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Sabkha Dolomite as an Archive for the Magnesium Isotope Composition of Seawater

Supplementary Information

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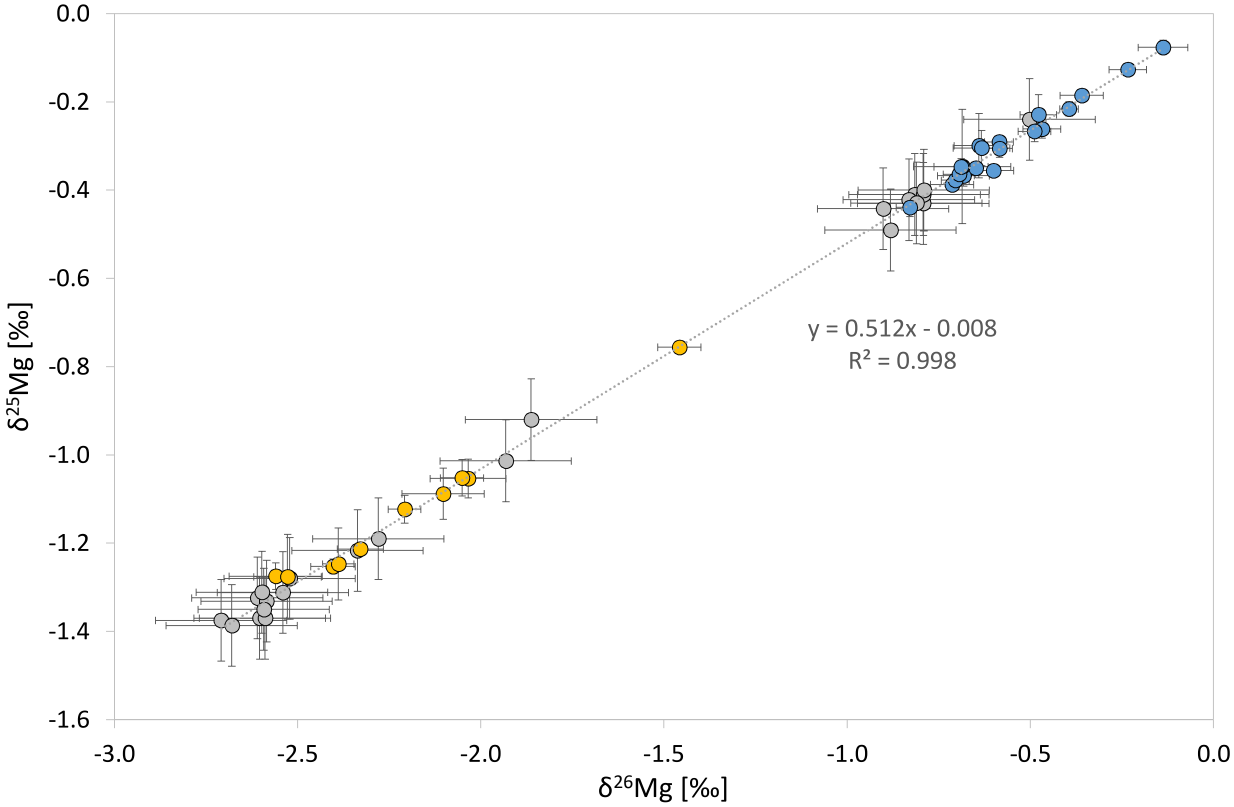
SUPPLEMENTARY INFORMATION

