

Supporting Information

Table S1. ICSD Database Code and Reference used for mineral phase quantification.

Mineral phase	ICSD Database Code	Reference
Mg-Calcite	-	Paquette and Reeder (1990) Single-crystal X-ray structure refinements of two biogenic magnesian calcite crystals, <i>American Mineralogists</i> 75, 1151-1158
Aragonite	170225	Caspi et al. (2005) On the structure of aragonite. <i>Acta Crystallographica B</i> 61, 129-132
Hydromagnesite	920	Akao and Iwai (1977) The hydrogen Bonding of Hydromagnesite, <i>Acta Crystallographica B</i> 33, 1273-1275

Table S2. Concentrations of free Ca^{2+} and Mg^{2+} ions and calculated molar $\text{Mg}^{2+}/\text{Ca}^{2+}$ ratios of the experimental solutions.

Experiment	Time	$[\text{Ca}^{2+}]_{\text{aq}}$	$[\text{Mg}^{2+}]_{\text{aq}}$	$[\text{Mg}^{2+}]_{\text{aq}}/[\text{Ca}^{2+}]_{\text{aq}}$
	min/day	mM	mM	
T_10 °C	0.3 min	1.4	28.0	20.1
	5 min	25.8	65.4	2.5
	11 min	29.9	72.1	2.4
	21 min	18.0	84.8	4.7
	32 min	14.5	90.3	6.2
	61 min	9.5	96.4	10.2
	1 day	1.7	97.9	56.6
	1 week	0.5	98.5	216.2
	2 months	0.3	99.9	370.4
T_20 °C	0.3 min	1.0	26.0	25.5
	5 min	17.2	63.2	3.7
	11 min	14.1	71.1	5.0
	21 min	11.3	80.6	7.1
	32 min	10.6	87.5	8.3
	61 min	4.8	91.9	19.1
	1 day	0.7	92.8	139.8
	1 week	0.2	91.5	409.6
	2 months	0.2	91.9	605.2
T_40 °C	0.3 min	0.8	24.5	31.6
	5 min	8.6	58.6	6.8
	11 min	6.2	65.8	10.6
	21 min	4.6	74.8	16.1
	32 min	1.9	78.0	40.6
	61 min	0.7	78.4	109.8
	1 day	0.3	72.6	252.9
	1 week	0.3	62.0	228.7
	2 months	0.3	62.8	191.5
T_60 °C	0.3 min	0.8	22.9	28.6
	5 min	3.6	46.2	13.0
	11 min	3.0	51.4	17.4
	21 min	2.2	53.9	24.3
	32 min	0.7	53.7	78.4
	61 min	0.4	53.0	131.0
	1 day	0.5	45.6	92.9
	1 week	0.5	42.1	91.3
	2 months	0.8	41.6	53.8
T_80 °C	0.3 min	0.8	20.7	27.0
	5 min	1.6	25.9	15.9
	11 min	0.8	20.6	26.1
	21 min	0.2	19.6	92.2
	32 min	0.2	18.1	80.6
	61 min	0.2	15.6	63.6
	1 day	0.3	14.5	53.8
	1 week	0.3	14.4	54.4
	2 months	0.8	13.9	17.9

Table S3. Activities (a) of Ca^{2+} , Mg^{2+} and CO_3^{2-} ions in the experimental solutions and apparent solubility product values (K) for ACMC and HMC calculated according to [eqn2](#).

