8. Supporting Information

8.1. BG11 Growth Medium Information

Stock	Component	Concentration
1	$NaNO_3$	15.0 g per litre
2	K_2HPO_4	2.0 g per 500 mL
3	$MgSO_4.7H_2O$	3.75 g per 500 mL
4	$CaCl_2.2H_2O$	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_2CO_3	1.0 g per 500 mL
	Trace metal solution:	Concentration per litre:
	H_3BO_3	2.86 g
	$MnCl_2.4H_2O$	1.81 g
9	$ZnSO_4.7H_2O$	0.22 g
	$Na_2MoO_4.2H_2O$	0.39 g
	$CuSO_4.5H_2O$	0.08 g
	$Co(NO_3)_2.6H_2O$	0.05 g

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

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.

8.3. Brucite Characterisation

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

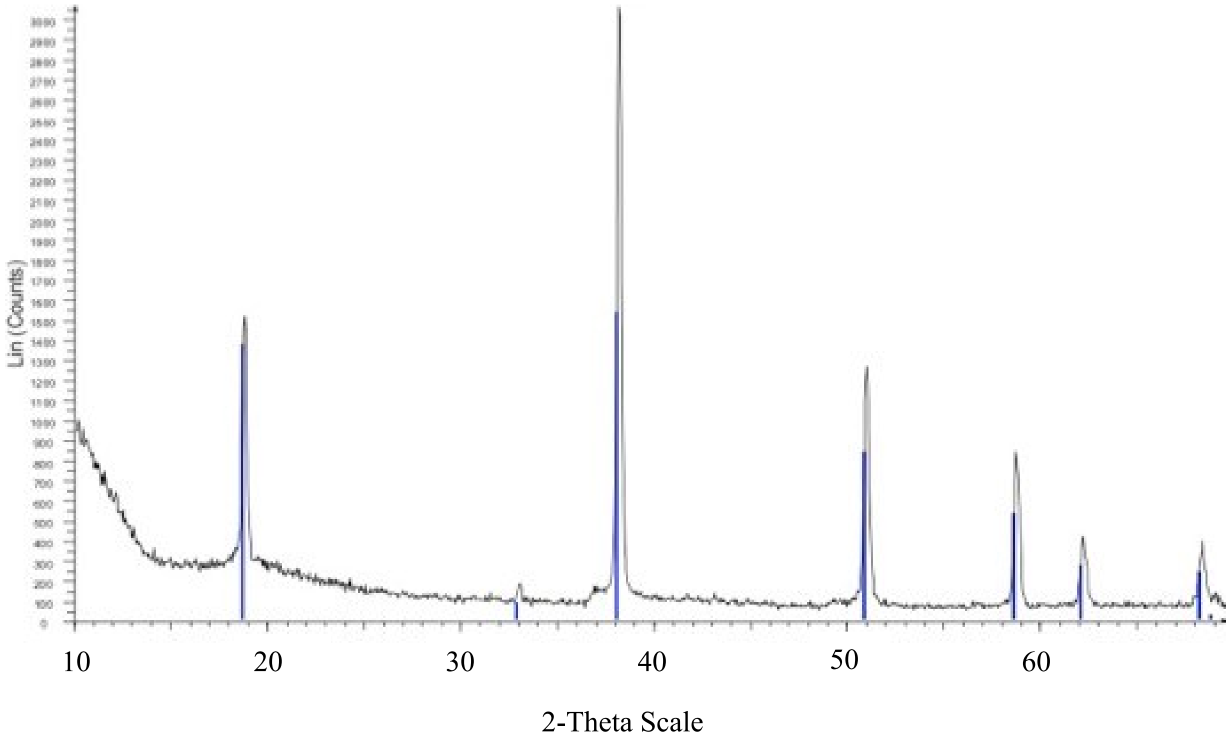


Figure SI 1. Powder XRD of brucite starting material (black) compared with reference for synthetic brucite (blue).

