

Supplementary Material

Table S1. The final concentrations of Mg^{2+} , NH_4^+ , PO_4^{3-} , and Ca^{2+} , pertaining to all batch tests in Table 2, along with the associated initial NH_4^+ concentration values. The results are the averages of three replicate experiments \pm one standard deviation.

Exp. No.	$\text{Mg}^{2+}:\text{NH}_4^+:\text{PO}_4^{3-}$ Molar Ratios	Mg^{2+} Source	$\text{Ca}^{2+}:\text{Mg}^{2+}$ Molar Ratio	Ca^{2+} Source	pH	Initial NH_4^+ (mg/L)	Final NH_4^+ (mg/L)	Final PO_4^{3-} (mg/L)	Final Mg^{2+} (mg/L)	Final Ca^{2+} (mg/L)
1	1:1:1	MgCl_2	0	-	9.5	4050	753.3 \pm 93.4	4033 \pm 351	2.6 \pm 2.2	22 \pm 6.9
2	1.25:1:1	MgCl_2	0	-	9.5	4050	320 \pm 52.9	58.7 \pm 10.1	250.7 \pm 75.1	57 \pm 8.5
3	1:1:1.25	MgCl_2	0	-	9.5	4050	690 \pm 99	7600 \pm 519	3.9 \pm 0.7	31 \pm 10.6
4	1.25:1:1.25	MgCl_2	0	-	9.5	4050	130 \pm 21.8	2846.7 \pm 223	6.1 \pm 1.4	33.4 \pm 8.2
5	1.25:1:1.25	MgCl_2	0	-	8.5	4050	93.3 \pm 17.5	3600 \pm 52.3	26.3 \pm 3.8	49.6 \pm 7.8
6	1.25:1:1.25	MgCl_2	0	-	10.5	4250	567 \pm 0	2833 \pm 181.5	4.4 \pm 1.7	28.5 \pm 1.9
7	1.25:1:1.25	MgCl_2	0.1	CaCl_2	9.5	3200	107 \pm 59.6	703.3 \pm 314.7	42.4 \pm 16.7	205.8 \pm 30.5
8	1.25:1:1.25	MgCl_2	0.2	CaCl_2	9.5	3200	145 \pm 36.3	148.7 \pm 39.9	51 \pm 7.2	175.3 \pm 17.8
9	1.25:1:1.25	MgCl_2	0.5	CaCl_2	9.5	4050	290 \pm 31	111 \pm 17.8	41.2 \pm 10.5	40.3 \pm 15.9
10	1.25:1:1.25	MgCl_2	1	CaCl_2	9.5	4250	1214 \pm 0	6.3 \pm 2.73	321.5 \pm 25.6	35.5 \pm 13.2
11	1.25:1:1.25	$\text{CaMg}(\text{CO}_3)_2$	1	$\text{CaMg}(\text{CO}_3)_2$	9.5	3744	3263 \pm 313.1	23475 \pm 1900	1.8 \pm 0.2	61.3 \pm 4.1
12	1.25:1:1.25	MgO	1	CaCO_3	9.5	3744	2351.4 \pm 156	8409.6 \pm 280	36 \pm 0	0
13	1.25:1:1.25	MgO	1	CaO	9.5	3744	1720.3 \pm 175.5	10633.3 \pm 152	0.2 \pm 0.06	38.3 \pm 7.2

Calcination of dolomite

Raw dolomite was subjected to two calcination procedures to increase magnesium activity: CO₂-calcination and air-calcination.

CO₂ – calcination

Raw dolomite was placed in a muffle furnace where the temperature was ramped up to 750°C under a heating rate of 6 °C/min then held for 2 hours. The heating was conducted under a continuous carbon dioxide (CO₂) flow of 100 L/hr. The dolomite was then allowed to cool to room temperature and was used as is without further treatment.

Air – calcination

Raw dolomite was placed in a muffle furnace where temperature was ramped to 950°C under a heating rate of 6 °C/min then held for 2 hours under normal atmospheric conditions. The dolomite was then allowed to cool to room temperature and was used as is without further treatment.

