

1 8. Supporting Information

2 8.1. BG11 Growth Medium Information

3

Stock	Component	Concentration
1	NaNO ₃	15.0 g per litre
2	K ₂ HPO ₄	2.0 g per 500 mL
3	MgSO ₄ ·7H ₂ O	3.75 g per 500 mL
4	CaCl ₂ ·2H ₂ O	1.80 g per 500 mL
5	Citric acid	0.30 g per 500 mL
6	Ammonium ferric citrate green	0.30 g per 500 mL
7	EDTANa ₂	0.05 g per 500 mL
8	Na ₂ CO ₃	1.0 g per 500 mL
Trace metal solution:		Concentration per litre:
	H ₃ BO ₃	2.86 g
	MnCl ₂ ·4H ₂ O	1.81 g
9	ZnSO ₄ ·7H ₂ O	0.22 g
	Na ₂ MoO ₄ ·2H ₂ O	0.39 g
	CuSO ₄ ·5H ₂ O	0.08 g
	Co(NO ₃) ₂ ·6H ₂ O	0.05 g

4 **Table SI 1.** Contents of stock solutions used to make BG11 growth medium.

5

Medium	per Litre
Stock solution 1	100 mL
Stock solutions 2-8	10 mL each
Stock solution 9	1 mL

Table SI 1. Volumes of stock solutions combined to create BG11 growth medium.

8.2. Humic Acid Characterisation

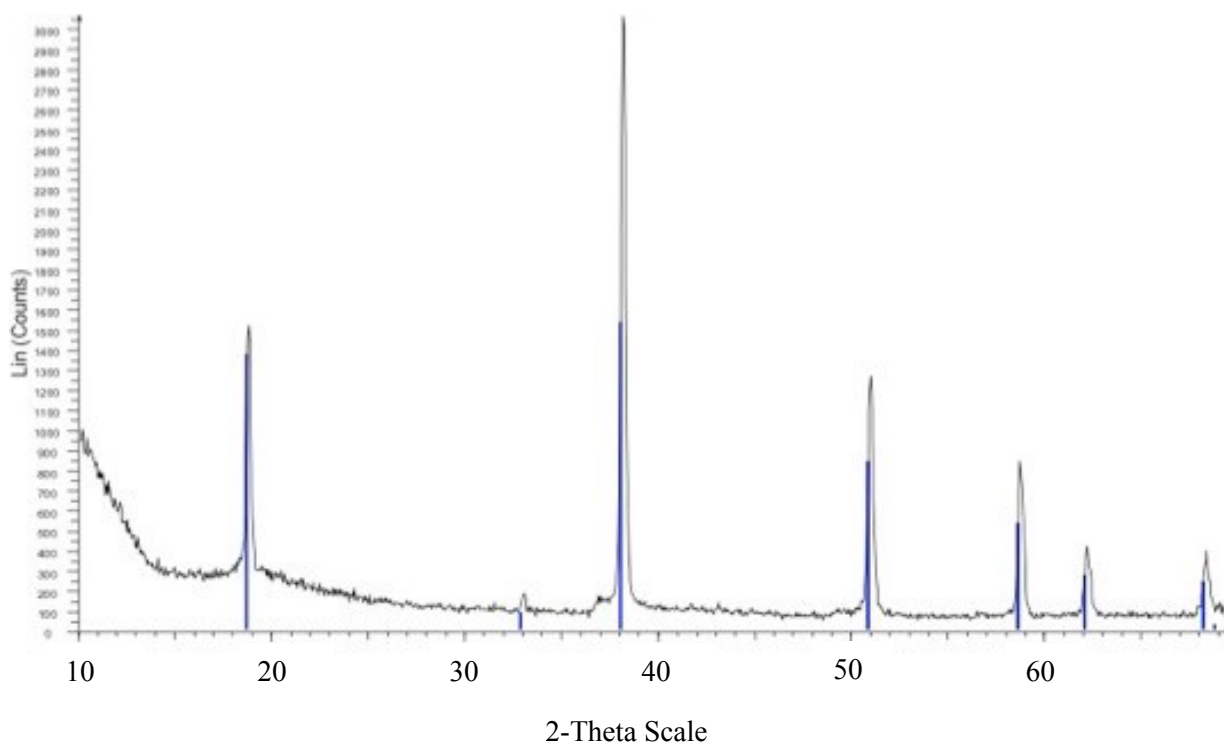
Trace metal content of the humic acid starting material was analysed by ICP-OES and is listed in Table SI 3.

