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1 **Precipitation of ordered dolomite via simultaneous dissolution of**
2 **calcite and magnesite: New experimental insights into an old**
3 **precipitation enigma**

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23 **Abstract**

24 In the present study, we demonstrate that ordered dolomite can be precipitated via
25 simultaneous dissolution of calcite and magnesite under hydrothermal conditions (from 100 to
26 200°C). The temperature and high-carbonate alkalinity have significantly co-promoted the
27 dolomite formation. For example, when high-purity water was initially used as interacting fluid,
28 only a small proportion of disordered dolomite was identified at 200°C from XRD patterns and
29 FESEM observations. Conversely, higher proportion of ordered dolomite, i.e. clear identification
30 of superstructure ordering reflections in XRD patterns, was determined when high-carbonate
31 alkalinity solution was initially used in our system at the same durations of reaction. For this
32 latter case, the dolomite formation is favorable therefrom 100°C and two kinetic steps were
33 identified (1) proto-dolomite formation after about five days of reaction, characterized by
34 rounded sub-micrometric particles from FESEM observations and by the absence of
35 superstructure ordering reflections at 22.02 (101), 35.32 (015), 43.80 (021), etc. 2theta on XRD
36 patterns; (2) proto-dolomite to dolomite transformation, probably produced by a coupled
37 dissolution-recrystallization process. Herein, the activation energy was estimated to 29 kJ/mol by
38 using conventional Arrhenius linear-equation. This study provides new experimental conditions
39 to which dolomite could be formed in hydrothermal systems. Temperature and carbonate
40 alkalinity are particularly key physicochemical parameters to promote dolomite precipitation in
41 abiotic systems.

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46 **Keywords:** Dolomite formation; High-carbonate alkalinity; Magnesite; Calcite; Crystal growth;

47 Hydrothermal systems.

48

49 **1. Introduction**

50 The formation and textural properties of dolomite ($\text{CaMg}(\text{CO}_3)_2$) have already been
51 investigated in the past two centuries (1-4). However, various questions still remain unanswered
52 concerning its formation mechanism and kinetics in natural systems as well as its synthesis in the
53 laboratory. For example, the formation of ordered dolomite at ambient temperature is virtually
54 impossible, possibly due to the high hydration nature of Mg^{2+} ions in solution at low temperature
55 (4-6). Moreover, the scanty distribution of modern dolomite in nature contrasts strongly with its
56 common abundance in ancient sedimentary rocks of marine origin, leading to the paradox
57 commonly referred to as the “dolomite problem” (7-9). Experimental syntheses regarding the
58 physicochemical conditions, reaction mechanisms and kinetics at which dolomite can be formed
59 could resolve this paradox. Typically, the dolomite precipitation in laboratory has been
60 investigated by reference to natural setting, in this way, three main kinds of experimental
61 configurations have been carried out: (1) Direct and homogenous precipitation by mixing (fast or
62 slowly) two pre-defined solutions, one containing Mg/Ca ratio (≥ 1) and other containing
63 dissolved carbonate ions. This simple reaction pathway has only success at high temperature
64 ($>100^\circ\text{C}$) (5, 10). In the similar way, more sophisticated experimental setups have been built
65 “hydrothermal flow reactors” to investigate the kinetic behavior of dolomite precipitation, but,
66 these systems have systematically used pre-existent dolomite crystals “or seed material”, this can
67 indeed provide idealized or limited information on the overgrowth of dolomite (syntaxial and/or
68 epitaxial growth) (9). (2) Calcite dolomitization by placing high-purity calcite or limestone
69 material in contact with Mg-rich solution. This calcite replacement by ordered dolomite is
70 particularly favorable also at high temperature ($>100^\circ\text{C}$) (11-13). This reaction mechanism could

71 explain the massive dolomite formation in sedimentary environments if such sediments are
72 submitted to significant temperature variations and/or to significant changes of pore-fluid
73 chemistry over geologic times (e.g. 14). (3) Bio-assisted dolomitization by using sulfate-reducing
74 or aerobic heterotrophic bacteria, hypersaline or seawater solutions and anoxic or oxic conditions
75 in controlled lab systems; these complex procedures seem to have success at low temperature to
76 synthesize dolomite as reported in various recent studies (2, 15-18); however, the provided
77 information has not shown convincing proof of the presence of ordered dolomite for these low-
78 temperature syntheses. For example, reported XRD patterns have not clearly shown the presence
79 of superstructure ordering reflections at 22.02 (101), 35.32 (015), 43.80 (021), etc. 2theta on
80 synthesized material as described by Lippmann (19). Moreover, the reaction mechanism and role
81 of all parameters (including culture media and/or cellular secretions) is poorly understood.
82 Identifying novel and/or innovative abiotic or biotic synthesis methods for dolomite at a broad
83 spectrum of experimental conditions still remain a major scientific challenge to obtain a better
84 understanding of its formation in natural systems and to facilitate its production at laboratory
85 scale.

86 In this context, the present study has explored a new synthesis pathway for dolomite by
87 using calcite and magnesite as Ca and Mg sources, respectively
88 ($\text{CaCO}_3 + \text{MgCO}_3 \rightarrow \text{CaMg}(\text{CO}_3)_2$). This reaction pathway has not been investigated to the best of
89 our knowledge. However, calcite and magnesite could co-exist in various natural media
90 (sedimentary deposits, modern marine sediments, hydrothermal systems, deep geological
91 formations...). Moreover, this simple reaction pathway allows us determining if dolomite
92 formation is favorable via dissolution of its Mg-rich and Ca-rich end-members under

93 hydrothermal conditions in closed systems.

94

95 **2. Materials and Methods**

96 *2.1. Preparation of solid reactants*

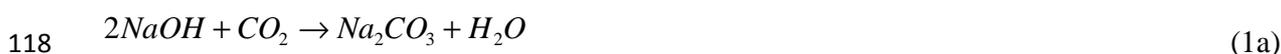
97 *Calcite:* High-purity calcite characterized by nanosized (<100nm) and sub-micrometric (<1µm)
98 particles were synthesized by aqueous carbonation of portlandite (Ca(OH)₂). The specific
99 procedure and fine calcite characterization have already been reported by Montes-Hernandez et
100 al. (20).

101 *Magnesite:* Rhombohedral single crystals (<2µm) of magnesite were synthesized by two main
102 sequential reactions: (1) aqueous carbonation of synthetic brucite (Mg(OH)₂) by injection of CO₂
103 in a highly alkaline medium (2 molal of NaOH) at ambient temperature (~20°C), leading to
104 precipitation of platy-compacted aggregates of dypingite ($Mg_5(CO_3)_4(OH)_2 \cdot 5H_2O$) after 24h;
105 (2) complete dypingite-to-magnesite transformation after 24h by a simple heat-ageing step from
106 20 to 90°C. These synthesis pathways and magnesite characterizations have been previously
107 reported by Montes-Hernandez et al. (21).