Mg Isotope Measurements

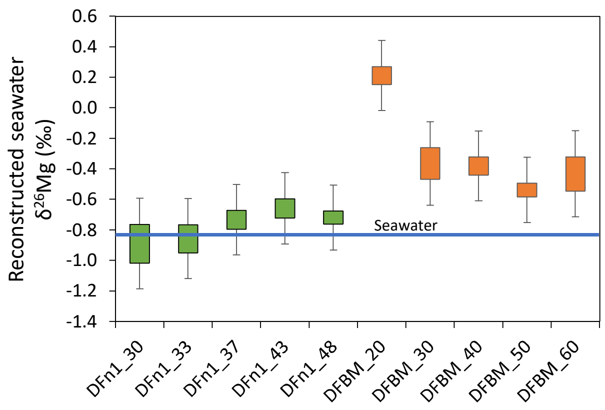
XRD analyses were done using a Bruker AXS D8 Advance Diffractometer. There was no further preparation of the pore-water samples, except for the Mg column chemistry described below. Concentrations were measured on a Thermo Scientific Element XR ICP-MS. Mg was purified using 0.5M and 2.0M HCl on Bio-Rad AG® 50W-X12 (200–400 mesh) resin in 30 ml Savillex Microcolumns. A yield of close to 100% and a total matrix element/Mg ratio of <0.05 were measured for each sample. Magnesium isotope ratios were measured on a Thermo Scientific Neptune MC-ICP-MS using a standard-sample bracketing method. The $\delta^{26}Mg$ values are reported relative to DSM3. Results of pure Mg solutions and natural reference materials are identical within error to the values reported in the literature (Suppl. Table 2; e.g., Foster et al., 2010; Ling et al., 2011; An and Huang, 2014, Shalev et al., 2018a). The $\delta^{25}Mg$ versus $\delta^{26}Mg$ results determined in this study plot on a single line with a slope of 0.512 (Suppl. Figure 1), suggesting no major influence of isobaric interferences on the measured Mg isotope ratios.

Supplementary Fig. 1



Supplementary Figure 1. $\delta^{25}Mg$ versus $\delta^{26}Mg$ values of samples and reference materials measured in this study. Data from Supplementary Tables 2-4. Grey – reference materials; Blue – pore water samples from DFS; Yellow – sediment samples from DFS. Error bars are 2SD of each result. The data are in accordance with a regression line (dotted) that crosses close to the origin and has a slope of 0.512, typical of mass dependent fractionation of terrestrial material.

Supplementary Fig. 2



Supplementary Figure 2. Reconstructed $\delta^{26}Mg$ values of seawater as calculated from DFS dolomites. Colors: DFn1 – green; DF_{BM} – orange; True seawater – blue line. An isotope fractionation of -1.67‰ (for 32°C, in equation 1; Li et al., 2015) was used. Boxes indicate the results within the 2SD on the $\delta^{26}Mg$ of the dolomite. Error bars show the further uncertainty results from the uncertainty on the temperature (±6°C).

Supplementary Tables

Supplementary Table 1: Core sampling sites location

Core	Latitude	Longitude
DFn1	25°38'13.4"N	50°57'31.9"E
DFn3	25°37'31.5"N	50°57'39.2"E
DF_{BM}	25°38'05.4"N	50°57'35.3"E

Supplementary Table 2: Mg isotope results of reference materials processed through the same Mg separation and instrumental procedures as the samples.