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

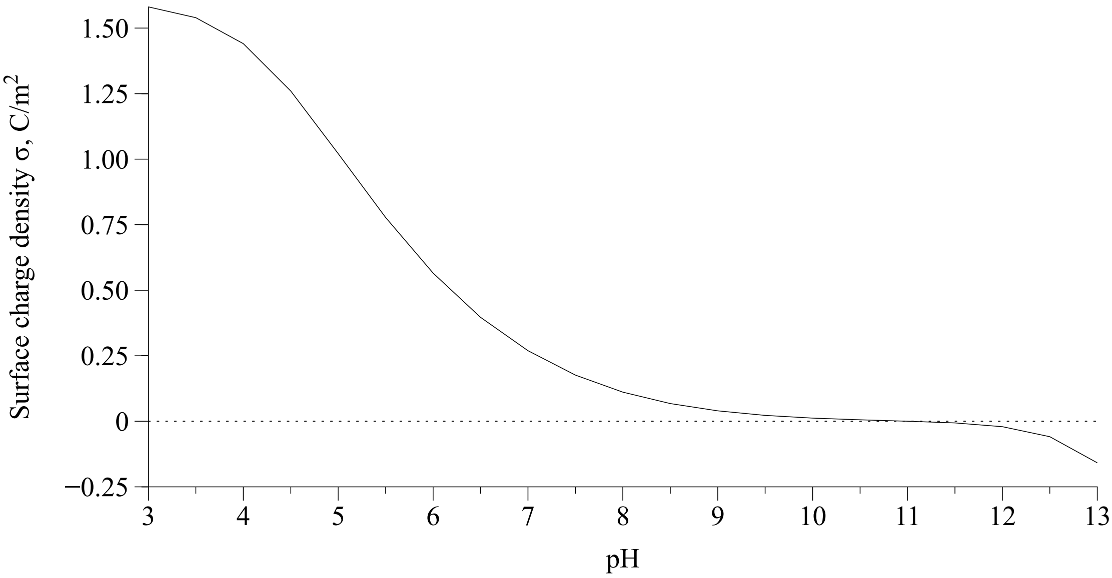


Figure SI 2. Brucite surface charge density vs. pH modelled with PHREEQC.

The input data for the model is shown below:

```
phases
pH_fix
H+ = H+
log_k 0

surface_master_species
Brucite_w Brucite_wOH

surface_species
Brucite_wOH = Brucite_wOH
log_k 0

Brucite_wOH + H+ = Brucite_wOH2+
log_k 10

Brucite_wOH = Brucite_wO- + H+
log_k -12

solution 1
pH 2
end

surface 1
-sites_units density
Brucite_w 10 5.4346 0.1
end

selected_output
```

```
-file Brucite surface charge vs pH.xls
-reset false
-pH

USER_PUNCH
-headings charge sigma
-start
10 PUNCH EDL("charge","Brucite")
20 PUNCH EDL("sigma","Brucite")
-end

use solution 1
use surface 1
equilibrium_phases
pH_fix -3 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -3.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -4 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -4.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -5.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -6 NaOH
```

```
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -6.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -7 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -7.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -8 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -8.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -9 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -9.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -10 NaOH
end

use solution 1
```

```
use surface 1
equilibrium_phases
pH_fix -10.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -11 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -11.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -12 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -12.5 NaOH
end

use solution 1
use surface 1
equilibrium_phases
pH_fix -13 NaOH
end
```