Metal	% Composition
Al	3
Ca	2
Mg	<0.3
Na	4
Fe	1
Cu	<0.3
K	0.7

Table SI 3. Trace metal composition of humic acid starting material determined by ICP-OES.

14 8.3. Brucite Characterisation

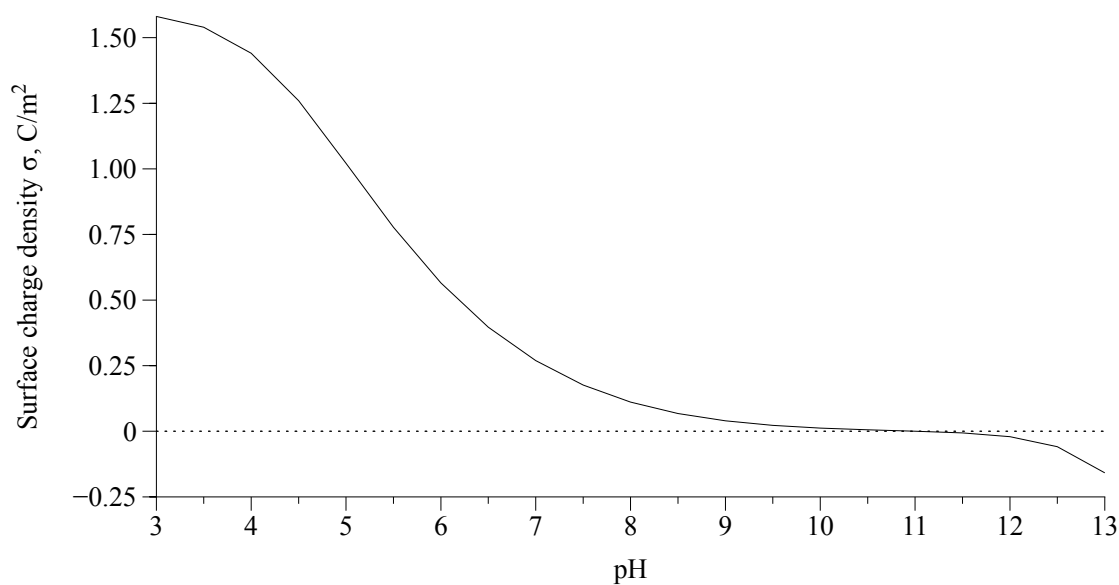
15 Brucite starting material was a very fine white powder shown to be consistent with
16 synthetically produced $\text{Mg}(\text{OH})_2$ (Figure SI 1). Surface area analysis using the N_2 gas
17 adsorption BET method calculated the surface area of the brucite at $5.43 \text{ m}^2/\text{g}$.



18 **Figure SI 1.** Powder XRD of brucite starting material (black) compared with reference for
19 synthetic brucite (blue).

22

23 The PHREEQC v.3.3.3 model and LLNL database was used to calculate the surface
24 charge density, σ , versus pH to predict sorption behaviour of the different system
25 components (Figure SI 2). A site density of 10 sites nm^{-2} was used from Pokrovsky and
26 Schott.⁸



27

28 **Figure SI 2.** Brucite surface charge density vs. pH modelled with PHREEQC.

29 The input data for the model is shown below:

```

30 phases
31 pH_fix
32 H+ = H+
33 log_k 0
34
35 surface_master_species
36 Brucite_w Brucite_wOH
37
38 surface_species
39 Brucite_wOH = Brucite_wOH
40 log_k 0
41
42 Brucite_wOH + H+ = Brucite_wOH2+
43 log_k 10
44
45 Brucite_wOH = Brucite_wO- + H+
46 log_k -12
47
48 solution 1
49 pH 2
50 end
51
52 surface 1
53 -sites_units density
54 Brucite_w 10 5.4346 0.1
55 end
56
57 selected_output