Material and replicate [a]	$\delta^{26}Mg$ (‰)	2SD (‰)	$\delta^{25}Mg$ (‰)	2SD (‰)	n
DSM3					
Pure Mg passed through column	0.00	0.06	0.01	0.04	4
Cambridge-1					
A	-2.60	0.21	-1.37	0.20	3
B	-2.59	0.08	-1.37	0.13	4
C	-2.52	0.08	-1.28	0.08	3
D	-2.54	0.05	-1.31	0.02	4
E	-2.61	0.18	-1.32	0.22	4
F	-2.58	0.09	-1.33	0.11	4
G	-2.60	0.21	-1.31	0.22	4
H	-2.71	0.11	-1.37	0.02	4
I	-2.68	0.07	-1.39	0.02	3
Pure Mg passed through column	-2.59	0.10	-1.35	0.12	4
Average	**-2.60**	**0.11**	**-1.34**	**0.07**	**10**
Literature [b]	**-2.61**	**0.05**	**-1.34**	**0.04**	
Seawater					
A	-0.82	0.06	-0.41	0.03	4
B	-0.79	0.13	-0.43	0.13	4
C	-0.79	0.06	-0.41	0.09	4
D	-0.79	0.05	-0.40	0.05	4
E	-0.83	0.14	-0.42	0.18	4
F	-0.81	0.08	-0.43	0.14	8
G	-0.90	0.08	-0.44	0.02	4
H	-0.88	0.11	-0.49	0.03	4
Average	**-0.83**	**0.09**	**-0.43**	**0.06**	**8**
Literature [c]	**-0.83**	**0.09**	**-0.43**	**0.06**	**90**
Jdo-1 Dolomite					
A	-2.28	0.06	-1.19	0.05	4
B	-2.34	0.09	-1.22	0.09	4
Literature [d]	**-2.35**	**0.15**	**-1.23**	**0.09**	**11**
CRM-512 dolomite					
A	-1.86	0.09	-0.92	0.11	4
B	-1.93	0.02	-1.01	0.02	4
Literature [d]	**-2.03**	**0.17**	**-1.05**	**0.09**	**6**
DSW-1					
Dead Sea brine	-0.50	0.08	-0.24	0.10	4
Literature [d]	**-0.58**	**0.12**	**-0.30**	**0.07**	**8**

[a] Different column chemistry replicates are indicated by A-H, except for replicates A-I of the pure Mg Cambridge-1, which include the MC-ICP-MS measurements only; [b] An and Huang (2014), Shalev et al. (2018a); [c] Ling et al. (2011); [d] Shalev et al. (2018).

Supplementary Table 3: Major cations concentrations and Mg isotope results of pore water from DFS.

			Major cations				Mg isotopes				
Location	**Sampl. date**	**Depth**	**Na**	**Mg**	**K**	**Ca**	**δ^{26}Mg**	**2SD**	**δ^{25}Mg**	**2SD**	**n**
		cm	mM	mM	mM	mM	‰	‰	‰	‰	
Seawater[a]			460	55	11	11	-0.83	0.09	-0.43	0.06	8
Lagoon water	Mar-16	0	847	103	17	22	-0.83	0.04	-0.44	0.02	4
Lagoon water	Nov-17	0	731	86	15	18					
DFn1	Mar-16	5	4021	373	64	27					
DFn1	Mar-16	10	n.a.	382	67	25	-0.68	0.03	-0.37	0.01	4
DFn1	Mar-16	15	4051	377	64	28					
DFn1	Mar-16	20	4120	385	62	26	-0.68	0.07	-0.37	0.02	4
DFn1[b]							-0.71	0.06	-0.39	0.01	4
DFn1	Mar-16	25	n.a.	386	69	24					
DFn1	Mar-16	30	3847	363	63	26	-0.64	0.07	-0.30	0.07	2
DFn1	Mar-16	35	n.a.	396	71	23					
DFn1	Mar-16	40	n.a.	392	69	23	-0.70	0.04	-0.38	0.01	4
DFn1	Mar-16	45	4138	378	62	26					
DFn1	Nov-16	8	4498	396	70	29					
DFn1	Nov-16	23	4392	388	72	28					
DFn1	Nov-16	33	4345	386	71	28					
DFn1	Nov-16	43	4159	366	70	30					
DFn1	Feb-17	10	3942	359	65	24					
DFn1	Feb-17	20	4137	380	68	24					
DFn1	Feb-17	30	4239	384	66	24					
DFn1[b]	Feb-17	30	4323	394	68	24					
DFn1	Feb-17	40	4054	365	66	26	-0.65	0.01	-0.35	0.01	4
DFn1	Feb-17	50	3862	339	64	29	-0.59	0.04	-0.29	0.01	4
DFn1	Feb-17	60	3792	347	61	27	-0.69	0.13	-0.35	0.13	4
DF_{BM}	Nov-17	9	3384	529	79	15	-0.69	0.04	-0.36	0.02	4
DF_{BM}	Nov-17	19	3533	477	81	20	-0.58	0.04	-0.31	0.02	4
DF_{BM}[b]							-0.60	0.06	-0.36	0.01	3
DF_{BM}	Nov-17	29	3439	434	81	26	-0.47	0.05	-0.26	0.02	4
DF_{BM}	Nov-17	39	3308	394	73	31	-0.39	0.03	-0.22	0.02	4
DF_{BM}	Nov-17	49	3328	366	78	41	-0.23	0.05	-0.13	0.01	3
DF_{BM}	Nov-17	59	3479	359	80	50	-0.14	0.07	-0.08	0.02	3
DF_{BM}[b]	Nov-17	59	3348	351	74	52					
DFn3 (inside mat)	Nov-17	2	988	117	18	24					
DFn3	Nov-17	8	2849	332	53	25	-0.69	0.07	-0.35	0.02	4
DFn3[b]	Nov-17	8	2785	328	53	24					
DFn3	Nov-17	18	2862	316	56	27	-0.63	0.08	-0.30	0.04	4
DFn3	Nov-17	28	2772	298	53	30	-0.49	0.04	-0.27	0.02	4
DFn3	Nov-17	38	2790	292	51	33	-0.48	0.05	-0.23	0.05	4
DFn3	Nov-17	48	2588	271	52	34	-0.36	0.06	-0.19	0.01	4