XRPD characterization of calcined dolomite

The X-Ray diffraction analysis of raw dolomite clearly detected the characteristic peaks corresponding to dolomite MgCa(CO₃)₂ at 30.938°, 41.127° and 56.477° (PDF 00-036-0426) (Figure S1). Calcination under CO₂ atmosphere and 750°C resulted in the formation of periclase (MgO) and calcite (CaCO₃) as evidenced by their characteristic peaks at 42.855°, 62.215° (PDF 01-071-1176) and 23.07°, 29.454°, 48.578° (PDF 00-024-0027), respectively. The obtained XRPD patterns of dolomite and CO₂-calcined dolomite are consistent with those obtained by other researchers. The calcination under normal atmosphere and a temperature of 950°C is expected to result in the formation of periclase and lime (CaO). The peaks of both of these solid phases were detected by XRPD with characteristic peaks at 42.855°, 62.215° (PDF 01-071-1176) and 32.171°, 37.318°, 53.803° (PDF 01-070-5490), respectively. However, characteristic peaks corresponding to portlandite Ca(OH)₂ at 17.98° and 47.04° (PDF 00-001-1079), were also detected which indicates that this phase is present in the calcined sample. Portlandite is the product of lime hydration. It appears that the calcined sample absorbed moisture from the atmosphere, which led to the partial hydration of lime resulting from the calcination process.

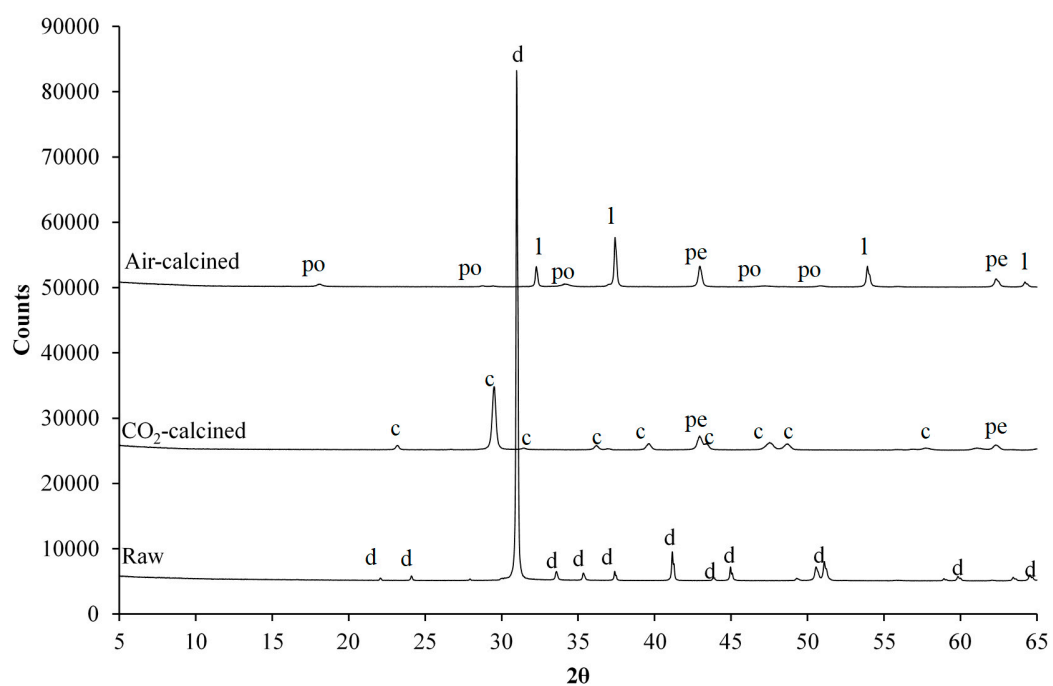


Figure S1: X-Ray Diffractograms of the products of the different dolomite thermal pretreatment processes. d = dolomite $\text{MgCa}(\text{CO}_3)_2$; c = calcite CaCO_3 ; pe = periclase; MgO ; l = lime CaO ; po = portlandite $\text{Ca}(\text{OH})_2$

