

Methods

The planktonic stable isotope data were obtained from core M78/1-235-1 off the coast of Trinidad (Schönfeld et al., 2011). Samples were collected in intervals of 5 cm between 3 and 118 cm and in high resolution every cm between 118 and 300 cm. The sediment samples were wet-sieved through mesh sizes of 63 and 250 µm and afterwards dried at 50°C. Specimens of the surface dwelling planktonic foraminifera *Globigerinoides ruber* (pink variety) were sampled from the 250-355 µm size fraction after dry sieving, avoiding size-related ontogenetic effects (Elderfield et al., 2002; Friedrich et al., 2012). A total of 50-60 specimens (~600 µg) of each sample were picked and cracked under the microscope. 1/3 of this amount was taken for stable isotope measurements, the remaining batch for trace element analyses. To prepare the samples for measuring, they were cleaned with ultra-pure ethanol and dried overnight. A total of ~100 µg were weighed in and measured with a ThermoFinnigan 235 MAT mass spectrometer coupled with a Gas Bench II in the laboratories at Frankfurt University and calibrated with an internal standard.

For Ba/Ca ratio analyses the cracked samples were cleaned according to the processes by Schmidt and Lynch-Stieglitz (2011) and Mashotta et al. (1999) without an additional DTPA step (Bahr et al., 2013). To summarize, samples were cleaned several times with deionized ultra-pure distilled water and methanol to remove clay material, followed by a reduction step for the removal of metal-oxides with an ammonium citrate/hydrazine solution and an oxidation step with H₂O₂ for the removal of organic matter. Subsequently, the prepared samples were transferred into new acid-leached vials and ultimately leached with ultra-pure 0.001 N HNO₃ prior to the dissolution with 0.1 N HNO₃. Trace element analyses were made on a Thermo Scientific™ Element 2 ICP-MS at Frankfurt University. Within each sample ⁴³Ca, ⁴⁴Ca, ²⁶Mg and ¹³⁸Ba were measured to calculate Mg/Ca temperatures as well as Ba/Ca ratios of the foraminiferal shells. All measurements were made relative to the external standard ECRM752-1 and with the measuring of blanks to avoid contamination during the cleaning processes.

$\delta^{18}\text{O}_{\text{ivf-sw}}$ was calculated according to Thunnel et al. (1999) based on the combination of Mg/Ca-SST and $\delta^{18}\text{O}$. A total of 183 samples were measured for Ba/Ca and $\delta^{18}\text{O}$, respectively. Errors (2σ) from replicates amount to ± 0.3 mmol/mol for Mg/Ca ($n=13$) and 0.36 µmol/mol for Ba/Ca ($n=13$). To assess the propagated error for $\delta^{18}\text{O}_{\text{seawater}}$ we used the 2σ standard deviation of $\delta^{18}\text{O}$ values from 0-6 kyr ($\pm 0.23\text{\textperthousand}$, $n=16$) because no replicates were made. The resultant error for $\delta^{18}\text{O}_{\text{seawater}}$ amounts to $\pm 0.31\text{\textperthousand}$ (2σ).

Radiocarbon analyses were performed on four relatively small planktic foraminifera samples (mixed species: *Globigerinoides ruber* (pink), *Globigerinoides ruber* (white), *Globigerinoides saacculifer*) at CologneAMS (Germany) following pretreatment protocol described by Rethemeyer et al. (2013) but using a short acid treatment (1% HCl, 2 min) to avoid material loss.

References

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Table DR1. List of AMS radiocarbon measurements on planktic foraminifera (mixed *G. ruber* and *G. sacculifer*) from core M78/1-235-1

Lab Code	Sample weight (mg)	Depth (cm)	Age (yrs BP)	\pm (yrs BP)	Calibrated age (kyr)	2σ calibrated (kyr)
COL1475.1.1	5.66	133	8.424	44	8.999	0.1435
COL1476.1.1	5.07	188	10.500	48	11.617	0.2645
COL1477.1.1	5.57	218	11.586	48	13.037	0.183
COL1478.1.1	7.41	298	13.098	49	14.925	0.321

Table DR2 List of trace element and stable isotope measurements on planktic foraminifera samples of *G. ruber* (pink) derived from core M78/1-235-1