8.4. Sr Speciation in Solution

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

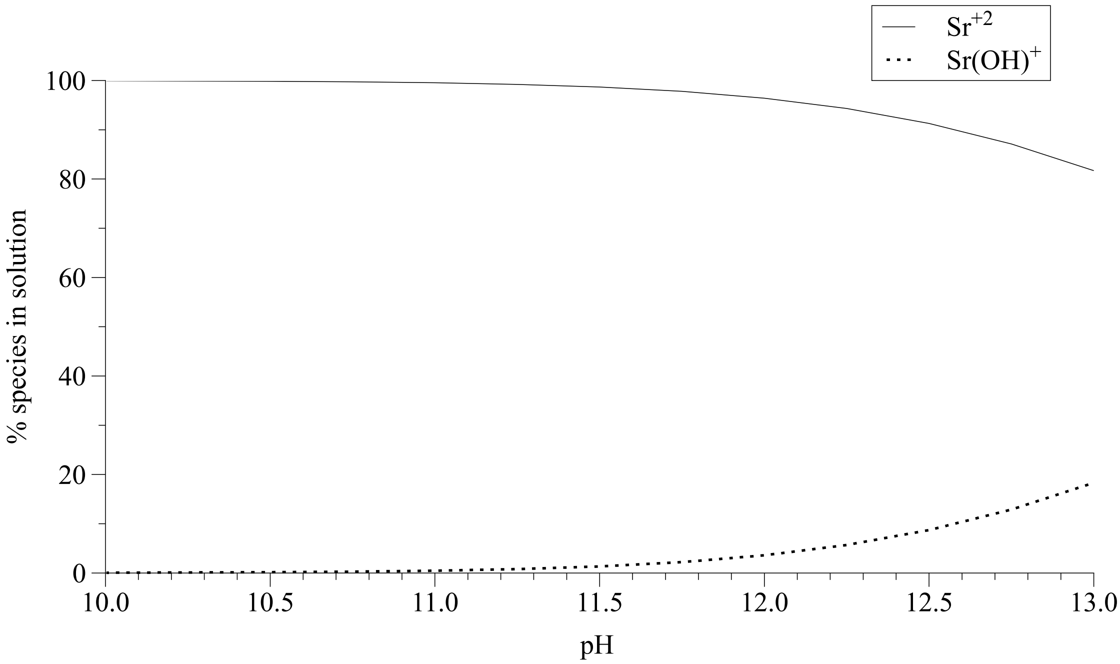


Figure SI 3. Sr speciation in solution at high pH.

The input data for the speciation model is shown below:

```
SOLUTION 1
   temp      25
   pH        10
   pe        4
   redox     pe
   units     mol/kgw
   density   1
   Na        1e-010  charge
   Sr        2.17e-011
   -water    1 # kg

END

SOLUTION 1
   temp      25
   pH        10.25
   pe        4
   redox     pe
   units     mol/kgw
   density   1
   Na        1e-010  charge
   Sr        2.17e-011
   -water    1 # kg

END
```

```
SOLUTION 1
   temp      25
   pH        10.5
   pe        4
   redox     pe
   units     mol/kgw
   density   1
   Na        1e-010  charge
   Sr        2.17e-011
   -water    1 # kg

END

SOLUTION 1
   temp      25
   pH        10.75
   pe        4
   redox     pe
   units     mol/kgw
   density   1
   Na        1e-010  charge
   Sr        2.17e-011
   -water    1 # kg

END

SOLUTION 1
   temp      25
   pH        11
   pe        4
   redox     pe
   units     mol/kgw
   density   1
   Na        1e-010  charge
   Sr        2.17e-011
   -water    1 # kg

END

SOLUTION 1
   temp      25
   pH        11.25
   pe        4
   redox     pe
   units     mol/kgw
   density   1
   Na        1e-010  charge
   Sr        2.17e-011
   -water    1 # kg

END
```

```
SOLUTION 1
   temp     25
   pH       11.5
   pe       4
   redox    pe
   units    mol/kgw
   density  1
   Na       1e-010  charge
   Sr       2.17e-011
   -water   1 # kg

END

SOLUTION 1
   temp     25
   pH       11.75
   pe       4
   redox    pe
   units    mol/kgw
   density  1
   Na       1e-010  charge
   Sr       2.17e-011
   -water   1 # kg

END

SOLUTION 1
   temp     25
   pH       12
   pe       4
   redox    pe
   units    mol/kgw
   density  1
   Na       1e-010  charge
   Sr       2.17e-011
   -water   1 # kg

END

SOLUTION 1
   temp     25
   pH       12.25
   pe       4
   redox    pe
   units    mol/kgw
   density  1
   Na       1e-010  charge
   Sr       2.17e-011
   -water   1 # kg
```

```
END

SOLUTION 1
   temp      25
   pH        12.5
   pe        4
   redox     pe
   units     mol/kgw
   density   1
   Na        1e-010  charge
   Sr        2.17e-011
   -water    1 # kg

END

SOLUTION 1
   temp      25
   pH        12.75
   pe        4
   redox     pe
   units     mol/kgw
   density   1
   Na        1e-010  charge
   Sr        2.17e-011
   -water    1 # kg

END

SOLUTION 1
   temp      25
   pH        13
   pe        4
   redox     pe
   units     mol/kgw
   density   1
   Na        1e-010  charge
   Sr        2.17e-011
   -water    1 # kg

END
```