```

```
58 -file Brucite surface charge vs pH.xls
59 -reset false
60 -pH
61
62 USER_PUNCH
63 -headings charge sigma
64 -start
65 10 PUNCH EDL("charge","Brucite")
66 20 PUNCH EDL("sigma","Brucite")
67 -end
68
69 use solution 1
70 use surface 1
71 equilibrium_phases
72 pH_fix -3 NaOH
73 end
74
75 use solution 1
76 use surface 1
77 equilibrium_phases
78 pH_fix -3.5 NaOH
79 end
80
81 use solution 1
82 use surface 1
83 equilibrium_phases
84 pH_fix -4 NaOH
85 end
86
87 use solution 1
88 use surface 1
89 equilibrium_phases
90 pH_fix -4.5 NaOH
91 end
92
93 use solution 1
94 use surface 1
95 equilibrium_phases
96 pH_fix -5 NaOH
97 end
98
99 use solution 1
100 use surface 1
101 equilibrium_phases
102 pH_fix -5.5 NaOH
103 end
104
105 use solution 1
106 use surface 1
107 equilibrium_phases
108 pH_fix -6 NaOH
```

109 end
110
111 use solution 1
112 use surface 1
113 equilibrium_phases
114 pH_fix -6.5 NaOH
115 end
116
117 use solution 1
118 use surface 1
119 equilibrium_phases
120 pH_fix -7 NaOH
121 end
122
123 use solution 1
124 use surface 1
125 equilibrium_phases
126 pH_fix -7.5 NaOH
127 end
128
129 use solution 1
130 use surface 1
131 equilibrium_phases
132 pH_fix -8 NaOH
133 end
134
135 use solution 1
136 use surface 1
137 equilibrium_phases
138 pH_fix -8.5 NaOH
139 end
140
141 use solution 1
142 use surface 1
143 equilibrium_phases
144 pH_fix -9 NaOH
145 end
146
147 use solution 1
148 use surface 1
149 equilibrium_phases
150 pH_fix -9.5 NaOH
151 end
152
153 use solution 1
154 use surface 1
155 equilibrium_phases
156 pH_fix -10 NaOH
157 end
158
159 use solution 1

160 use surface 1
161 equilibrium_phases
162 pH_fix -10.5 NaOH
163 end
164
165 use solution 1
166 use surface 1
167 equilibrium_phases
168 pH_fix -11 NaOH
169 end
170
171 use solution 1
172 use surface 1
173 equilibrium_phases
174 pH_fix -11.5 NaOH
175 end
176
177 use solution 1
178 use surface 1
179 equilibrium_phases
180 pH_fix -12 NaOH
181 end
182
183 use solution 1
184 use surface 1
185 equilibrium_phases
186 pH_fix -12.5 NaOH
187 end
188
189 use solution 1
190 use surface 1
191 equilibrium_phases
192 pH_fix -13 NaOH
193 end
194

