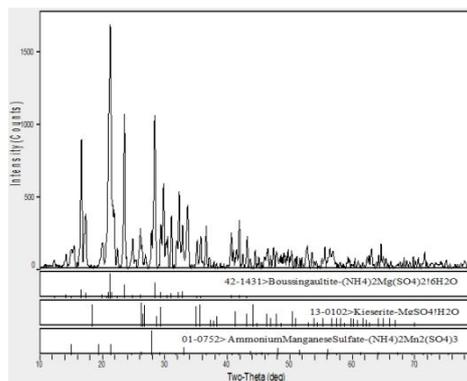
S_2 : $MnSO_4 \cdot H_2O$, S_4 : $MnSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$, S_6 : $2MnSO_4 \cdot (NH_4)_2SO_4$



(a) $S_3+S_5+S_6$ at D_2



(b) S_5+S_6 at D_4



(c) $S_5+S_6+S_7$ at D_7

Figure S10 XRD pattern of D series solid phase sample at 373.15 K

S_3 : $(NH_4)_2SO_4$, S_5 : $MgSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$,

S_6 : $2MnSO_4 \cdot (NH_4)_2SO_4$, S_7 : $MgSO_4 \cdot H_2O$