8.5. Brucite-^{90}Sr Investigations

Additional results confirming minimal sorption of ^{90}Sr to brucite in the binary system are shown in Figure SI 4. Natural variations in the results could be due to the proximity of the solution pH to the pH_{pzc} of the brucite surface.

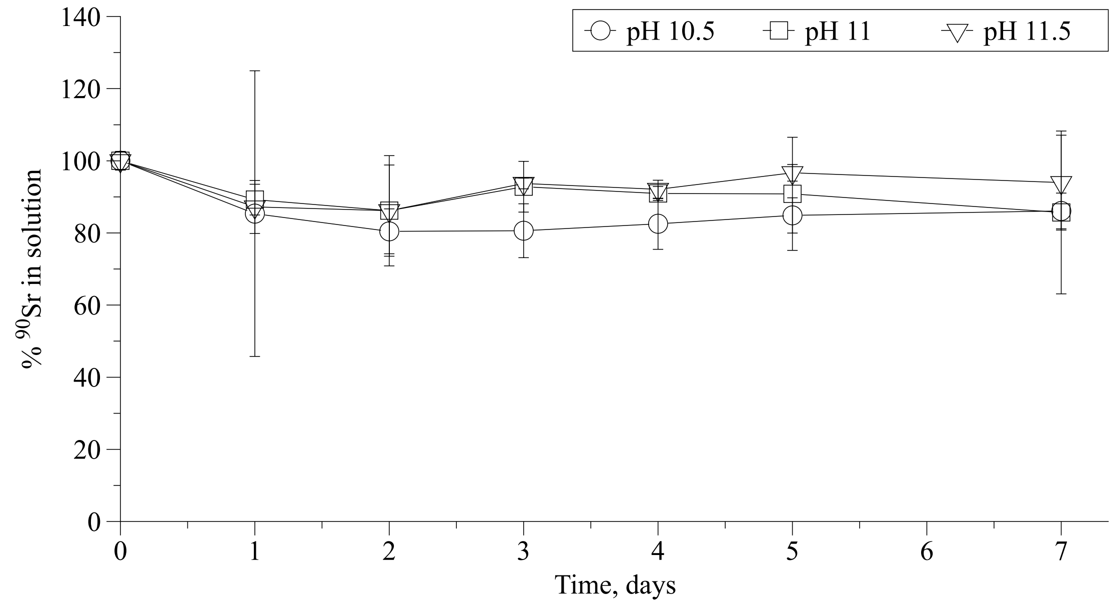


Figure SI 4. ^{90}Sr in solution, as a percentage of total initial ^{90}Sr for the brucite-^{90}Sr sorption binary system at pH 10.5, 11 and 11.5.