108 *2.2. Preparation of reacting solutions*

109 High-purity water with an electrical resistivity of 18.2 MΩ cm (PW) and high-carbonate alkaline
110 solution (HAS) were used as interacting solutions in the dolomitization experiments. The HAS
111 was prepared by direct capture of CO₂ in contact with a concentrated NaOH solution (2m).
112 Herein, 50bar of CO₂ (~2mol) were injected into the titanium reaction cell (2L of volume) at

113 ambient temperature (~20°C). The CO₂ consumption (or pressure drop of CO₂) and temperature
114 (exothermic reaction) were in-situ monitored until a macroscopic equilibrium that was reached
115 after about 24h. Then, the residual CO₂ gas was removed from reactor and the solution was
116 recovered by simple decanting of supernatant solution. Based on Solvay typical reactions, the
117 following global reactions are expected:



120 The X-ray diffraction on the recovered solid and the measurements in the solution (pH=8.7 and
121 total carbon (TC) = 0.95M) have confirmed this above reactions.

122 *2.3. Dolomitization experiments*

123 Five Teflon reaction cells were loaded with 1.5 ml of high-carbonate alkaline solution (HAS),
124 100 mg of calcite and 100 mg of magnesite. Five other reaction cells were loaded with the same
125 mineral amounts, but with 1.5 ml of high-purity water (PW). All reaction cells (cap-cell also in
126 Teflon) were immediately assembled into independent steel mini-autoclaves without agitation,
127 referred to as “static batch reactor” and the closed autoclaves were placed in a multi-oven (ten
128 independent temperature compartments). This allowed the simultaneous investigation of five
129 independent temperatures (50, 75, 100, 150 and 200 °C) and two different interacting solutions
130 (PW and HAS). The reaction duration for these ten experiments was arbitrarily imposed to 90
131 days. These exploratory experiments have revealed that ordered dolomite is preferentially formed
132 in carbonate alkaline medium therefrom 100°C for the investigated lapse of time. For this reason,

133 complementary dolomitization experiments were performed using exclusively carbonate alkaline
134 solution as interacting fluid in order to determine the dolomite precipitation rate. For this case,
135 five reaction durations were arbitrarily imposed (5, 13, 21, 42 and 62 days) at three different
136 temperatures (100, 150 and 200°C). We note that only two reaction durations (5 and 20 days)
137 were considered for experiments at 100°C. In all experiments, the same mineral amounts of
138 reactants and volume of interacting solution were used. All experiments and some results are
139 summarized in Table 1. At the end of the experiment, the autoclave was quenched in cold water.
140 This manipulation limits a significant perturbation of the solid-reaction products with respect to a
141 slow cooling process. Then, the autoclave was disassembled and the fluid was collected for pH
142 measurement exclusively. Finally, the solid product was directly dried in the Teflon reaction cells
143 at 90 °C for 24 h. The dry solid product was recovered for further solid characterizations
144 described below.

145 *2.4. Characterization of solid products*

146 X-Ray Powder Diffraction (XRD) analyses were performed using a Siemens D5000
147 diffractometer in Bragg-Brentano geometry; equipped with a theta-theta goniometer with a
148 rotating sample holder. The XRD patterns were collected using Cu $k\alpha_1$ ($\lambda_{k\alpha_1}=1.5406\text{Å}$) and $k\alpha_2$
149 ($\lambda_{k\alpha_2}=1.5444\text{Å}$) radiation in the range $2\theta = 10 - 70^\circ$ with a step size of 0.04° and a counting time
150 of 6 seconds per step. Residual calcite and magnesite, dolomite and natrite minerals on XRD
151 patterns were systematically refined by Rietveld method using the BGMN software and its
152 associated database (22), except for run 5 where eitelite mineral was also added. The
153 precipitation of this latter mineral was probably promoted by an unexpected micro-leakage in the
154 system, which was confirmed at the end of experiment.

155 *FESEM observations:* Selected samples containing dolomite were dispersed by ultrasonic
156 treatment in absolute ethanol for five to ten minutes. One or two droplets of the suspension were
157 then deposited directly on an aluminum support for SEM observations, and coated with platinum.
158 The morphology of crystal faces was observed by using a Zeiss Ultra 55 field emission gun
159 scanning electron microscope (FESEM) with a maximum spatial resolution of approximately
160 1nm at 15kV.

161 *TEM observations:* one selected sample (from run 16) was shaken in ethanol for a short time in
162 order to split the aggregates without any additional treatment. A drop of the suspension was
163 deposited on a holey carbon foil and placed on a conventional copper micro-grids for further
164 observations with JEOL 2100F Transmission Electron Microscope (TEM) operating at 200 kV,
165 equipped with a field emission gun and a high-resolution pole piece achieving a point-to-point
166 resolution of 1.8 Å. Chemical mapping was achieved by combining the scanning module of the
167 microscope (STEM) to the EDS detector.

168 *Thermogravimetric analyses:* TGA for all solid products were performed with a Mettler Toledo
169 TGA/SDTA 851e instrument under the following conditions: sample mass of about 10 mg, 150
170 µl alumina crucible with a pinhole, heating rate of 10°C min⁻¹, and inert N₂ atmosphere of 50 ml
171 min⁻¹. We note that all samples containing dolomite were also analyzed under CO₂ atmosphere
172 using the same flow (50 ml/min) in order to separate correctly the dolomite decomposition from
173 magnesite and calcite decomposition in the samples. Sample mass loss and associated thermal
174 effects were obtained by TGA/SDTA. In order to identify the different mass loss steps, the TGA
175 first derivative (rate of mass loss) was used. The TGA apparatus was calibrated in terms of mass
176 and temperature. Calcium oxalate was used for the sample mass calibration. The melting points

177 of three compounds (indium, aluminum and copper) obtained from the DTA signals were used
178 for the sample temperature calibration.

179

180 **3. Results and Discussion**

181 Under Earth's surface conditions, calcite and magnesite are the most stable carbonates
182 containing calcium and magnesium, respectively. Assuming that these two minerals could co-
183 exist in hydrothermal systems and other Earth or planetary systems, this study provides new
184 experimental conditions to which the dolomite can be formed via simultaneous dissolution of
185 calcite and magnesite. Obviously, this particular case could not explain the dolomite abundance
186 in ancient sedimentary rocks of marine origin.