Depth (cm)	age (kyr)	Ba ¹³⁸ /Ca ⁴³ (µmol/mol)	δ ¹⁸ O (‰ V-PDB)	δ ¹⁸ O _{ivf-sw} (‰ SMOW)	Mg ²⁵ /Ca ⁴³ (mmol/mol)	T Mg ²⁵ /Ca ⁴³ (°C)
3	0.174		-1.806			
8	0.485					
13	0.796		-1.843			
18	1.107		-1.833			
23	1.418		-1.549			
28	1.729		-1.731			
33	2.040		-1.539			
38	2.351		-1.614			
43	2.662		-1.739			
48	3.014					
53	3.366		-1.551			
58	3.718		-1.573			
63	4.070		-1.704			
68	4.422		-1.853			
73	4.775		-1.777			
78	5.127	1.02	-1.645	0.857	3.84	25.71
88	5.831	1.17	-1.758	0.837	4.02	26.22
93	6.183	1.17	-1.590	0.769	3.64	25.12
103	6.887	1.19	-1.803	0.580	3.70	25.29
108	7.239	0.98	-1.719	0.696	3.77	25.49
118	7.943	1.10	-1.755	0.703	3.87	25.80
119	8.014	1.38	-1.556	0.975	4.00	26.16
120	8.084	1.68	-1.567	0.874	3.86	25.75
121	8.155	1.33	-1.514	0.748	3.58	24.92
122	8.225	1.65	-1.513	0.984	3.97	26.08
123	8.295	1.10	-1.394	0.918	3.65	25.22
124	8.366	1.41	-1.430	1.053	3.97	26.06
125	8.436	1.47	-1.101	1.410	4.03	26.22
126	8.507	1.58	-1.472	0.847	3.71	25.33
127	8.577	1.73	-1.444	0.911	3.78	25.53
128	8.647	1.11	-1.168	1.127	3.69	25.27
129	8.718	1.55	-1.485	0.906	3.86	25.76
130	8.788	1.87	-1.501	1.035	4.12	26.48
131	8.859	1.44	-1.575	0.938	4.09	26.40
132	8.929	1.79	-1.484	1.010	4.06	26.33
133	9.000	1.30	-1.228	0.835	3.38	24.29
134	9.047	1.91	-1.484	0.729	3.61	25.02
135	9.095	1.68	-1.392	0.858	3.68	25.22
136	9.142	1.61	-1.525	0.839	3.86	25.77
137	9.190	1.55	-1.412	0.770	3.58	24.91
138	9.237	1.09	-1.675	0.510	3.59	24.94
139	9.285	1.44	-1.581	0.604	3.59	24.95
140	9.333	1.40	-1.346	0.979	3.82	25.64
141	9.380	1.94	-1.531	0.701	3.67	25.21
142	9.428	1.86	-1.570	0.762	3.84	25.70
143	9.475	1.40	-1.381	0.699	3.45	24.51

Depth (cm)	age (kyr)	Ba ¹³⁸ /Ca ⁴³ (μmol/mol)	δ ¹⁸ O (‰ V-PDB)	δ ¹⁸ O _{ivf-sw} (‰ SMOW)	Mg ²⁵ /Ca ⁴³ (mmol/mol)	T Mg ²⁵ /Ca ⁴³ (°C)
144	9.523	1.89	-1.497	0.976	4.09	26.41
145	9.570	1.57	-1.395	0.972	3.91	25.91
146	9.618	2.01	-1.482	1.064	4.23	26.78
147	9.666	2.15	-1.303	0.842	3.56	24.87
148	9.713	1.88	-1.342	0.852	3.64	25.12
149	9.761	2.29	-1.207	1.059	3.77	25.48
150	9.808	2.01	-1.183	1.035	3.69	25.26
151	9.856	2.44	-1.455	0.911	3.94	25.99
152	9.904	2.66	-1.440	0.870	3.85	25.73
153	9.951	1.02	-1.424	0.768	3.66	25.18
154	9.999	2.09	-1.184	1.041	3.72	25.35
155	10.046	2.72	-1.379	0.811	3.67	25.20
156	10.094	1.85	-1.218	1.032	3.77	25.51
157	10.141	2.22	-1.253	0.844	3.54	24.79
158	10.189	1.16	-1.109	1.110	3.73	25.39
159	10.237	2.84	-1.259	0.889	3.63	25.07
160	10.284	2.26	-1.077	1.201	3.84	25.71
161	10.332	1.82	-1.248	0.951	3.72	25.35
162	10.379	2.13	-1.165	0.829	3.41	24.39
163	10.427	0.96	-0.998	1.329	3.95	26.01
164	10.475	1.91	-1.091	1.237	3.96	26.03
165	10.522	2.50	-1.055	0.977	3.49	24.63
166	10.570	2.05	-1.234	0.859	3.59	24.94
167	10.617	1.79	-1.139	0.908	3.52	24.74
168	10.665	1.16	-1.116	1.112	3.81	25.63
169	10.712	1.87	-1.169	0.990	3.71	25.31
170	10.760	1.78	-1.027	1.127	3.71	25.31
171	10.808	1.66	-1.098	1.131	3.83	25.68
172	10.855	1.72	-1.115	1.136	3.88	25.81
173	10.903	0.84	-0.880	1.238	3.67	25.19
174	10.950	0.84	-1.228	0.774	3.49	24.65
175	10.998	0.82	-1.225	1.031	3.91	25.89
176	11.046	0.88	-1.230	0.985	3.85	25.74
177	11.093					
178	11.141	0.75	-1.041	1.143	3.84	25.69
179	11.188	0.79	-0.973	1.170	3.78	25.54
180	11.236	0.90	-0.919	1.371	4.05	26.29
181	11.283	0.84	-1.025	1.005	3.64	25.09
182	11.331	0.76	-0.768	1.494	4.04	26.25
183	11.379	0.71	-0.790	1.231	3.65	25.15
184	11.426	0.73	-0.847	1.339	3.94	25.99
185	11.474	0.80	-0.864	1.448	4.18	26.64
186	11.521	0.72	-0.596	1.488	3.80	25.57
187	11.569	0.78	-0.873	1.325	3.99	26.14
188	11.617					
189	11.664	1.37	-0.840	1.945	5.16	28.97
190	11.711	0.75				
191	11.759	0.86	-0.737	1.381	3.87	25.79
192	11.806		-0.912	1.469	4.34	27.07