8.6. Brucite-HA Investigations

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

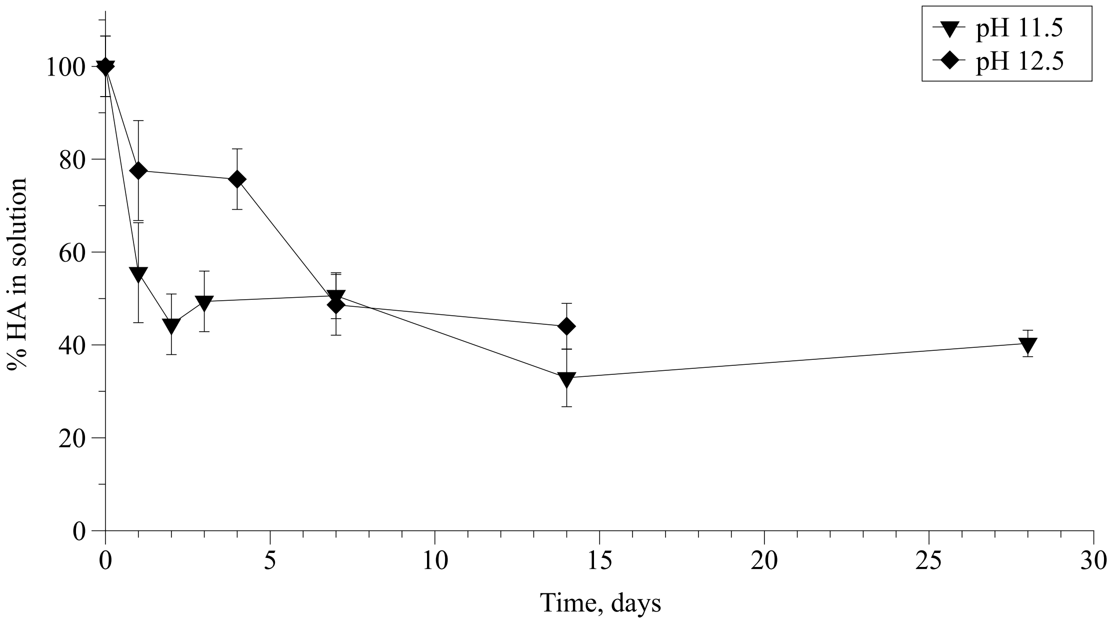
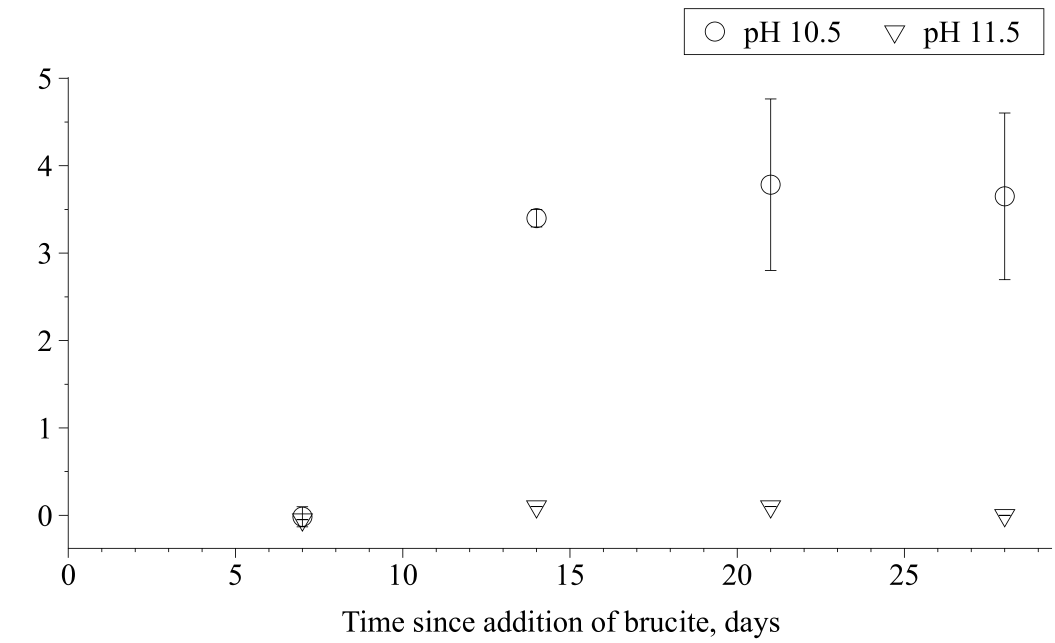


Figure SI 5. Percentage of HA in solution for the brucite-HA binary system at pH 11.5 and 12.5.