n.a. not analyzed; [a] Seawater concentration data from Riley & Chester (1971); isotope data from current study; [b] Replicate.

Supplementary Table 4: Mineralogy and Mg isotope composition of sediments from DFS. Dol – dolomite, Ara – aragonite, Cal – calcite, Gyp – gypsum, Hal – halite, Q – quartz.

		Mineralogy						Mg isotopes				
Location	**Depth**	**Dol**	**Ara**	**Cal**	**Gyp**	**Hal** [a]	**Q**	**δ^{26}Mg**	**2SD**	**δ^{25}Mg**	**2SD**	**n**
	cm	wt%	wt%	wt%	wt%	wt%	wt%	‰	‰	‰	‰	
DFn1	17	0	0	0	93	7	0					
DFn1[b]	17	0	0	10	90	0	0					
DFn1	30	48	0	0	21	30	0	-2.56	0.13	-1.27	0.03	4
DFn1	33	78	0	0	9	12	0	-2.53	0.09	-1.28	0.10	4
DFn1	37	80	0	0	6	14	0	-2.40	0.06	-1.25	0.02	4
DFn1	43	68	0	0	8	18	6	-2.33	0.06	-1.21	0.01	4
DFn1	48	83	4	0	0	11	3	-2.39	0.04	-1.25	0.08	4
DFn1[b]	48	79	6	0	0	16	0					
DFn1[c]	48	80	0	0	0	20	0					
DF_{BM}	10	0	0	16	47	37	0					
DF_{BM}	20	22	0	8	36	33	0	-1.46	0.06	-0.76	0.01	4
DF_{BM}	30	37	0	4	0	53	6	-2.03	0.10	-1.05	0.04	4
DF_{BM}	40	21	3	5	0	67	4	-2.05	0.06	-1.05	0.04	4
DF_{BM}	50	34	10	6	0	45	5	-2.21	0.04	-1.12	0.03	4
DF_{BM}	60	33	17	7	0	42	0	-2.10	0.11	-1.09	0.06	4
DF_{BM}[b]	60	35	17	0	0	48	0					
DFn3	14	0	71	0	0	29	0					
DFn3	34	0	73	0	0	27	0					

[a] Halite might be an artifact of the pore water evaporation that occurs in the laboratory.
[b] Duplicate.
[c] Replicate.

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