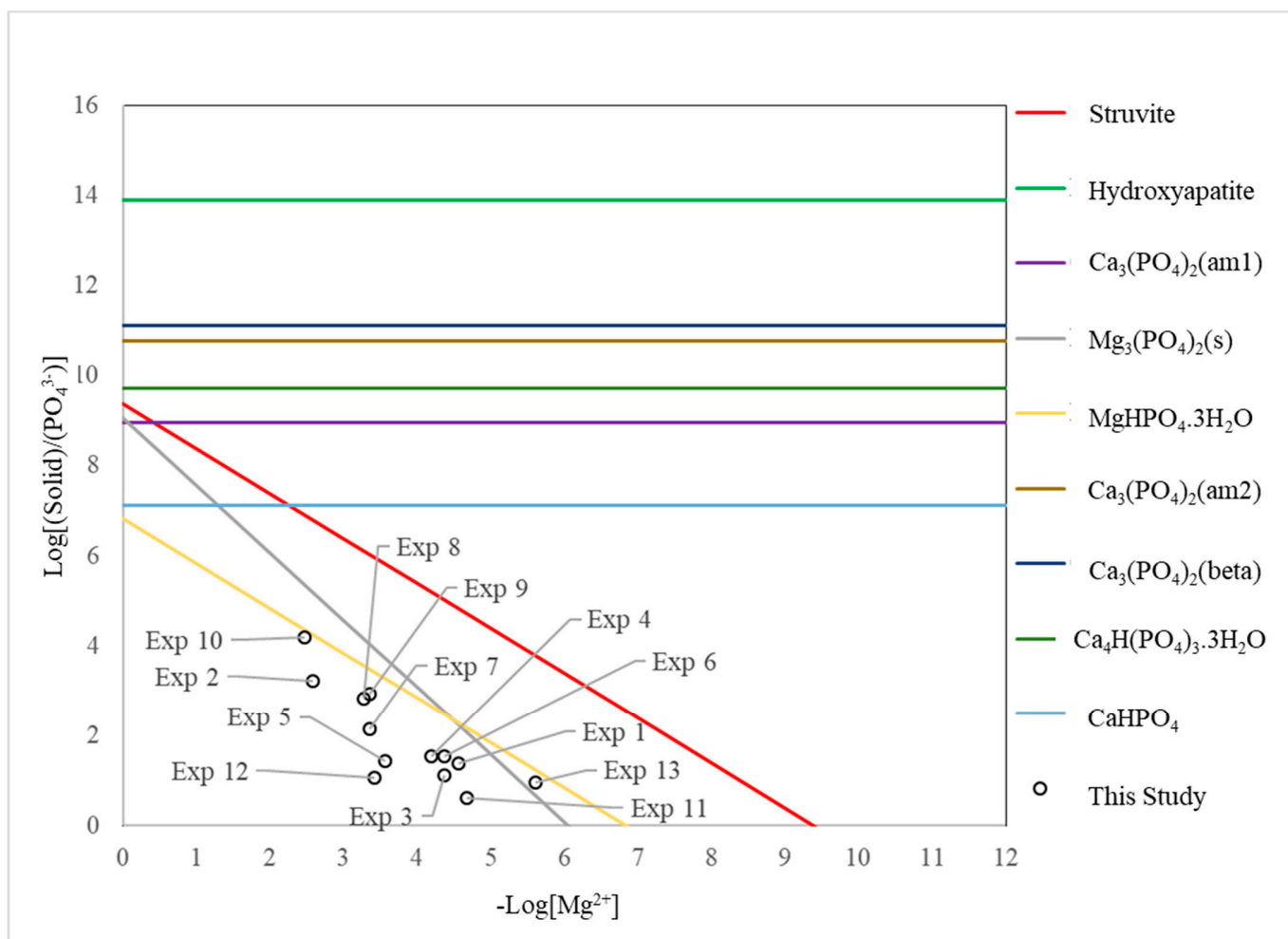


Figure S2. Activity ratio diagram for PO_4^{3-} solid phases vs Mg^{2+} . $\text{pH} = 9.5$, $\text{NH}_4^+ = 0.0527 \text{ M}$, $\text{Ca}^{2+} = 0.2 \text{ M}$.