187 X-ray diffraction results have revealed the formation of ordered dolomite therefrom 100°C when
188 high-carbonate alkaline solution is used as interacting fluid. This was clearly identified by the
189 presence of superstructure ordering reflections 101, 015, 021, etc. from 036-0426 pattern for
190 dolomite (Figure 1). Conversely, small proportion of disordered dolomite was exclusively
191 identified at 200°C whether high-purity water is used as interacting fluid for the same duration of
192 reaction (90 days) (Figure 1b). Electron microscopy observations (FESEM) have shown rounded
193 sub-micrometric particles for disordered dolomite and rhombohedral micrometric particles for
194 ordered dolomite (see insets in Figure 2). These morphologies are not surprising results because
195 rounded sub-micrometric particles have been also identified from lab bio-assisted experiments at
196 low temperature (e.g. 2, 17, 23), and rhombohedral morphology is typical for ordered dolomite
197 from natural Earth systems or synthesized under hydrothermal conditions via mineral
198 replacement of calcite (e.g. 24).

199 The Figure 2 summarizes the dolomite content as a function of temperature. The dolomite
200 content was deduced from Rietveld refinements of XRD patterns. When high-carbonate alkalinity
201 was used, the dolomite content in solid-products seems to be directly proportional to temperature
202 from 100 to 200°C. However, dolomite was not detected at 50 and 75°C for the same reaction
203 duration. The dolomitization process is limited via simultaneous hydrothermal dissolution in
204 high-purity water. In fact, small proportion of dolomite (6%) was only determined at 200°C for a
205 reaction duration of 90 days. Based on these exploratory results, we assume that formation of
206 dolomite via simultaneous dissolution of calcite and magnesite is significantly co-promoted by
207 temperature and high-carbonate alkalinity. We note that carbonate alkalinity has been suspected
208 to increase significantly in bio-assisted dolomite synthesis at low temperature (e.g. 2, 15-16) or in
209 natural systems (8, 25); but, this parameter is not enough to promote alone the dolomite
210 formation in abiotic systems at low temperature (<100°C) via simultaneous dissolution of calcite
211 and magnesite; probably, because both minerals remain stable in high-carbonate alkaline
212 medium. However, this original result opens new possibilities to investigate dolomite formation
213 in abiotic systems at low-temperature; obviously, by using soluble salts as Ca and Mg sources.

214 Considering now that dolomite formation is promoted in high-carbonate alkaline medium
215 therefrom 100°C; complementary dolomitization experiments were performed at five different
216 reaction durations (5, 13, 21, 42, 60 days) and three different temperatures (100, 150 and 200°C)
217 in order to assess the dolomitization rate and reaction mechanism. In this way, two kinetic steps
218 were clearly identified:

219 (I) Rapid proto-dolomite formation by simultaneous dissolution of calcite and magnesite
220 (or disordered dolomite: absence of superstructure reflections 101, 015, 021, etc.), dominant in
221 the first twenty days and positively correlated with temperature. In fact, the proto-dolomite is a

222 nanocrystalline phase (see Figure 3) which contains a very high Mg atomic concentration
223 (>38%), but an irregular intercalation between Ca and Mg into the crystals is only expected as
224 clearly determined by XRD (Fig. 4).

225 (II) Proto-dolomite to dolomite transformation, probably by coupled dissolution-
226 recrystallization process. This second step remains still an open question for dolomite formation
227 in our experiments; but it seems dominant therefrom 20 days of reaction as clearly identified on
228 experimental XRD patterns (see Figure 4). Based on XRD patterns and some TEM observations,
229 we suggest that the so-called proto-dolomite is rapidly transformed to ordered dolomite; but, both
230 crystalline phases can coexist as a function of time if Ca and Mg sources are still available. This
231 is in agreement with a suspected overlapping in 104 peaks. Consequently, it is very difficult to
232 determine if an evolution of the order degree exists during dolomite formation in our
233 experiments.

234 The temporal variation of dolomite content was determined from Rietveld refinements of
235 XRD patterns. These experimental kinetic data were then fitted by using a simple kinetic model
236 (kinetic pseudo-second-order model) in order to estimate the initial reaction rate of
237 dolomitization. Graphically, this initial rate is defined as the slope of the tangent line when the
238 time tends toward zero on the “dolomite content versus time” curve (20). The results summarized
239 in Table 2 reveal that the initial reaction rate of dolomitization and the maximum of dolomite
240 content are positively correlated with temperature (see Figure 5 and Table 2). This temperature
241 dependence suggests an agreement with Arrhenius law, that allows a simple estimation of
242 activation energy ($E_a = 29$ kJ/mol) for dolomitization reaction in our experiments. This value is
243 about four times lower than the value of 133.3 kJ/mol reported by Arvidson and Mackenzie (8-9).
244 The experimental configurations are not necessary comparable; however, we assume that the

245 high-carbonate alkalinity decreases significantly the energetic barriers to form dolomite in a
246 given system.

247 The results deduced from the Rietveld refinements of XRD patterns were compared with
248 thermogravimetric (TG) measurements performed in 100% N₂ or CO₂ atmosphere. The results
249 obtained from both analytical techniques are generally in agreement, except for lower dolomite
250 contents in the solid products. Herein, the dolomite decomposition, concerning the first step
251 (CaMg(CO₃)₂ → MgO + CaCO₃) during heating process was systematically overlapped with
252 magnesite decomposition in both gas atmospheres, magnesite decomposition starting at lower
253 temperature. For this specific study, we assumed that Rietveld refinement of XRD patterns is
254 better adapted to estimate the dolomite content in synthesized solids.

255 Calcite and magnesite could co-exist in various active natural media (sedimentary
256 deposits, modern marine sediments, hydrothermal systems, deep geological formations...). Based
257 on above results, the calcite-magnesite interactions in alkaline media (e.g. the Lost City field and
258 Samail Ophiolite in Oman) could represent a potential source of dolomite. At the present time,
259 this scenario has not been considered in geo-sciences to the best of our knowledge.

260

261 **4. Conclusion**

262 This study provides new experimental conditions to which dolomite can be formed in
263 hydrothermal systems via simultaneous dissolution of calcite and magnesite. Herein, the dolomite
264 formation was co-promoted by temperature and high-carbonate alkalinity. The activation energy
265 for this reaction pathway ($CaCO_3 + MgCO_3 \rightarrow CaMg(CO_3)_2$) is 29 kJ/mol. This reaction
266 pathway has not been documented in the literature; however, it could exist in deep geological
267 formations and/or hydrothermal systems. In conclusion, this basic research opens new

268 possibilities to investigate abiotic formation of dolomite at laboratory scale, probably towards the
269 abiotic formation of dolomite at low-temperature (<100°C).

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- 342 (25) Katz, A.; Matthews, A. *Geochim. Cosmochim. Acta*, **1977**, 41, 297.