195

196 8.4. Sr Speciation in Solution

197 Figure SI 3 indicates the percentage of strontium as Sr^{2+} and SrOH^+ in solution between
198 pH 10 and 13.

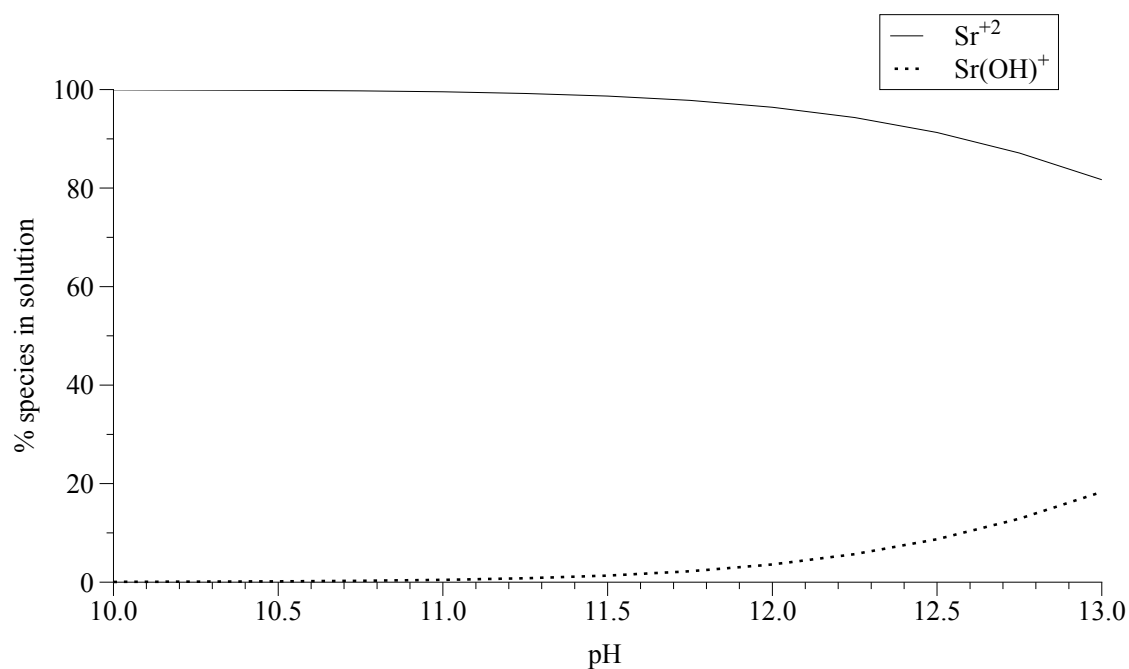


Figure SI 3. Sr speciation in solution at high pH.

The input data for the speciation model is shown below:

```

202 SOLUTION 1
203   temp    25
204   pH      10
205   pe      4
206   redox   pe
207   units   mol/kgw
208   density 1
209   Na      1e-010 charge
210   Sr      2.17e-011
211   -water  1 # kg
212
213 END
214
215 SOLUTION 1
216   temp    25
217   pH      10.25
218   pe      4
219   redox   pe
220   units   mol/kgw
221   density 1
222   Na      1e-010 charge
223   Sr      2.17e-011
224   -water  1 # kg
225
226 END
227

```

228 SOLUTION 1
229 temp 25
230 pH 10.5
231 pe 4
232 redox pe
233 units mol/kgw
234 density 1
235 Na 1e-010 charge
236 Sr 2.17e-011
237 -water 1 # kg
238
239 END
240
241 SOLUTION 1
242 temp 25
243 pH 10.75
244 pe 4
245 redox pe
246 units mol/kgw
247 density 1
248 Na 1e-010 charge
249 Sr 2.17e-011
250 -water 1 # kg
251
252 END
253
254 SOLUTION 1
255 temp 25
256 pH 11
257 pe 4
258 redox pe
259 units mol/kgw
260 density 1
261 Na 1e-010 charge
262 Sr 2.17e-011
263 -water 1 # kg
264
265 END
266
267 SOLUTION 1
268 temp 25
269 pH 11.25
270 pe 4
271 redox pe
272 units mol/kgw
273 density 1
274 Na 1e-010 charge
275 Sr 2.17e-011
276 -water 1 # kg
277
278 END

```
279
280 SOLUTION 1
281   temp    25
282   pH      11.5
283   pe       4
284   redox    pe
285   units    mol/kgw
286   density  1
287   Na       1e-010 charge
288   Sr       2.17e-011
289   -water   1 # kg
290
291 END
292
293 SOLUTION 1
294   temp    25
295   pH      11.75
296   pe       4
297   redox    pe
298   units    mol/kgw
299   density  1
300   Na       1e-010 charge
301   Sr       2.17e-011
302   -water   1 # kg
303
304 END
305
306 SOLUTION 1
307   temp    25
308   pH      12
309   pe       4
310   redox    pe
311   units    mol/kgw
312   density  1
313   Na       1e-010 charge
314   Sr       2.17e-011
315   -water   1 # kg
316
317 END
318
319 SOLUTION 1
320   temp    25
321   pH      12.25
322   pe       4
323   redox    pe
324   units    mol/kgw
325   density  1
326   Na       1e-010 charge
327   Sr       2.17e-011
328   -water   1 # kg
329
```

```

330 END
331
332 SOLUTION 1
333   temp    25
334   pH      12.5
335   pe      4
336   redox   pe
337   units   mol/kgw
338   density 1
339   Na      1e-010 charge
340   Sr      2.17e-011
341   -water  1 # kg
342
343 END
344
345 SOLUTION 1
346   temp    25
347   pH      12.75
348   pe      4
349   redox   pe
350   units   mol/kgw
351   density 1
352   Na      1e-010 charge
353   Sr      2.17e-011
354   -water  1 # kg
355
356 END
357
358 SOLUTION 1
359   temp    25
360   pH      13
361   pe      4
362   redox   pe
363   units   mol/kgw
364   density 1
365   Na      1e-010 charge
366   Sr      2.17e-011
367   -water  1 # kg
368
369 END
370
371