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

a)



b)

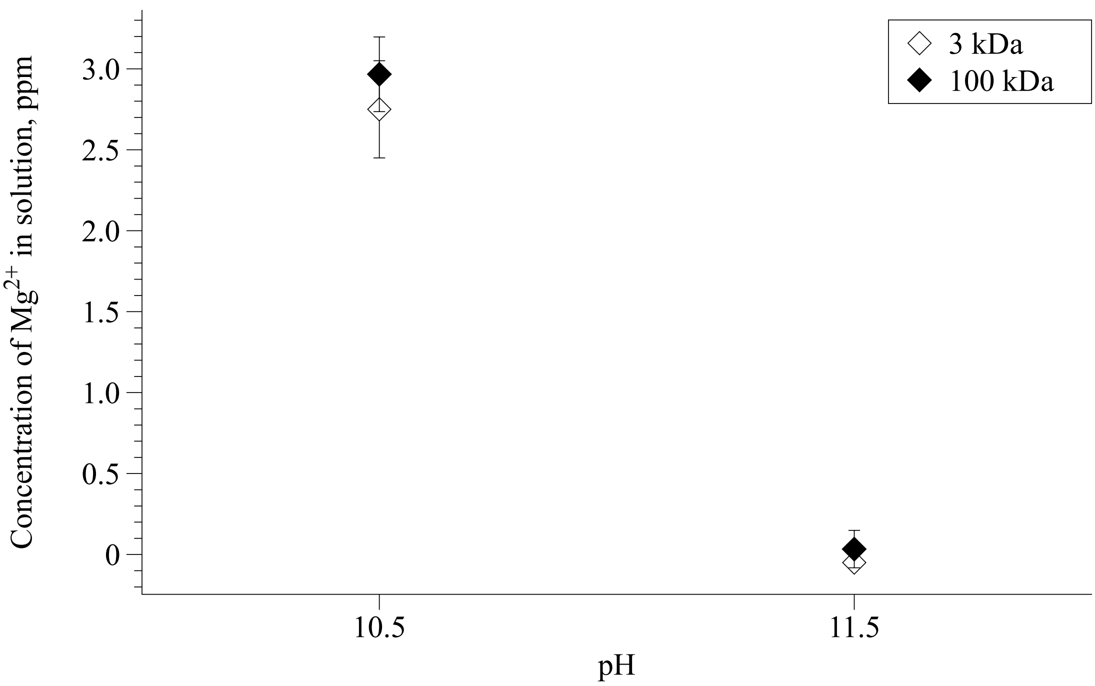


Figure SI 6. Mg^{2+} concentration corrected for sample dilution in **a)** HA-^{90}Sr-brucite ternary system solution after addition of brucite and; **b)** HA-^{90}Sr-brucite ternary system after ultrafiltration of the supernatant at day 28.

<u>8.8. Ultrafiltration of ^{90}Sr Standards</u>

Ultrafiltration of ^{90}Sr standards to assess retention of Sr on the filter membrane demonstrated significant natural variations regardless of the pre-treatment approach with stable saturated $Sr(NO_3)_2$ solution (Figure SI 7). Pre-treatment with $Sr(NO_3)_2$ solution consisted of centrifugation of the solution either straight after filling the ultracentrifugation device, or after soaking the device in the solution for a minimum of 12 hours. A reliable retention factor could not be calculated, and so ^{90}Sr ultrafiltration data from experiments should be treated with caution.