343 Table 1. Summary of experimental conditions and mineral content in solid-products deduced
 344 from Rietveld refinements of XRD patterns

Run #	Solid Reactants	t days	T (°C)	Solution	pH		Product amount (%) from XRD		
					initial	final	Calcite	Magnesite	Dolomite
1*	CaCO ₃ -MgCO ₃	90	50	HAS	8.9	9.0	38	57	0
2*	CaCO ₃ -MgCO ₃	90	75	HAS	8.9	9.1	47	49	0
3*	CaCO ₃ -MgCO ₃	90	100	HAS	8.9	9.2	43	43	9
4*	CaCO ₃ -MgCO ₃	90	150	HAS	8.9	9.3	26	40	30
5**	CaCO ₃ -MgCO ₃	90	200	HAS	8.9	8.0 ^a	11	4	49
6	CaCO ₃ -MgCO ₃	90	50	PW	≈6.5	10.3	61	37	0
7	CaCO ₃ -MgCO ₃	90	75	PW	≈6.5	10.2	47	52	0
8	CaCO ₃ -MgCO ₃	90	100	PW	≈6.5	10.0	49	50	0
9	CaCO ₃ -MgCO ₃	90	150	PW	≈6.5	9.6	27	72	0
10	CaCO ₃ -MgCO ₃	90	200	PW	≈6.5	9.0	54	39	6 ^b
11	CaCO ₃ -MgCO ₃	5	150	HAS	8.9	9.1	44	45	9
12	CaCO ₃ -MgCO ₃	13	150	HAS	8.9	9.2	56	25	13
13	CaCO ₃ -MgCO ₃	21	150	HAS	8.9	9.2	39	42	16
14	CaCO ₃ -MgCO ₃	42	150	HAS	8.9	9.3	28	38	26
15	CaCO ₃ -MgCO ₃	60	150	HAS	8.9	9.4	28	34	28
16	CaCO ₃ -MgCO ₃	5	200	HAS	8.9	9.2	34	37	24
17	CaCO ₃ -MgCO ₃	13	200	HAS	8.9	9.1	29	40	26
18	CaCO ₃ -MgCO ₃	21	200	HAS	8.9	9.2	39	30	28
19	CaCO ₃ -MgCO ₃	42	200	HAS	8.9	9.1	16	26	50
20	CaCO ₃ -MgCO ₃	60	200	HAS	8.9	9.2	14	21	52
21	CaCO ₃ -MgCO ₃	5	100	HAS	8.9	9.1	46	47	3
22	CaCO ₃ -MgCO ₃	20	100	HAS	8.9	9.0	47	45	6

345 *: for runs 1 to 4, natrite mineral NaCO₃ was also quantified, completing it 100% in solid; **: for run 5, a micro-
 346 leakage was suspected at the end of experiment, probably, this has enhanced the precipitation of eitelite (26%);
 347 pH was measured ex-situ at room temperature (≈20°C); a: unrealistic pH; b: disordered dolomite; HAS: high-
 348 carbonate alkaline solution; PW: high-purity water. CaCO₃: calcite; MgCO₃: magnesite.

349 Table 2. Summary of kinetic parameters for dolomite formation via simultaneous dissolution of
 350 calcite and magnesite in high-carbonate alkaline medium.

Temperature (°C)	$\xi_{extent,max}$ (%)	$t_{1/2}$ days	v_0 1/days	E_a kJ/mol
<i>CaCO₃ + MgCO₃ → CaMg(CO₃)₂</i>				
100	10.7	17.8	6.01 $\times 10^{-3}$	29
150	38.5	23.8	1.61 $\times 10^{-2}$	
200	59.4	13.5	4.40 $\times 10^{-2}$	

351 $\xi_{extent,max}$ is the maximum value of dolomite content at apparent equilibrium and $t_{1/2}$ is the half-
 352 content time determined by using a kinetic pseudo-second-order model. v_0 is the initial reaction
 353 rate ($v_0 = \xi_{extent,max} / t_{1/2} * 100$). E_a : activation energy determined by Arrhenius equation
 354 (conventional linear form).