```

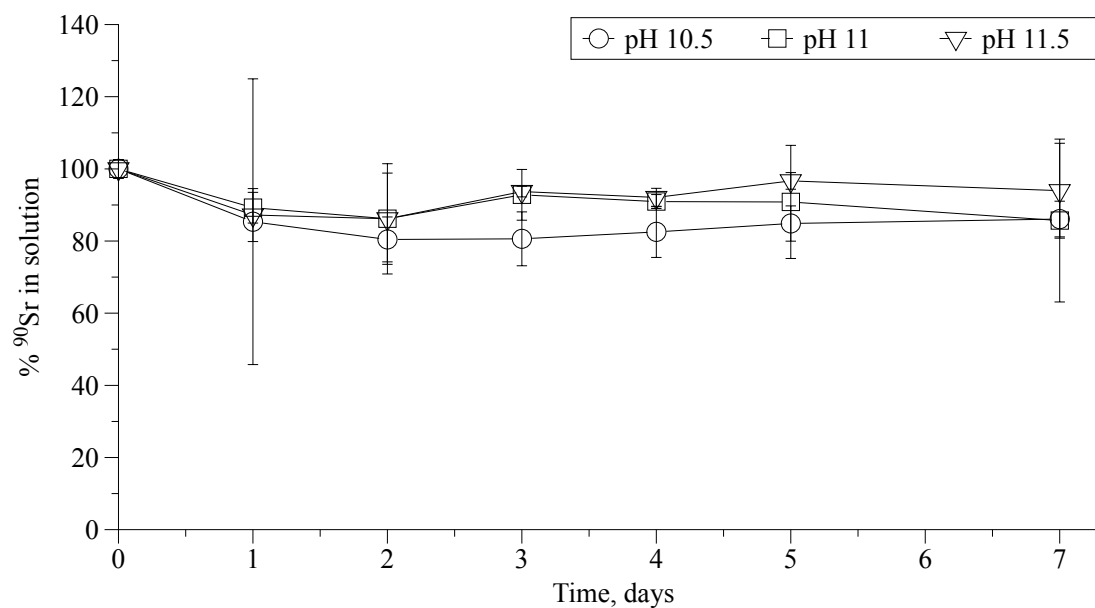
372 8.5. Brucite-⁹⁰Sr Investigations

373 Additional results confirming minimal sorption of ⁹⁰Sr to brucite in the binary system

374 are shown in Figure SI 4. Natural variations in the results could be due to the proximity

375 of the solution pH to the pH_{pzc} of the brucite surface.