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193	11.853	0.84	-0.611	1.626	4.09	26.39
194	11.901	0.74	-0.586	1.656	4.10	26.42
195	11.948	0.61	-0.608	1.413	3.73	25.37
196	11.995	0.62	-0.641	1.324	3.64	25.12
197	12.043	0.70	-0.443	1.760	4.05	26.28
198	12.090	0.84	-0.918	1.016	3.61	25.01
199	12.137	0.68	-0.598	1.443	3.78	25.54
200	12.185	0.72	-0.425	1.755	4.03	26.22
201	12.232	0.84	-0.642	1.709	4.34	27.06
202	12.279	1.81	-0.641	1.588	4.13	26.50
203	12.327	0.86	-0.906	1.210	3.94	25.98
204	12.374	0.81	-0.665	1.192	3.53	24.75
205	12.421	0.66	-0.693	1.164	3.53	24.77
206	12.469	0.65	-0.665	1.228	3.59	24.96
207	12.516	0.61	-0.682	1.396	3.90	25.87
208	12.564	0.54	-0.757	1.204	3.71	25.33
209	12.611	0.63	-0.523	1.504	3.83	25.67
210	12.658	0.55	-0.676	1.198	3.59	24.95
211	12.706	0.69	-0.450	1.378	3.52	24.75
212	12.753	0.69	-0.837	1.126	3.74	25.42
213	12.800	0.61	-0.726	1.120	3.56	24.87
214	12.848	0.64	-0.623	1.264	3.64	25.09
215	12.895	0.72	-0.888	0.993	3.63	25.08
216	12.942	0.78	-0.797	0.918	3.39	24.30
217	12.990	0.75	-0.664	1.246	3.69	25.26
218	13.037	0.64	-1.010	0.611	3.26	23.89
219	13.061	0.76	-0.868	1.031	3.68	25.24
220	13.084	0.88	-0.679	1.250	3.73	25.39
221	13.108	0.76	-0.768	1.005	3.49	24.65
222	13.131	0.79	-0.712	1.150	3.63	25.09
223	13.155	0.76	-0.702	1.145	3.61	25.03
224	13.179	0.75	-0.674	1.236	3.72	25.34
225	13.202	0.81	-0.733	1.233	3.81	25.62
226	13.226	0.67	-0.666	1.195	3.65	25.12
227	13.249	1.06	-0.657	1.159	3.58	24.92
228	13.273	0.80	-0.506	1.198	3.41	24.39
229	13.297	0.73	-0.866	1.224	4.04	26.26
230	13.320	1.01	-1.219	0.901	4.09	26.41
231	13.344	0.78	-0.839	1.014	3.65	25.14
232	13.367	0.82	-0.770	1.092	3.67	25.19
233	13.391	0.80	-0.729	1.000	3.47	24.56
234	13.415	0.87	-0.688	1.129	3.61	25.00
235	13.438	0.92	-0.628	1.184	3.60	24.99
236	13.462	0.75	-0.725	1.091	3.61	25.02
237	13.485	1.07	-0.726	1.264	3.90	25.86
238	13.509	0.71	-0.628	1.193	3.62	25.06
239	13.533	0.77	-0.898	1.240	4.16	26.59
240	13.556	0.87	-0.674	1.178	3.68	25.23
241	13.580	0.73	-0.883	1.056	3.83	25.66