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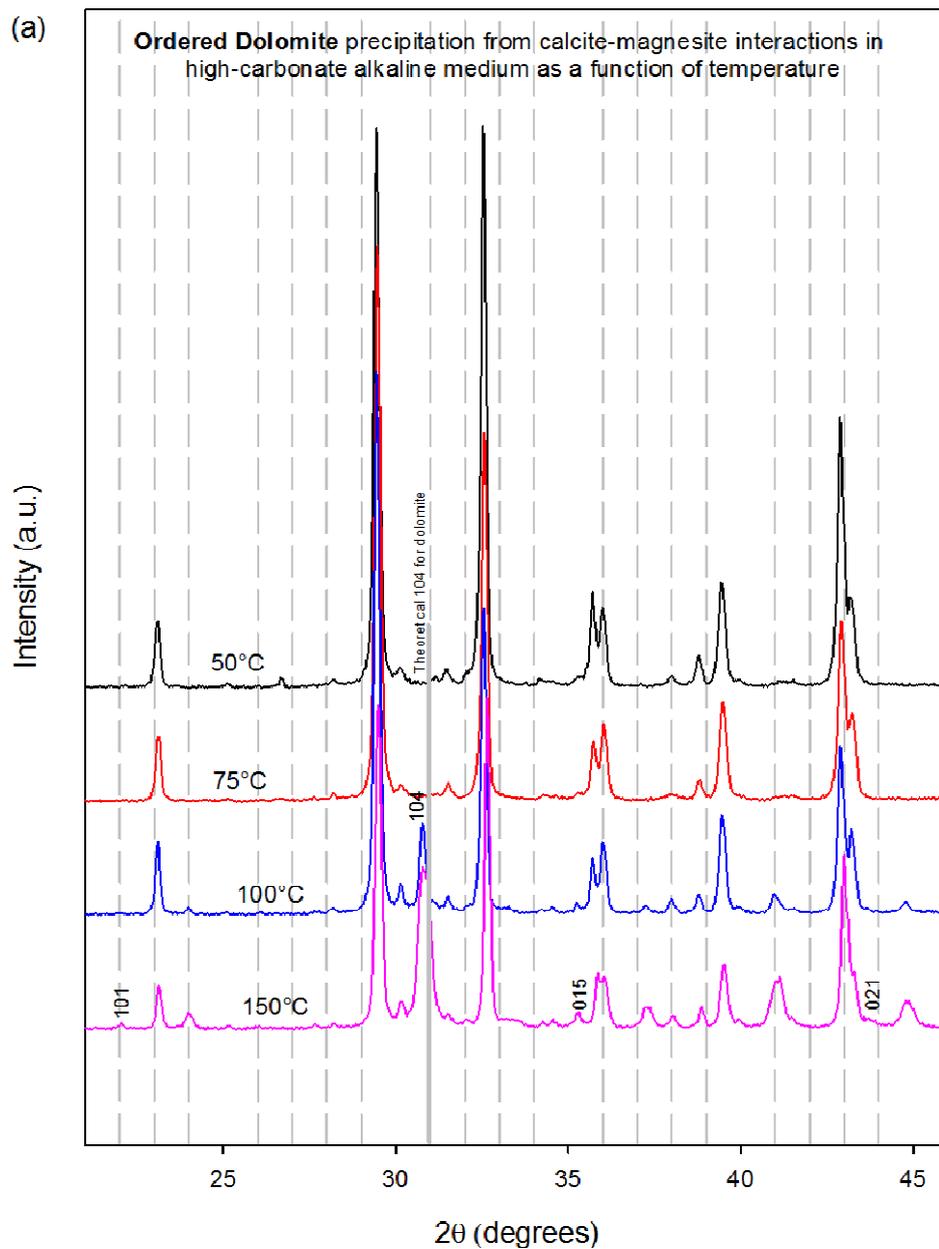
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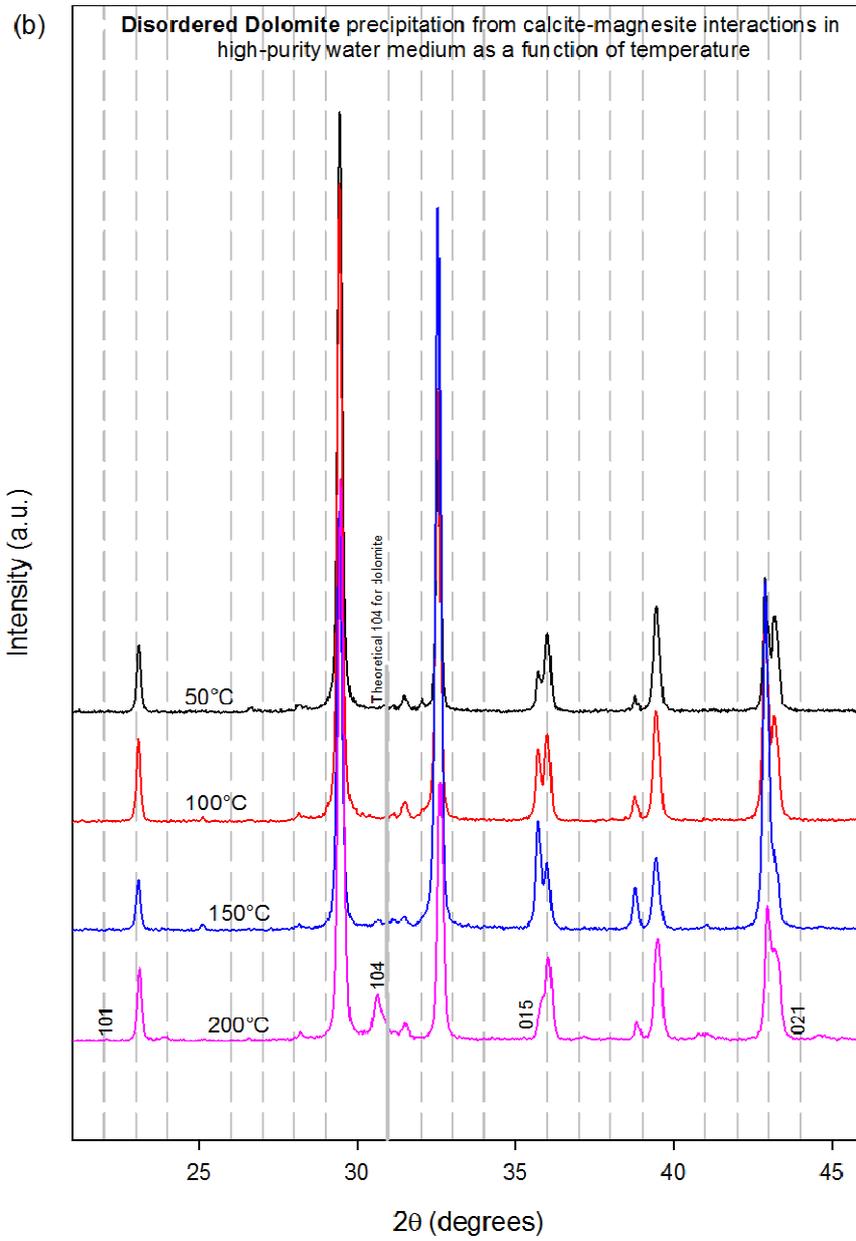
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364 Figure 1. Experimental XRD patterns for dolomite precipitation via simultaneous dissolution of
 365 calcite and magnesite. 101, 015 and 021 are typical superstructure reflections for dolomite in the
 366 20-45 2θ range (ICDD 036-0426). Influence of temperature and nature of interacting fluid. (a)
 367 reaction in high-carbonate alkaline solution and (b) in high-purity water.