376



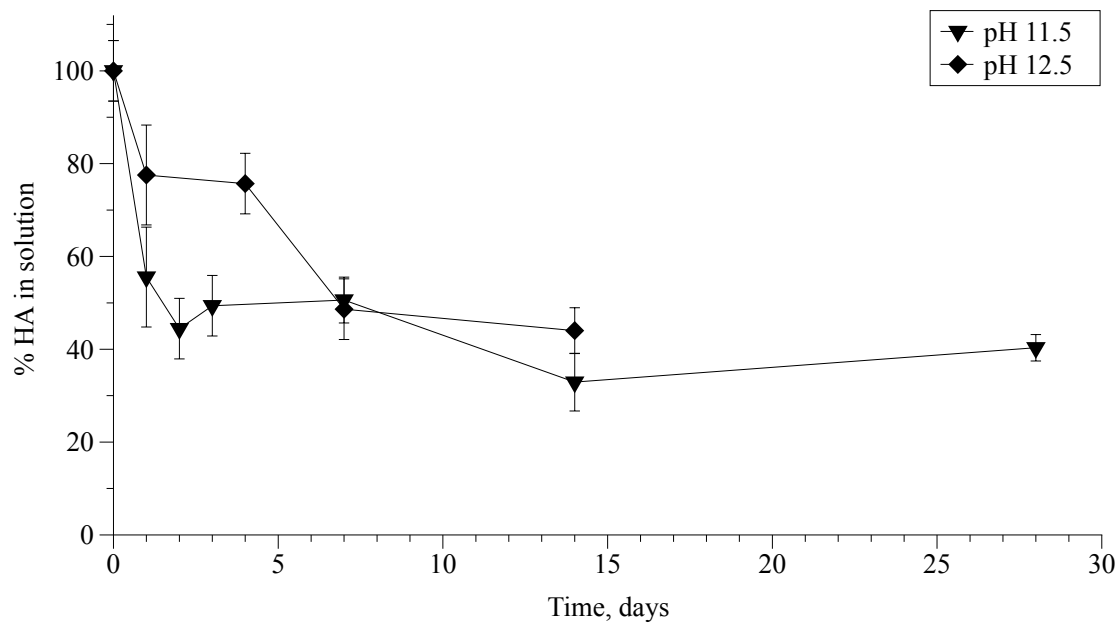
377

378 **Figure SI 4.** ^{90}Sr in solution, as a percentage of total initial ^{90}Sr for the brucite- ^{90}Sr sorption
 379 binary system at pH 10.5, 11 and 11.5.

380

381 8.6. Brucite-HA Investigations

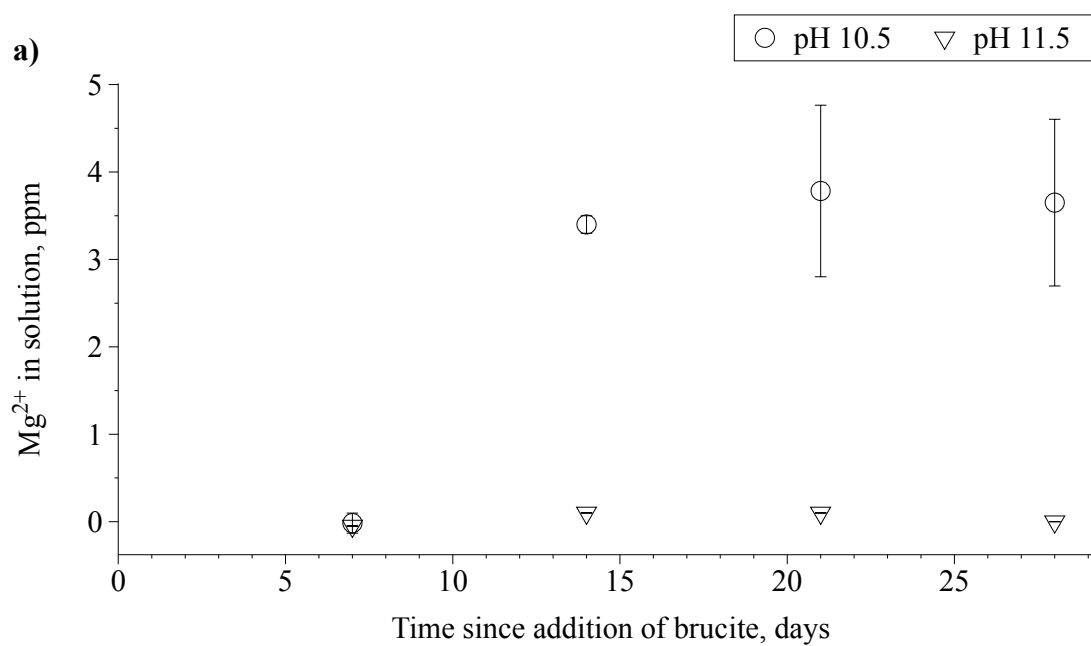
382 Additional experimental results for the brucite-HA binary system with varying pH also
 383 demonstrated an equilibrium period of approximately 7 days (Figure SI 5).



384

385 **Figure SI 5.** Percentage of HA in solution for the brucite-HA binary system at pH 11.5 and
 386 12.5.

