Supplementary information – Ba incorporation in benthic foraminifera – De Nooijer et al.

Table 1: measured calcitic El/Ca, calculated partition coefficients and experimental/ field conditions. The selected publications reflect the range in known ratios, but is not aimed to encompass all published element ratios. Particularly for Mg/Ca and Sr/Ca, the listed ratios only represent a small selection of published values.

Low-Mg species are marked in green (darker shade for benthics, light one for planktonics), high Mg-species are in red (milliolid species are in light shade). Reported element/Ca ratios are reported as a range of values (min-max) when reported in the original study, in other cases average values are reported. 'Study type' refers to core-top/ sediment trap calibrations (1) or culture experiment (2). 'n.d.' means not determined or not reported. Data from this study are referenced as 't.s.'. Numbers between parentheses refer to the standard deviation. For a number of field studies, (conservative) element concentrations are not measured, but are here calculated ('*') to obtain a partition coefficient. Assumed concentrations at salinity of 35.0 are 10.3 mmol/kg for Ca, 24.5 µmol/kg for Li, 416 µmol/kg for B, 0.469 mol/kg for Na, 52.8 mmol/kg for Mg, 90.6 µmol/kg for Sr and 109 nmol/kg for Ba.

Li/Ca							
calcite (µmol/mol)	seawater (mmol/mol)	D_{El} (*1000)	species	T (°C)	salinity	study type	ref
3.5 – 5.5	2.39*	1.5 – 2.3	*Hoeglundina elegans*	4 – 16.5	n.d.	1	24
2.7 – 4.6	2.39*	1.1 – 1.9	*Hoeglundina elegans*	5.8 – 19.0	34.9 – 36.8	1	22
12 - 20	2.39*	5.0 – 8.4	*Cibicidoides* spp.	4 – 16.5	n.d.	1	24
11 - 14	2.39*	4.6 – 5.9	*Cibicidoides pachyderma*	5.8 – 18.6	34.9 – 36.8	1	22
12 – 14	2.39*	5.0 – 5.9	*Cibicidoides wuellerstorfi*	2.9 – 3.4	n.d.	1	26
14 – 18	2.52	5.6 – 7.1	*Oridorsalis umbonatus*	1.1-3.6	n.d.	1	1
12 - 15	2.39*	5.0 – 6.3	*Planulina ariminensis*	7.0 – 12.1	34.9 – 36.8	1	22
11 - 17	2.39*	4.6 – 7.1	*Planulina foveolata*	11.0 – 17.8	34.9 – 36.8	1	22
13 - 19	2.39*	5.4 – 7.6	*Uvigerina* spp.	3.6 – 22.5	34.9 – 36.2	1	25
15 – 18	2.39*	6.3 – 7.1	*Uvigerina peregrina*	5.8 – 17.2	34.9 – 36.8	1	22
			Amphistegina lessonii	25	n.d.	2	31
14-18	2.39*	5.9 - 7.5	*Amphistegina lessonii*	18-33	35	2	32
13-16	2.39*	5.4 – 6.7	*Amphistegina lobifera*	24	35	2	32