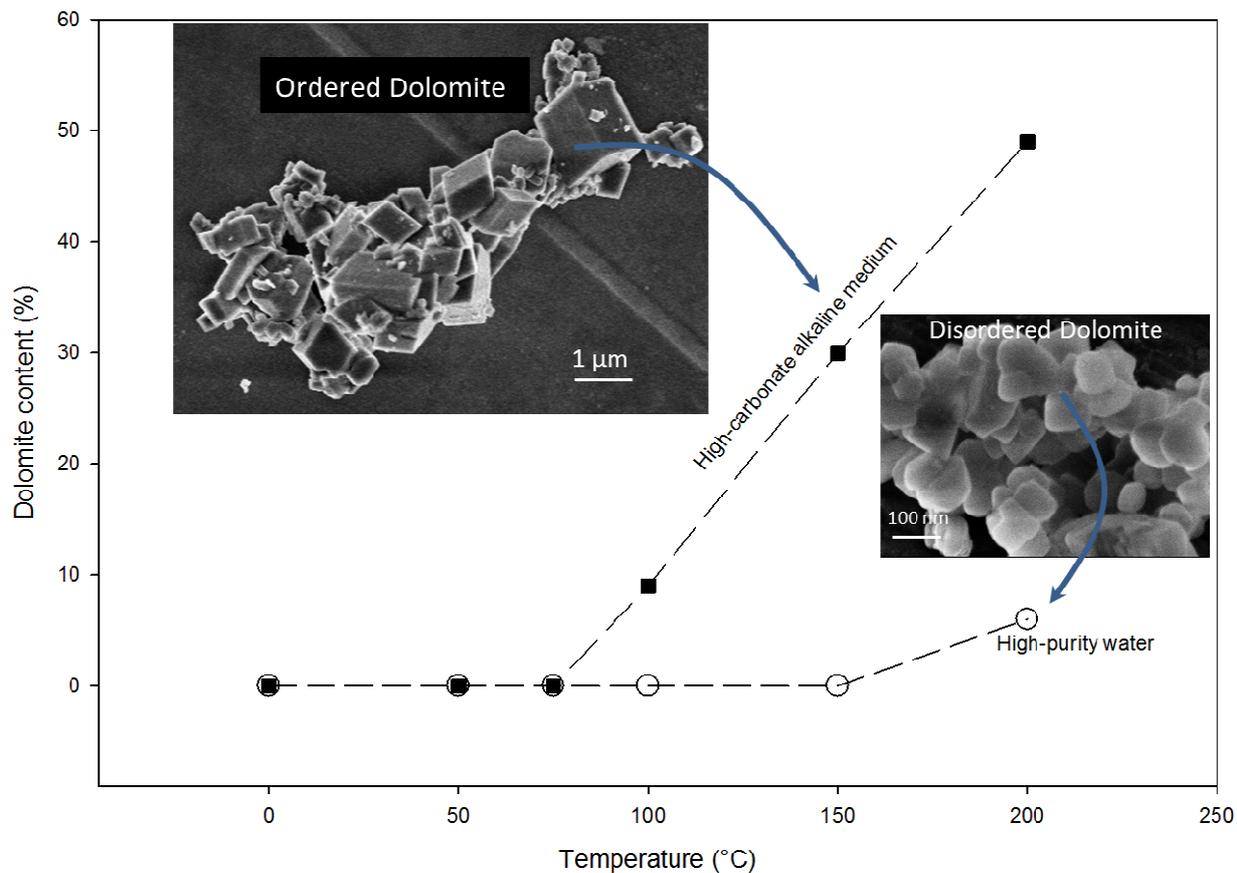


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370 Figure 1 (b)

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Figure 2. Dolomite content behavior as a function of temperature for two different initial

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interacting fluids (high-carbonate alkaline solution and high-purity water). Dolomite content was

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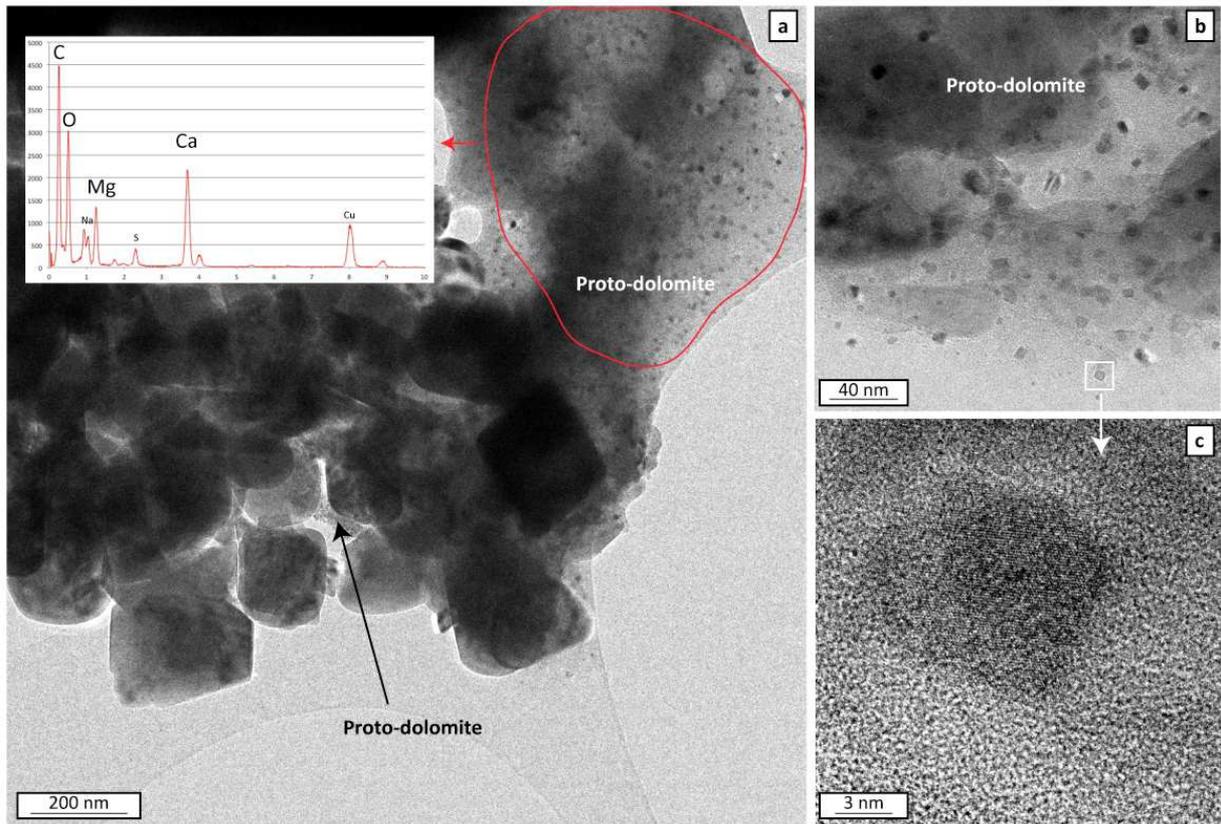
deduced from Rietveld refinement of XRD patterns shown in Fig. 1. Insets: FESEM micro-

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images showing ordered and disordered dolomite morphologies.