Experiment	Time	ionic strength	$\log(a\text{Ca}^{2+})$	$\log(a\text{Mg}^{2+})$	$\log(a\text{CO}_3^{2-})$	K
	min/day	M				
T_10 °C	0.3 min	0.14	-3.32	-2.01	-2.81	-5.52
	5 min	0.35	-2.12	-1.72	-4.11	-
	11 min	0.38	-2.06	-1.67	-4.06	-
	21 min	0.38	-2.28	-1.60	-4.31	-
	32 min	0.39	-2.37	-1.58	-4.03	-
	61 min	0.39	-2.56	-1.55	-4.09	-
	1 day	0.37	-3.29	-1.54	-4.39	-
	1 week	0.36	-3.87	-1.54	-4.23	-
	2 months	0.36	-4.10	-1.53	-4.03	-
T_20 °C	0.3 min	0.14	-3.45	-2.05	-2.75	-5.56
	5 min	0.31	-2.30	-1.73	-3.95	-
	11 min	0.33	-2.39	-1.69	-4.02	-
	21 min	0.35	-2.49	-1.63	-3.95	-
	32 min	0.37	-2.52	-1.60	-3.95	-
	61 min	0.36	-2.86	-1.58	-4.05	-
	1 day	0.35	-3.72	-1.57	-4.18	-
	1 week	0.34	-4.19	-1.58	-3.92	-7.63
	2 months	0.34	-4.36	-1.58	-3.85	-7.68
T_40 °C	0.3 min	0.13	-3.59	-2.09	-2.92	-5.80
	5 min	0.27	-2.61	-1.78	-3.88	-
	11 min	0.29	-2.76	-1.73	-3.85	-
	21 min	0.31	-2.89	-1.68	-3.86	-
	32 min	0.31	-3.27	-1.66	-3.94	-
	61 min	0.30	-3.70	-1.66	-3.97	-
	1 day	0.28	-4.09	-1.69	-4.12	-
	1 week	0.24	-4.10	-1.75	-4.03	-
	2 months	0.24	-4.02	-1.74	-4.29	-
T_60 °C	0.3 min	0.13	-3.59	-2.13	-3.24	-6.13
	5 min	0.21	-3.00	-1.89	-3.82	-
	11 min	0.23	-3.09	-1.85	-3.82	-
	21 min	0.23	-3.21	-1.83	-3.87	-
	32 min	0.22	-3.72	-1.82	-4.01	-
	61 min	0.22	-3.95	-1.83	-4.09	-
	1 day	0.19	-3.85	-1.88	-4.54	-
	1 week	0.18	-3.87	-1.91	-4.96	-8.04
	2 months	0.18	-3.64	-1.91	-5.20	-8.14
T_80 °C	0.3 min	0.12	-3.62	-2.19	-3.65	-6.58
	5 min	0.14	-3.32	-2.12	-3.85	-
	11 min	0.12	-3.61	-2.20	-4.05	-
	21 min	0.12	-4.17	-2.21	-4.41	-
	32 min	0.11	-4.14	-2.24	-4.49	-
	61 min	0.10	-4.10	-2.29	-4.54	-
	1 day	0.10	-4.05	-2.32	-4.62	-
	1 week	0.10	-4.06	-2.32	-4.55	-
	2 months	0.06	-3.52	-2.27	-4.78	-

Table S4. Summary of solubility data of amorphous Ca-(Mg-) carbonate of this study, Brečević and Nielsen²⁸ and Purgstaller et al.³³. The solubility (K) values of ACC ($[\text{Mg}]_{\text{solid}} = 0$ mol% Mg) were calculated using the equation $K = -0.00010960 T^2 + 0.05453848 T - 12.91852871$, where T is given in Kelvin (Brečević and Nielsen²⁸). At a given temperature, the linear increase of the solubility (K) of ACMC as a function of the Mg content $[\text{Mg}]_{\text{solid}}$ (in mol%) is expressed as $K = m [\text{Mg}]_{\text{solid}} + y_0$ (m = slope; y_0 = intercept). Note that the average m value of 0.01629 ± 0.00060 is given in eqn 5.

Temperature	Reference	$[\text{Mg}]_{\text{solid}}$	K	slope	intercept
		mol%		m	y_0
10 °C	Brečević and Nielsen ²⁸	0	-6.26	0.01603	-6.260
	This study	46.0	-5.52		
20 °C	Brečević and Nielsen ²⁸	0	-6.35	0.01723	-6.346
	This study	45.6	-5.56		
40 °C	Brečević and Nielsen ²⁸	0	-6.58	0.01665	-6.584
	This study	47.0	-5.80		
60 °C	Brečević and Nielsen ²⁸	0	-6.91	0.01632	-6.910
	This study	47.5	-6.13		
80 °C	Brečević and Nielsen ²⁸	0	-7.32	0.01548	-7.323
	This study	48.3	-6.58		
10, 20, 40, 60 and 80 °C	Brečević and Nielsen ²⁸ This study			Average = 0.01634 ± 0.00066	
25 °C	Purgstaller et al. ³³	2.2	-6.20	0.01602	-6.286
	Purgstaller et al. ³³	10.5	-6.13		
	Purgstaller et al. ³³	15.8	-6.04		
	Purgstaller et al. ³³	21.2	-6.00		
	Purgstaller et al. ³³	29.3	-5.81		
	Purgstaller et al. ³³	37.4	-5.71		
	Purgstaller et al. ³³	51.1	-5.43		
10, 20, 25, 40, 60 and 80 °C	Brečević and Nielsen ²⁸ This study Purgstaller et al. ³³			Average = 0.01629 ± 0.00060	