12-20	2.39*	5.0 – 8.4	*Globorotalia inflata*	6 -13	35.0 – 35.8	1	23
13 – 17	2.39*	5.3 – 7.0	*Globigerinoides ruber*	n.d.	n.d.	1	28
12 - 14	2.39*	4.8 – 5.6	*Globigerinoides sacculifer*	26	n.d.	1	24
0 - 14	2.39*	≤5.6	*Globigerinoides sacculifer*	n.d.	n.d.	1	28
17 - 20	2.39*	7.1 – 8.4	*Neogloboquadrina pachyderma*	-2 - 0	32.5 – 33.5	1	18
10 - 11	2.39*	4.2 – 4.5	*Orbulina universa*	26	n.d.	1	24
10-20	1-5	4-10	*Globigerinoides sacculifer*	30	n.d.	2	34
Maximum range in D_{Li}		**1 - 9* 10^{-3}**					
55.7	1.8	31	*Operculina ammonoides*	22	n.d.	1	10
53-62	2.1	25 - 30	*Operculina ammonoides*	19-27	37 – 38	2	10
Maximum range in D_{Li}		**25 – 31 * 10^{-3}**					
B/Ca							
calcite (µmol/mol)	seawater (mmol/mol)	D_{El} (*1000)	species	T (°C)	salinity	study type	ref
30 - 60	40*	0.75 – 1.5	*Hoeglundina elegans*	-1 - 4	n.d.	1	21
172	40*	5.1	*Cibicidoides mundulus*	5.3	35	1	27
100 - 175	40*	2.5 – 4.4	*Cibicidoides mundulus*	-1 - 4	n.d.	1	21
125 - 250	40*	3.1 – 6.2	*Cibicidoides wuellerstorfi*	-1 - 4	n.d.	1	21
202 - 218	40*	5.1 - 5.5	*Cibicidoides wuellerstorfi*	2.9 – 3.4	n.d.	1	26
239	40*	6.0	*Cibicidoides wuellerstorfi*	3.7	35	1	27
20 – 60	40*	1.5 – 1.5	*Oridorsalis umbonatus*	1.1-3.6	n.d.	1	1
15 - 50	40*	0.4 – 1.3	*Uvigerina* spp.	-1 - 4	n.d.	1	21
113 – 212	40*	2.8 – 5.3	*Globigerinoides ruber*	24.0 – 29.3	33 - 40	2	12
90 - 160	43.8*	2.1 – 3.7	*Globigerinoides ruber*	19-27	36.2 – 37.0	1	16
112 - 121	40*	2.8 – 3.0	*Globigerinoides ruber*	19.5 – 30.4	34.7 – 36.8	1	27
103-122	40*	2.6 – 3.1	*Globigerinoides sacculifer*	28	36	1	12
79 - 145	40*	2.0 – 3.6	*Globigerinoides sacculifer*	24.0 – 29.3	33 - 40	2	12

73 - 98	40*	1.8 – 2.5	*Globigerinoides sacculifer*	23.8 – 28.0	34.8 – 35.9	1	27
48 - 62	40*	1.2 – 1.6	*Neogloboquadrina dutertrei*	18.7 – 24.2	34.8 – 36.7	1	27
45 - 77	40*	1.1 – 1.9	*Neogloboquadrina pachyderma*	-2 - 0	32.6 – 33.6	1	18
53 - 92	38 - 43	0.6 – 3.0	*Orbulina universa*	17.7 – 26.5	29.9 – 35.4	2	11
66 - 76	40*	1.7 – 1.9	*Orbulina universa*	28	36	1	12
Maximum range in D_B		**0.4 – 6 * 10^{-3}**					
1200 - 6360	392	3.1 - 16	*Amphistegina lessonii*	25	32	2	8
Maximum range in D_B		**3 – 16 * 10^{-3}**					
Na/Ca							
calcite (mmol/mol)	seawater (mol/mol)	D_{El} (*1000)	species	T (°C)	salinity	study type	ref
6.12 (±0.33)	47.8 (±0.7)	0.13	*Ammonia tepida*	20.0 (±0.2)	32.5 (±0.2)	2	3
5.9 – 7.6	45.5*	0.13 – 0.17	*Globigerinoides ruber*	n.d.	n.d.	1	28
5.1 – 6.4	45.5*	0.11 – 0.14	*Globigerinoides sacculifer*	n.d.	n.d.	1	28
5.5 – 6.0	45.5*	0.12 – 0.13	*Globigerinoides sacculifer*	n.d.	n.d.	1	29
4.5 – 5.2	45.5*	0.099 – 0.11	*Neogloboquadrina dutertrei*	n.d.	n.d.	1	29
4.0-6.0	30-50	0.1-0.15	*Globigerinoides sacculifer*	30	n.d	2	34
Maximum range in D_{Na}		**0.1 – 0.2 * 10^{-3}**					
24	41.6	0.58	*Operculina ammonoides*	24	37	2	10
Maximum range in D_{Na}		**0.6 * 10^{-3}**					
Mg/Ca							
calcite (mmol/mol)	seawater (mmol/mol)	D_{El} (*1000)	species	T (°C)	salinity	study type	ref
2 - 7	5158	0.39 – 1.4	*Ammonia tepida*	25 (±0.5)	32.2 (±0.2)	2	2
1.3 – 2.2	5080 (±30)	0.26 – 0.43	*Ammonia tepida*	20.0 (±0.2)	32.5 (±0.2)	2	3
1 - 3	5100 – 5300	0.31 – 0.70	*Ammonia tepida*	18.0 (±0.5)	35.0 (±0.3)	2	4
40 - 60	5200	7.7 - 12	*Amphistegina lessonii*	24	35	2	7
68 - 86	5126*	13 - 17	*Amphistegina lessonii*	21 - 29	n.d.	1	30