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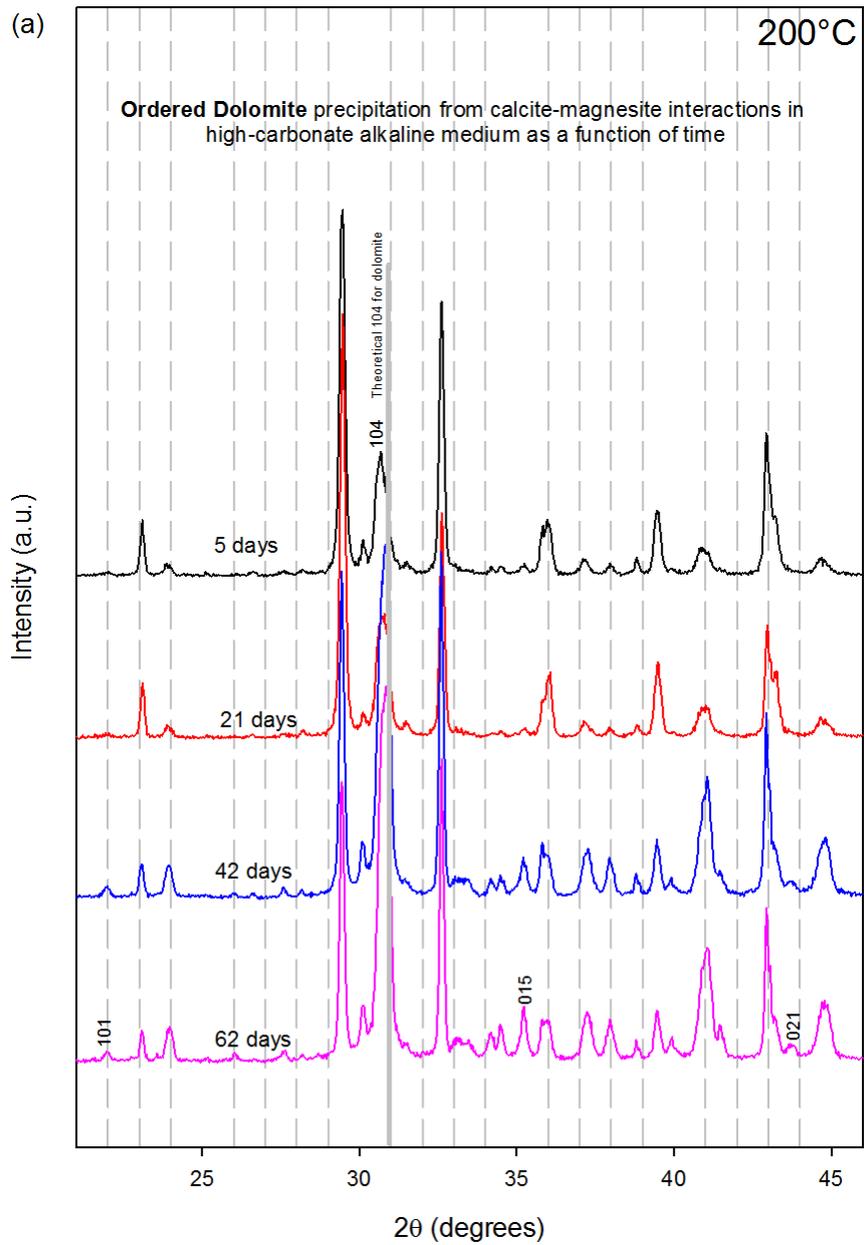
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384 Figure 3. Bright field image of a) proto-dolomite mixed with calcite and magnesite grains (from
 385 run 16) (inset: EDS spectrum extracted from STEM chemical mapping), magnification of proto-
 386 dolomite where nanoparticles are scattered in an amorphous gel, c) high-resolution of a
 387 crystalline nano-particle.

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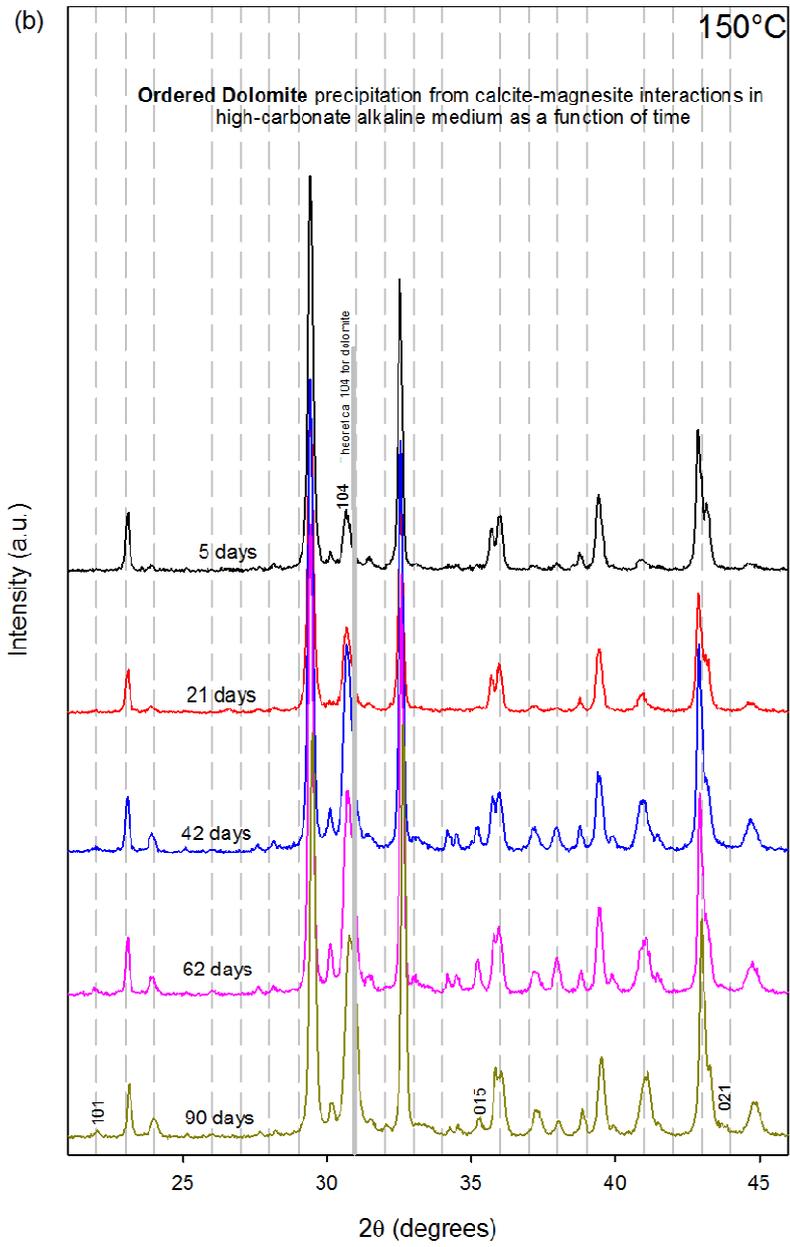
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392 Figure 4. Experimental XRD patterns for dolomite precipitation via simultaneous dissolution of
 393 calcite and magnesite. 101, 015 and 021 are typical superstructure reflections for dolomite in the
 394 20-45 2θ range (ICDD 036-0426). Kinetic behavior at (a) 200°C and (b) 150°C.