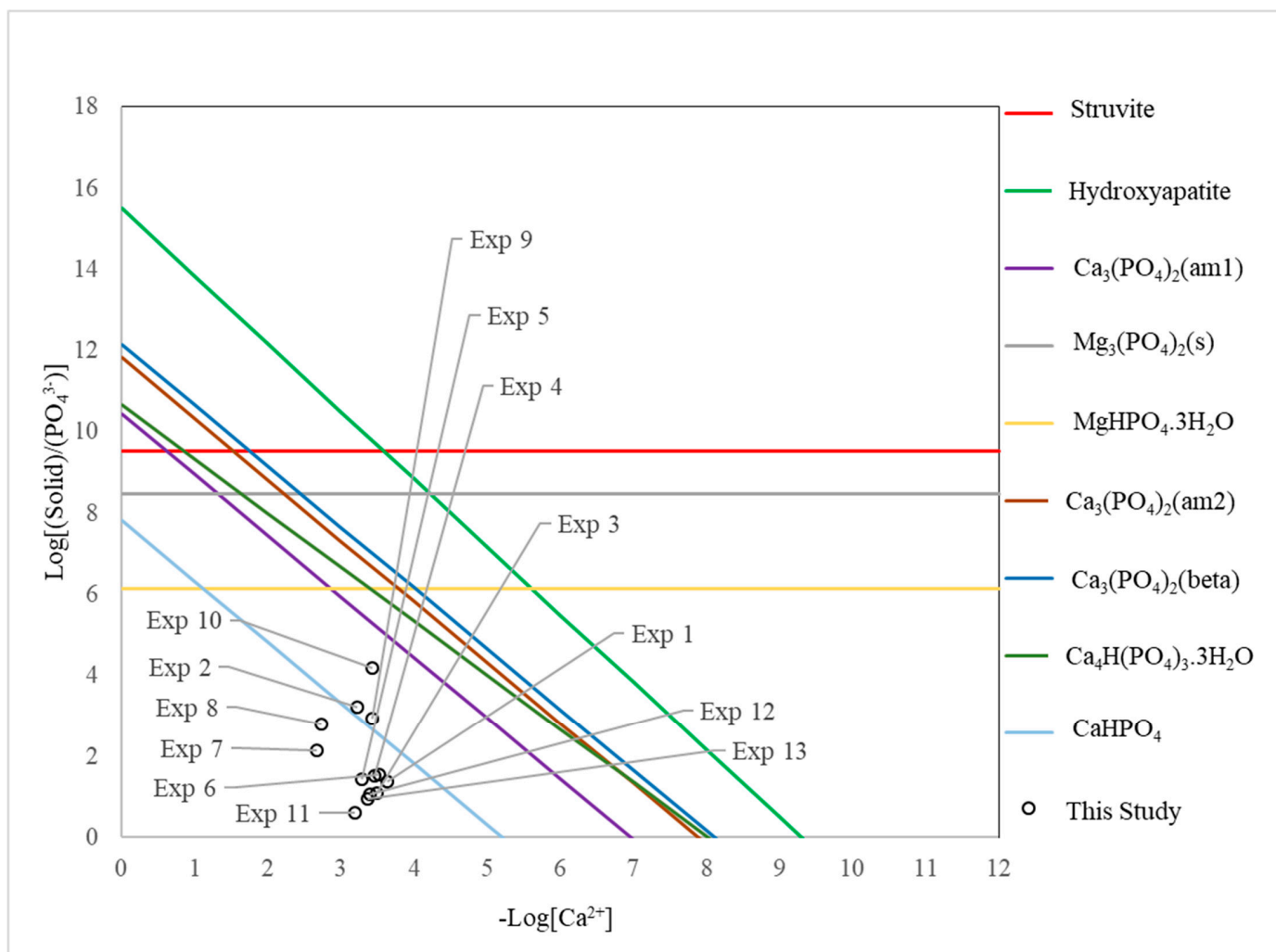


Figure S3. Activity ratio diagram for PO_4^{3-} solid phases vs Ca^{2+} . $\text{pH} = 9.5$, $\text{NH}_4^+ = 0.0527 \text{ M}$, $\text{Mg}^{2+} = 0.2 \text{ M}$.