Geochemistry, Geophysics, Geosystems

Supporting Information for

An evaluation of benthic foraminiferal U/Ca and U/Mn for deep ocean conditions

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Additional Supporting Information (Files uploaded separately)

Introduction

This supporting information provides (1) core-top Mn/Ca versus U/Ca, (2) details of core-top and down-core data used in this study, (3) comparisons of cleaning effects, and (4) summary of regression analyses of U/Ca and U/Mn versus various hydrographic parameters.

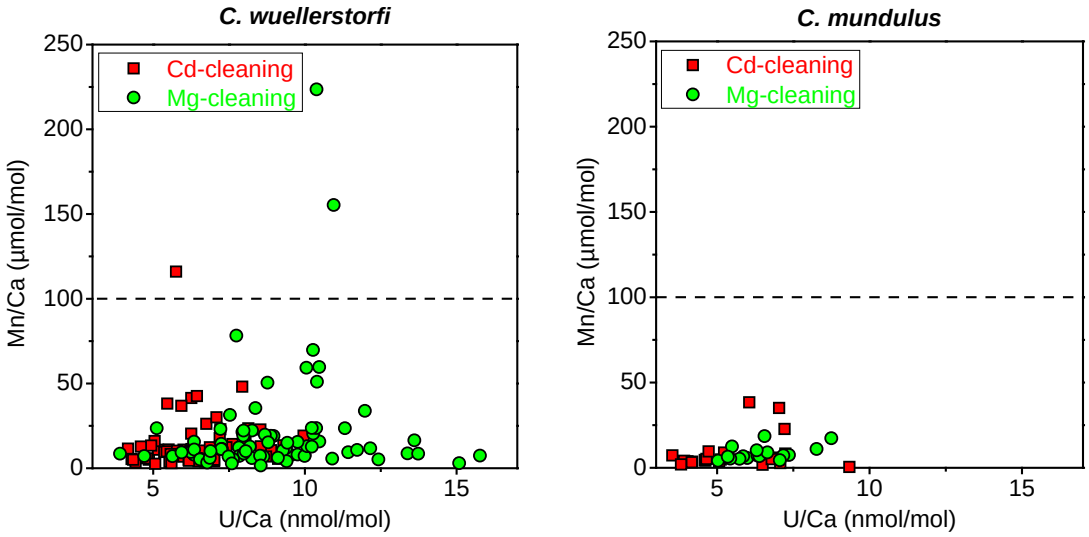

Figure S1. U/Ca versus Mn/Ca for core-top samples. Dash line represents Mn/Ca of 100 µmol/mol.

Table S1. Element/Ca ratios of *C. wuellerstorfi* together with core-top sample locations and hydrographic data. (Larger than 1 page, upload as separate file)

Table S2. Element/Ca ratios of *C. mundulus* together with core-top sample locations and hydrographic data. (Larger than 1 page, upload as separate file)

Table S3. Element/Ca ratios of *C. mundulus* for BOFS 17K. (Larger than 1 page, upload as separate file)

Table S4. Element/Ca ratios of *C. wuellerstorfi* for BOFS 8K. (Larger than 1 page, upload as separate file)

Table S5. Element/Ca ratios of *C. wuellerstorfi* for TNO57-21. (Larger than 1 page, upload as separate file)

Core ID	$\Delta U/Ca^{a}$	$\Delta Mn/Ca^{b}$	$\Delta U/Ca_{coating}{}^{c}$
NEAP 8K	0.24	0.25	0.05
NEAP 19B	0.38	0.34	0.01
NEAP 20B	0.13	0.42	0.08
T86 5B	0.23	0.11	0.01
T88 7B	0.31	0.43	0.03
T88 19B	0.43	0.10	0.00
T90 4B	0.35	0.19	0.01
T90 7B	0.26	0.22	0.01
CD113A-SiteA	0.36	0.25	0.01
CD113A-SiteC	0.37	0.39	0.07
GeoB1504-1	0.21	0.31	0.01
BOFS 10K	0.47	0.25	0.08
WIND 5B	0.39	0.21	0.01
WIND 6B	0.42	0.43	0.03
CD145 A3200	0.19	0.40	0.12
1.5BC11	0.35	0.35	0.01
1.5BC33	0.36	0.20	0.00
5.5BC58	0.26	0.57	0.02
BC66	0.23	0.41	0.02
4BC51	0.37	0.50	0.02
6BC74	0.57	0.47	0.00
Average	**0.32**	**0.27**	**0.03**