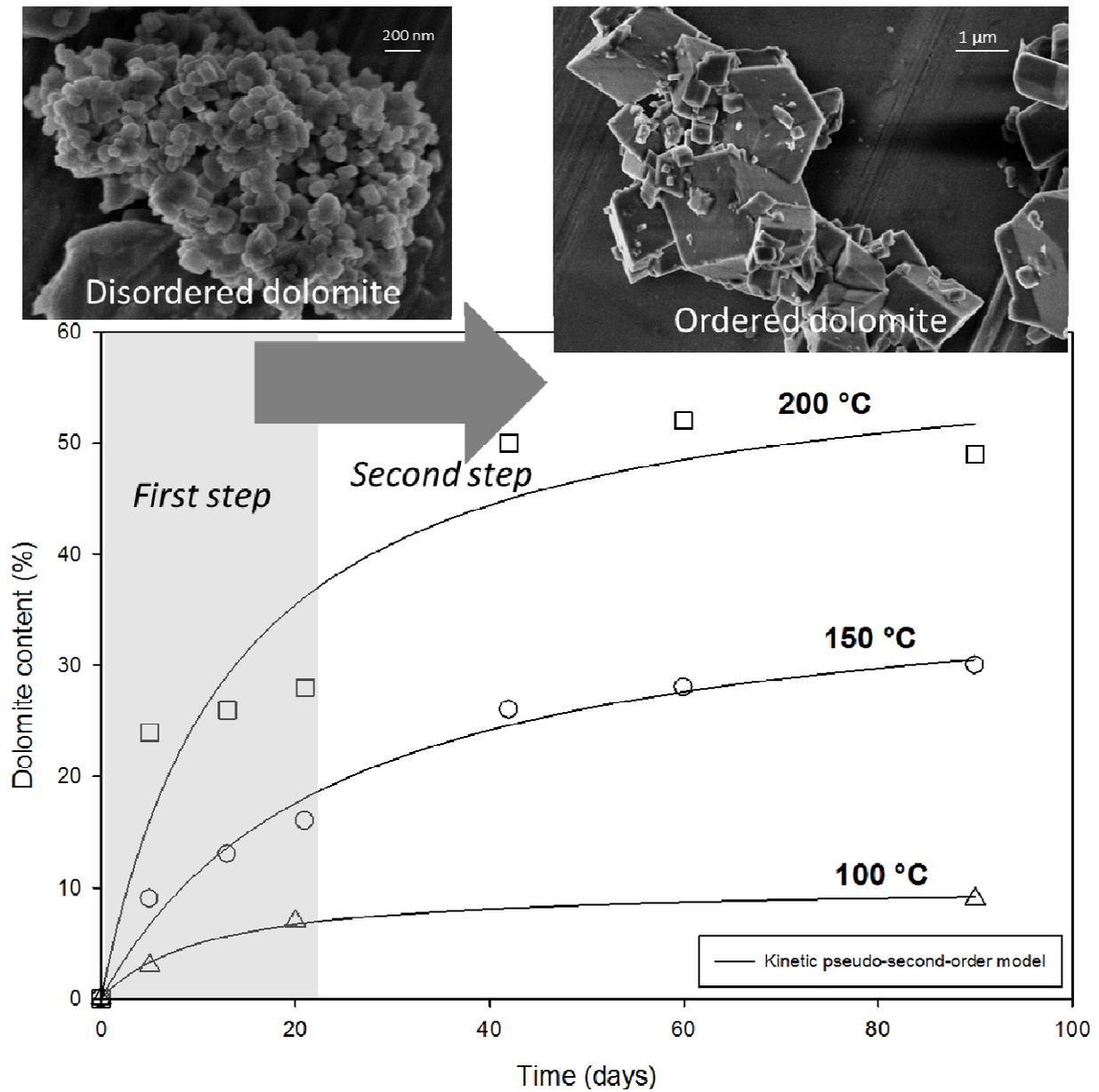


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397 Figure 4 (b)

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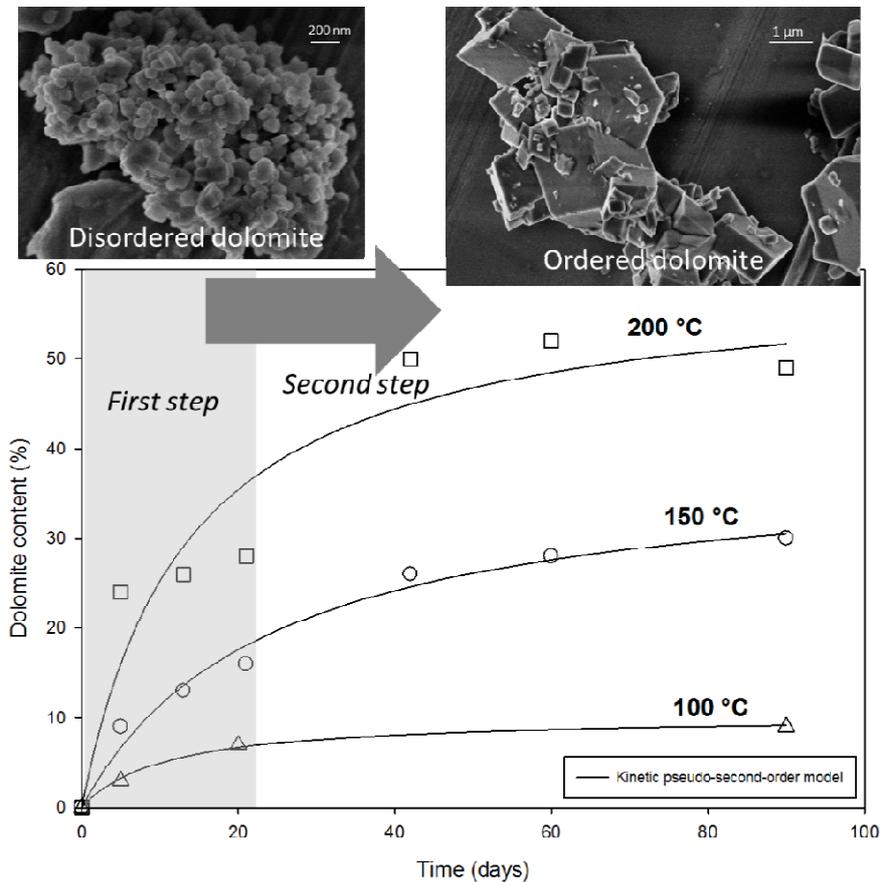
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401 Figure 5. Temperature influence on the kinetic of dolomite formation via simultaneous
 402 dissolution of calcite and magnesite in high-carbonate medium. Dolomite content was deduced
 403 from Rietveld refinement of XRD patterns shown in Fig. 3. Insets: FESEM micro-images show
 404 that disordered dolomite is firstly formed followed by the formation of ordered dolomite (slower
 405 step).

406

Table of Content Graphic

407 **Precipitation of ordered dolomite via simultaneous dissolution of calcite and magnesite:**
408 **New experimental insights into an old precipitation enigma by Montes-Hernandez et al.**
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412 **Synopsis:** This study provides new experimental conditions to which dolomite can be formed in
413 hydrothermal systems via simultaneous dissolution of calcite and magnesite. Herein, the dolomite
414 formation was co-promoted by temperature and high-carbonate alkalinity. The activation energy
415 for this reaction pathway () is 29 kJ/mol.

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