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242	13.603	0.76	-0.713	1.121	3.66	25.17
243	13.627	0.73	-0.604	1.243	3.68	25.24
244	13.651	0.80	-0.853	0.706	3.26	23.87
245	13.674	0.84	-0.835	1.338	4.25	26.83
246	13.698	0.68	-0.697	1.205	3.78	25.53
247	13.721	0.81	-0.776	1.177	3.87	25.79
248	13.745	0.68	-0.853	0.805	3.41	24.39
249	13.769	0.65	-0.645	0.931	3.30	24.01
250	13.792	0.75	-0.730	0.934	3.43	24.43
251	13.816	0.80	-0.847	0.974	3.67	25.20
252	13.839	0.78	-0.600	1.039	3.40	24.34
253	13.863	0.64	-0.677	0.965	3.40	24.36
254	13.887	0.74	-0.882	1.013	3.80	25.59
255	13.910	0.80	-0.701	1.071	3.61	25.01
256	13.934	0.79	-0.735	0.903	3.41	24.37
257	13.957	0.82	-0.253	1.359	3.37	24.26
258	13.981	0.90	-0.903	0.741	3.42	24.42
259	14.005	0.80	-0.506	1.526	4.05	26.30
260	14.028	0.92	-0.643	1.132	3.64	25.09
261	14.052	0.92	-0.633	1.148	3.66	25.15
262	14.075	0.79	-0.663	0.959	3.42	24.42
263	14.099	0.88	-1.063	0.551	3.42	24.41
264	14.123	0.71	-0.652	0.986	3.46	24.55
265	14.146	0.76	-0.488	1.217	3.57	24.90
266	14.170	0.77	-0.449	1.164	3.44	24.49
267	14.193	0.79	-0.845	0.948	3.73	25.38
268	14.217	0.76	-0.544	1.035	3.41	24.38
269	14.241	0.98	-0.628	1.080	3.61	25.03
270	14.264	0.83	-0.463	1.126	3.44	24.48
271	14.288	0.79	-0.653	0.881	3.37	24.25
272	14.311	1.03	-0.670	1.024	3.62	25.05
273	14.335					
274	14.359	0.93	-0.529	1.284	3.83	25.67
275	14.382	0.82	-0.541	1.097	3.56	24.86
276	14.406	0.79	-0.619	1.071	3.65	25.14
277	14.429	0.81	-0.684	0.756	3.29	23.97
278	14.453	0.80	-0.430	1.215	3.60	24.98
279	14.477	0.79	-0.613	0.865	3.36	24.20
280	14.500	1.02	-0.759	0.948	3.71	25.33
281	14.524	0.78	-0.556	1.246	3.87	25.80
282	14.547	0.76	-0.590	1.059	3.63	25.07
283	14.571	0.78	-0.160	1.309	3.36	24.21
284	14.595	0.74	-0.709	0.955	3.66	25.15
285	14.618	0.97	-0.487	1.208	3.71	25.31
286	14.642	0.95	-0.624	0.757	3.24	23.81
287	14.665	1.04	-0.558	1.191	3.80	25.58
288	14.689	0.66	-0.382	0.960	3.19	23.63
289	14.713	0.70	-0.499	1.020	3.44	24.49
290	14.736	0.74	-0.481	1.568	4.33	27.04

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291	14.760	0.69	-0.647	0.859	3.43	24.44
292	14.783	0.75	-0.663	1.124	3.87	25.80
293	14.807	1.16	-0.277	1.229	3.43	24.46
294	14.831	0.65	-0.385	1.312	3.73	25.38
295	14.854	0.75	-0.076	1.660	3.80	25.57
296	14.878	0.72	-0.364	1.278	3.65	25.13
297	14.901	0.70	-0.467	1.428	4.07	26.35
298	14.925	0.60	-0.227	1.320	3.50	24.68
299	14.988	0.93	-0.153	1.689	3.99	26.12
300	15.052	1.10	-0.374	1.451	3.97	26.06