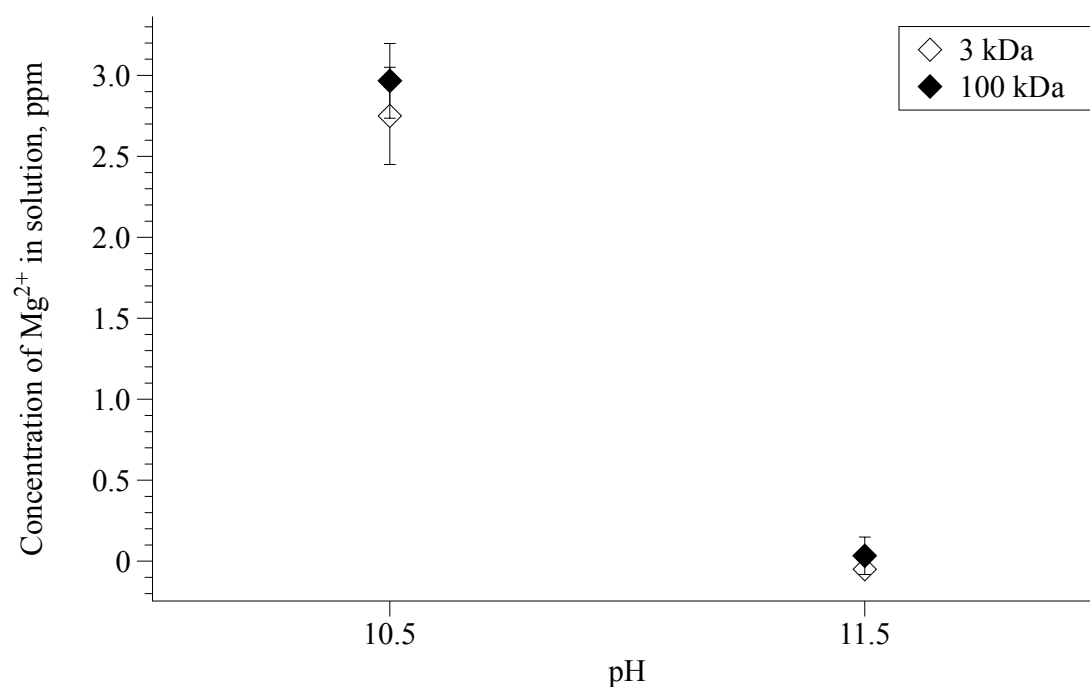
387 8.7. Analysis of Mg^{2+} in HA- ^{90}Sr -Brucite Ternary System



388

389

b)



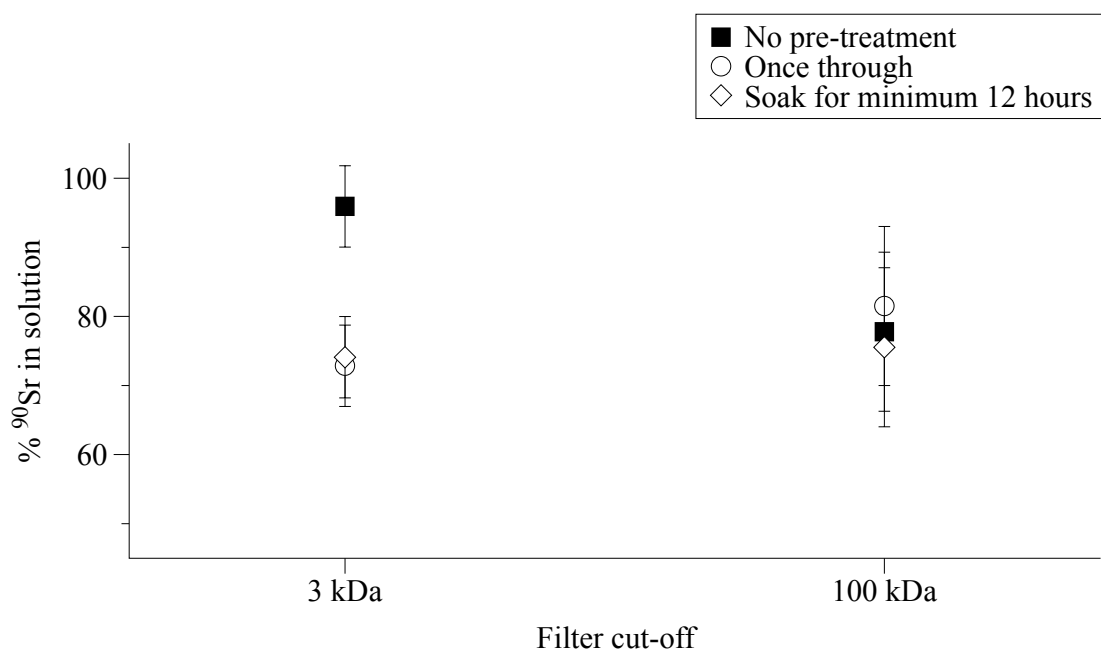
390

391 **Figure SI 6.** Mg^{2+} concentration corrected for sample dilution in **a)** HA- ^{90}Sr -brucite ternary
 392 system solution after addition of brucite and; **b)** HA- ^{90}Sr -brucite ternary system after
 393 ultrafiltration of the supernatant at day 28.