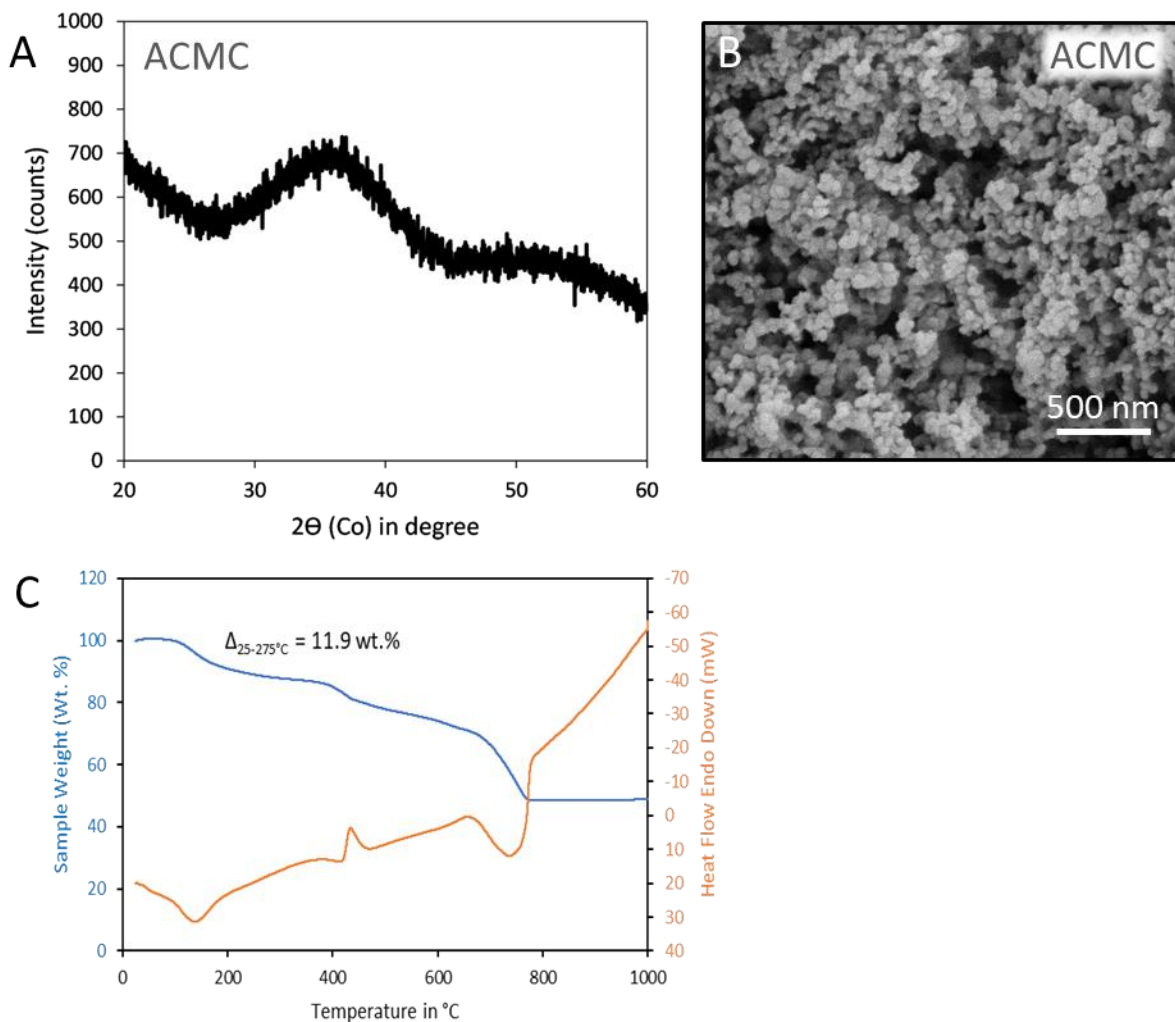


Fig. S1. (A) X-ray diffraction pattern, (B) SEM image and (C) thermal analysis (TGA: blue line, DSC: orange line) of synthesized ACMC with 47.9 ± 0.2 mol% MgCO_3 . The water content of ACMC was calculated from the weight loss between 25 and 275 °C ($\Delta_{25-275^\circ\text{C}}$) to be 0.67 moles per unit formula $\text{Ca}_{0.52}\text{Mg}_{0.48}\text{CO}_3$ (see also [Purgstaller et al.³³](#)).

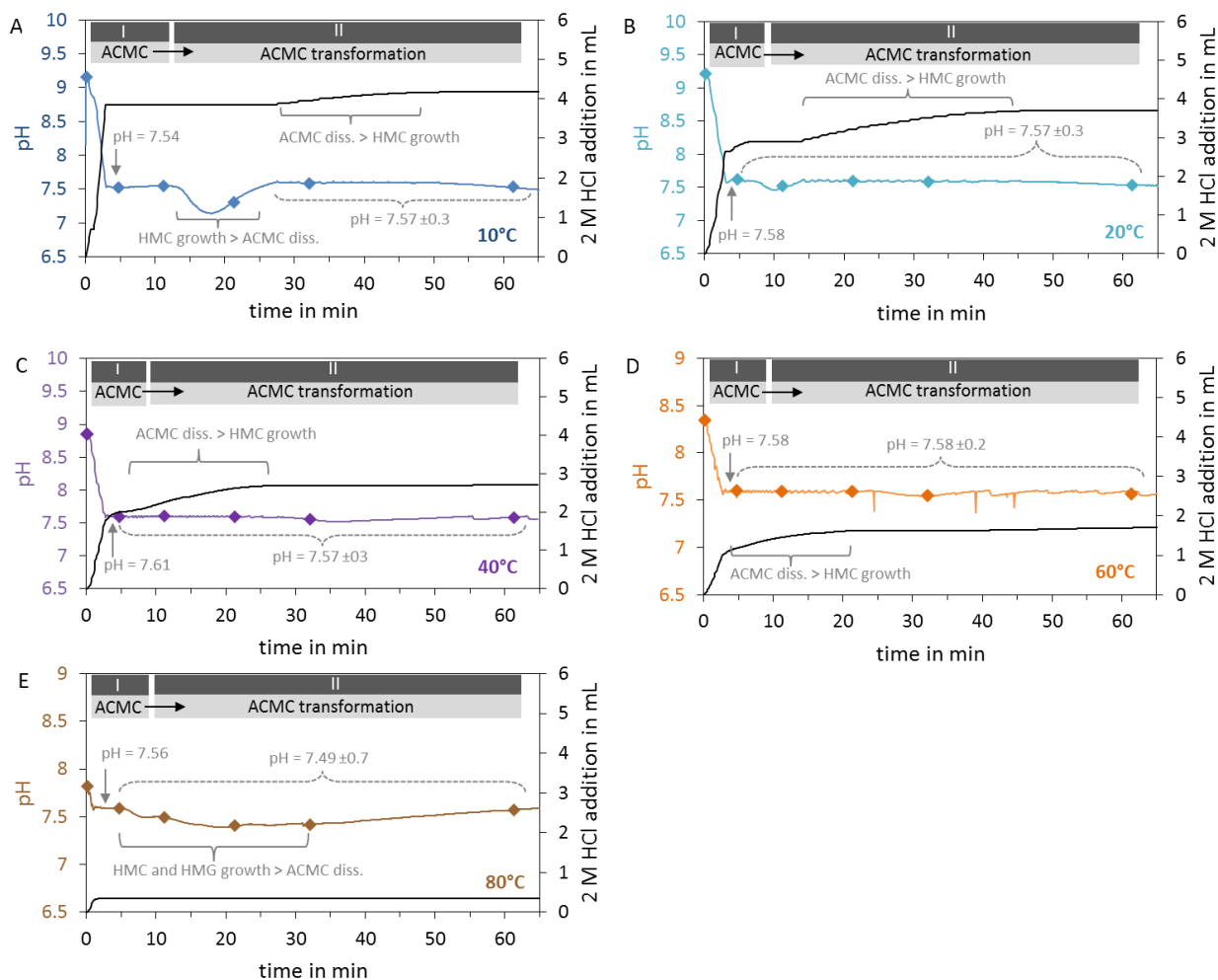


Fig. S2. Temporal evolution of pH of the experimental solution and of the mL HCl (2 M) added to the experimental solution by titration to keep the pH constant for experiments performed at (A) 10 °C, (B) 20 °C, (C) 40 °C, (D) 60 °C and (E) 80 °C.