50 - 70	5200	9.6 - 13	*Amphistegina lobifera*	24	35	2	7
0.98 – 1.40	5126*	0.19 – 0.27	*Cibicidoides wuellerstorfi*	2.9 – 3.4	n.d.	1	26
1 – 3	5300	0.19 – 0.57	*Oridorsalis umbonatus*	1.1-3.6	n.d.	1	1
0.75 – 2.5	5126*	0.15 – 0.49	*Uvigerina* spp.	1.6 - 20	n.d.	1	6
3.5 - 5.5	5126*	0.68 – 1.1	*Globigerinoides ruber*	20-26	n.d.	1	16
5.2	5126*	1.0	*Globigerinoides sacculifer*	26	36	2	17
0.75 – 1.05	5126*	0.15 – 0.20	*Neogloboquadrina pachyderma*	-2 - 0	32.6 – 33.6	1	18
Maximum range in D_{Mg}		**0.2 – 17 * 10^{-3}**					
110 - 140	5200 – 6200	25– 28	*Heterostegina depressa*	18.0 (±0.5)	35.0 (±0.1)	2	4
214 - 267	5126*	42 - 52	*Neorotalia calcar*	21 - 29	n.d.	1	30
141 (± 2)	5330	27	*Operculina ammonoides*	24	37	2	10
138 - 144	5050 (± 50)	27 - 29	*Planoglabratella opercularis*	23.1 (± 0.2)	35	2	9
136	5050 (± 50)	27	*Quinqueloculina yabei*	24.5 (± 1.5)	36.5	2	9
95 -103	5126*	19 - 20	*Triloculina triincarta*	18.3	n.d.	1	20
90 – 100	5126*	18 - 20	*Spiroloculina subimpressa*	18.3	n.d.	1	20
80 -105	5126*	16 - 20	*Pyrgo sarsi*	18.3	n.d.	1	20
224 - 256	5126*	44 - 50	*Amphisorus hemprichii*	21 – 29	n.d.	1	30
213 - 255	5126*	42 - 50	*Marginopora vertebralis*	21 - 29	n.d.	1	30
116 – 132	5126*	23 – 26	*Archaias ungulatus*	23.9 (± 0.1)	31.8 (± 0.2)	2	33
Maximum range in D_{Mg}		**16 – 52 * 10^{-3}**					
Sr/Ca							
calcite (mmol/mol)	seawater (mmol/mol)	D_{El}	species	T (ºC)	salinity	study type	ref
1.2 – 1.9	9.47	0.13 – 0.20	*Ammonia tepida*	25 (±0.5)	32.2 (±0.2)	2	2
1.4 – 2.0	9.27 (±0.15)	0.15 - 0.22	*Ammonia tepida*	20.0 (±0.2)	32.5 (±0.2)	2	3
1.35 (±0.03)	4.6 – 15.6	0.16 – 0.17	*Ammonia tepida*	18.0 (±0.5)	35.0 (±0.3)	2	4
1.6 – 1.9	8.83*	0.18 – 0.22	*Amphistegina lessonii*	21 - 29	n.d.	1	30