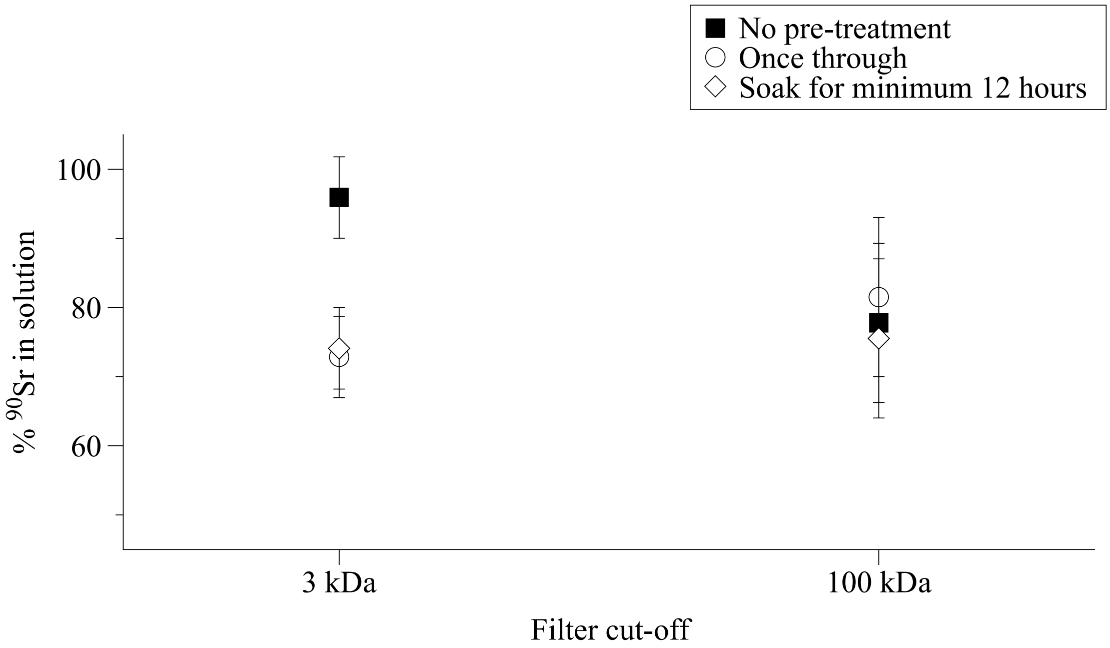


Figure SI 7. Ultrafiltration of ^{90}Sr in standards after no pre-treatment, one pre-treatment of saturated $SrNO_3$ solution, and pre-treatment of soaking the filters in saturated $SrNO_3$ solution for a minimum of 12 hours before once through.

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

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

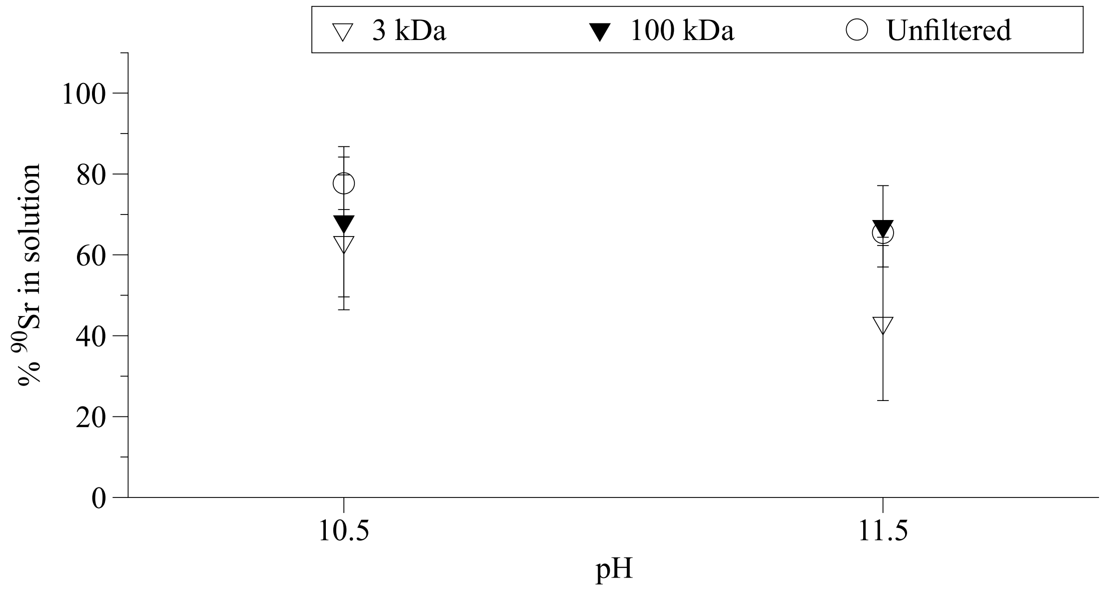


Figure SI 8. Ultrafiltration of ^{90}Sr in solution at day 28 of HA-^{90}Sr-brucite ternary system.