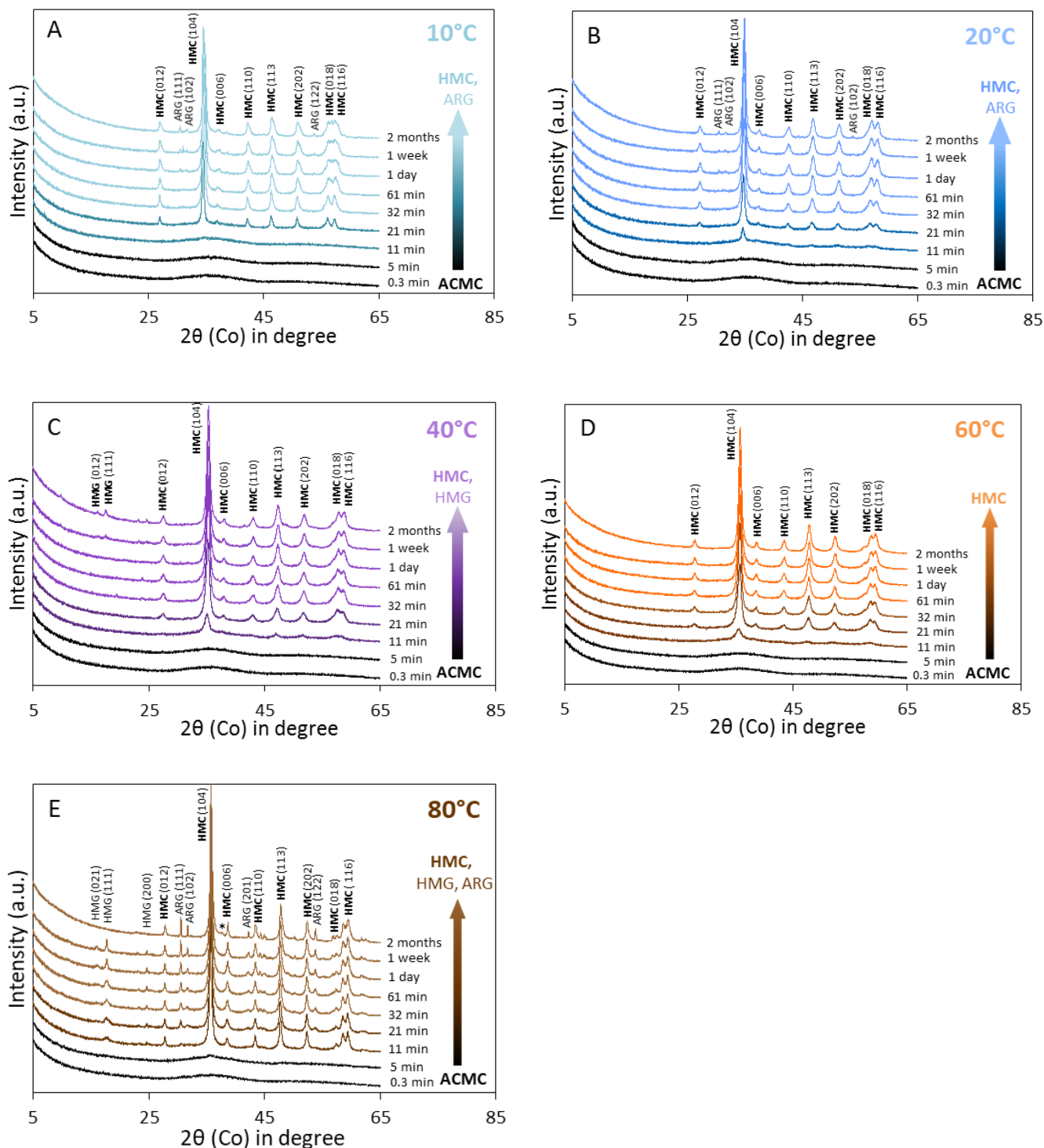


Fig. S3. Overview XRD patterns (2θ range = $4\text{--}65^\circ$) of precipitates obtained between 0.3 min and 2 months of reaction time in experiments performed at (A) 10°C , (B) 20°C , (C) 40°C , (D) 60°C and (E) 80°C (see [Table 1](#)). ACMC: Amorphous calcium magnesium carbonate; HMC: High