1.29 – 1.36	8.83*	0.15	*Cibicidoides wuellerstorfi*	2.6 – 3.4	n.d.	1	[26]
0.8 – 1.00	8.72	0.09 – 0.11	*Oridorsalis umbonatus*	1.1-3.6	n.d.	1	[1]
1.35	8.83*	0.15	*Globigerinoides sacculifer*	26	36	2	[17]
1.36 – 1.40	8.83*	0.15 – 0.16	*Neogloboquadrina pachyderma*	-2 - 0	32.6 – 33.6	1	[18]
Maximum range in D_{Sr}		**0.1 – 0.2**					
2.56	4.8 – 17.8	0.27 – 0.33	*Heterostegina depressa*	18.0 (±0.5)	35.0 (±0.1)	2	[4]
1.9 – 2.2	8.83*	0.22 – 0.25	*Neorotalia calcar*	21 - 29	n.d.	1	[30]
2.56	8.42	0.30	*Operculina ammonoides*	24	37	2	[10]
1.8 – 1.9	8.83*	0.20 – 0.22	*Amphisorus hemprichii*	21 - 29	n.d.	1	[30]
0.6 – 1.8	8.83*	0.08 – 0.20	*Marginopora vertebralis*	21 - 29	n.d.	1	[30]
Maximum range in D_{Sr}		**0.1 – 0.3**					
Ba/Ca							
calcite (µmol/mol)	seawater (µmol/mol)	D_{El}	species	T (°C)	salinity	study type	ref
10 - 40	50 - 90	0.32	*Amphistegina lessonii*	25	32.5	2	t.s.
2.2 – 5.0	4.8 – 7.3	0.39 - 0.41	*Cibicidoides kullenbergi*	n.d.	n.d.	1	[5]
1.8 – 4.4	4.5 – 13.5	0.35 – 0.37	*Cibicidoides wuellerstorfi*	n.d.	n.d.	1	[5]
1.9 – 4.7	4.6 - 13.1	0.32 – 0.34	*Uvigerina* spp.	n.d.	n.d.	1	[5]
0.5 - 0.8	3.7	0.14 – 0.22	*Globigerina bulloides*	22	33.7	2	[13]
1.2 – 3.1	10.6*	0.11 – 0.29	*Globigerinoides ruber*	n.d.	n.d.	1	[28]
0.7 – 1.0	3.3 – 4.0	0.17 – 0.19	*Globigerinoides ruber*	n.d.	n.d.	1	[15]
0.6 – 0.9	3.3 – 4.0	0.17 – 0.19	*Globigerinoides sacculifer*	n.d.	n.d.	1	[15]
0.65 – 2.17	4.4 - 15	0.14 - 0.15	*Globigerinoides sacculifer*	22 - 29	36.7	2	[14]
1.0 – 1.8	10.6*	0.094 – 0.17	*Globigerinoides sacculifer*	n.d.	n.d.	1	[28]
1.4 – 1.6	5.4 – 5.5	0.25 – 0.30	*Neogloboquadrina pachyderma*	0	n.d.	1	[19]
0.5 - 0.8	3.7	0.14 – 0.22	*Orbulina universa*	18 - 26	33.7	2	[13]

0.7 – 2.3	4.4 - 15	0.14 – 0.15	*Orbulina universa*	22 - 29	36.7	2	14
0.6 – 0.9	3.3 – 4.0	0.17 – 0.19	*Orbulina universa*	n.d.	n.d.	1	15
Maximum range in D_{Ba}		**0.1 – 0.4**					
30 - 90	50 - 90	0.81	*Heterostegina depressa*	25	32.5	2	t.s.
0.3 – 13.5	15 - 19	0.53 – 0.71	*Operculina ammonoides*	24	37	2	10
Maximum range in D_{Ba}		**0.5 – 0.8**					

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