394

395 8.8. Ultrafiltration of ^{90}Sr Standards

396 Ultrafiltration of ^{90}Sr standards to assess retention of Sr on the filter membrane
 397 demonstrated significant natural variations regardless of the pre-treatment approach
 398 with stable saturated $\text{Sr}(\text{NO}_3)_2$ solution (Figure SI 7). Pre-treatment with $\text{Sr}(\text{NO}_3)_2$
 399 solution consisted of centrifugation of the solution either straight after filling the
 400 ultracentrifugation device, or after soaking the device in the solution for a minimum of
 401 12 hours. A reliable retention factor could not be calculated, and so ^{90}Sr ultrafiltration
 402 data from experiments should be treated with caution.



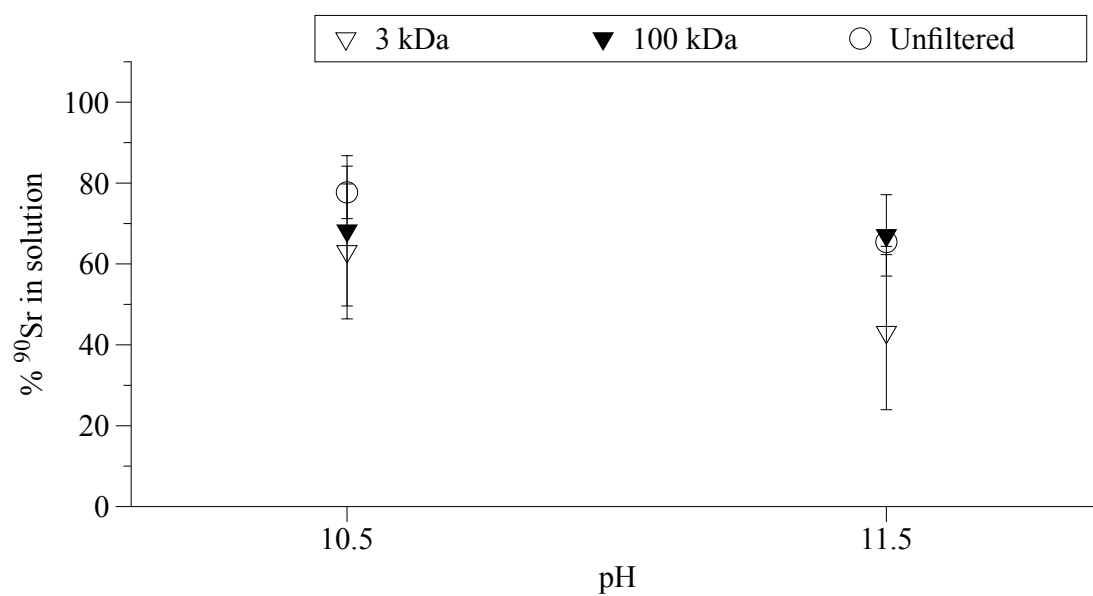
403

404 **Figure SI 7.** Ultrafiltration of ^{90}Sr in standards after no pre-treatment, one pre-treatment of
 405 saturated SrNO_3 solution, and pre-treatment of soaking the filters in saturated SrNO_3 solution
 406 for a minimum of 12 hours before once through.

407

408 8.9. Ultrafiltration of ^{90}Sr in Ternary Systems HA- ^{90}Sr -Brucite Ternary System

409 Ultrafiltration of ^{90}Sr at day 28 in the HA- ^{90}Sr -Brucite ternary systems identified no
 410 significant difference between the ultrafiltered samples and those that were not
 411 (Figure SI 8). These data should be treated with caution given the data presented in
 412 Figure SI 7.



413

414 **Figure SI 8.** Ultrafiltration of ^{90}Sr in solution at day 28 of HA- ^{90}Sr -brucite ternary system.

415

416