Mg-calcite; ARG: Aragonite; HMG: Hydromagnesite; *: Additional phase that could correspond to magnesite.

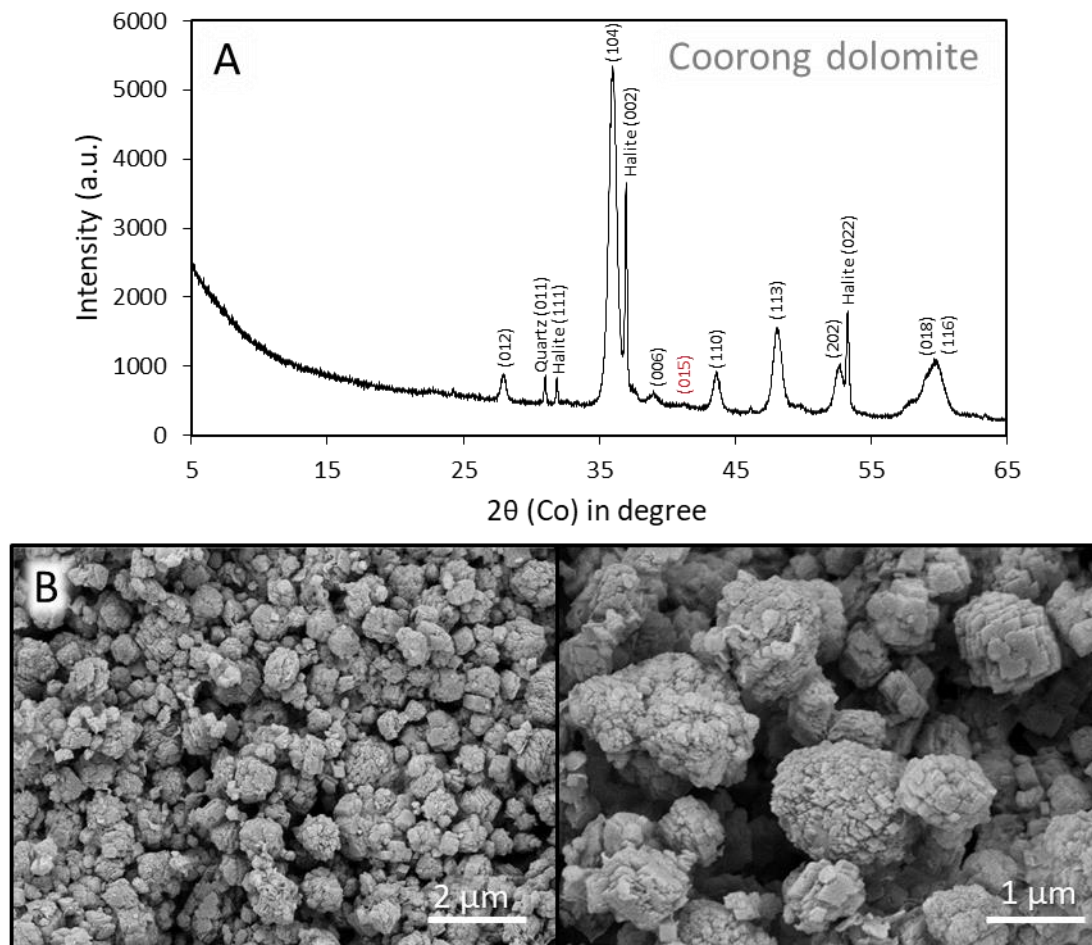


Fig. S4. (A) XRD pattern and (B) SEM images of the reference Coorong dolomite (48 mol% MgCO_3). Note that the 015 peak of the Coorong dolomite is very weak, indicating a low cation ordering degree.