[a] $\Delta U/Ca = (U/Ca_{oxidative} - U/Ca_{reductive}) / U/Ca_{oxidative}$.
[b] $\Delta Mn/Ca = (Mn/Ca_{oxidative} - Mn/Ca_{reductive}) / Mn/Ca_{oxidative}$.
[c] $\Delta U/Ca_{coating} = [U/Mn_{Fe\text{-}Mn\ oxides} * (Mn/Ca_{oxidative} - Mn/Ca_{reductive})] / (U/Ca_{oxidative} - U/Ca_{reductive})$. $U/Mn_{Fe\text{-}Mn\ oxides} = 10^{-5}$ mol/mol

Table S6. A comparison of two cleaning methods for *C. wuellerstorfi*. The extent of U/Ca and Mn/Ca decreased from the oxidative cleaning method to the reductive cleaning method ($\Delta U/Ca$ and $\Delta Mn/Ca$) and the extent of the decrease of U/Ca caused by removal of Fe-Mn oxide coatings with the reductive step ($\Delta U/Ca_{coating}$).

Core ID	$\Delta U/Ca^{a}$	$\Delta Mn/Ca^{b}$	$\Delta U/Ca_{coating}{}^{c}$
T88 12B	0.28	0.24	0.01
T90 4B	0.21	0.32	0.01
T90 5B	0.51	0.65	0.02
T90 8B	0.13	0.49	0.04
T90 11B	0.47	0.44	0.01
T90 13B	0.32	0.53	0.02
T90 15B	0.43	0.78	0.02
BOFS 17K	0.34	0.39	0.08
Average	**0.34**	**0.48**	**0.03**

[a] $\Delta U/Ca = (U/Ca_{oxidative} - U/Ca_{reductive}) / U/Ca_{oxidative}$.
[b] $\Delta Mn/Ca = (Mn/Ca_{oxidative} - Mn/Ca_{reductive}) / Mn/Ca_{oxidative}$.
[c] $\Delta U/Ca_{coating} = [U/Mn_{Fe\text{-}Mn\ oxides} * (Mn/Ca_{oxidative} - Mn/Ca_{reductive})] / (U/Ca_{oxidative} - U/Ca_{reductive})$. $U/Mn_{Fe\text{-}Mn\ oxides} = 10^{-5}$ mol/mol

Table S7. A comparison of two cleaning methods for *C. mundulus*. The extent of U/Ca and Mn/Ca decreased from the oxidative cleaning method to the reductive cleaning method ($\Delta U/Ca$ and $\Delta Mn/Ca$) and the extent of the decrease of U/Ca caused by removal of Fe-Mn oxide coatings with the reductive step ($\Delta U/Ca_{coating}$).

species	cleaning method	slope	intercept	R^2	P-value	N
U/Ca-[CO_3^{2-}]						
C. wuellerstorfi	Cd-cleaning	-0.016	8.074	0.042	0.098	67
C. wuellerstorfi	Mg-cleaning	-0.032	12.027	0.051	0.017	111
C. mundulus	Cd-cleaning	-0.042	9.826	0.106	0.105	26
C. mundulus	Mg-cleaning	0.200	-15.185	0.277	0.008	24
U/Ca-Δ[CO_3^{2-}]						
C. wuellerstorfi	Cd-cleaning	0.007	6.314	0.013	0.354	67
C. wuellerstorfi	Mg-cleaning	0.006	8.838	0.003	0.586	111
C. mundulus	Cd-cleaning	-0.001	5.361	8.77E-05	0.964	26
C. mundulus	Mg-cleaning	0.025	5.730	0.065	0.231	24
U/Ca-Temperature						
C. wuellerstorfi	Cd-cleaning	0.159	6.143	0.023	0.223	67
C. wuellerstorfi	Mg-cleaning	0.496	7.716	0.036	0.047	111
C. mundulus	Cd-cleaning	0.004	5.329	7.3E-06	0.990	26
C. mundulus	Mg-cleaning	0.360	5.367	0.038	0.362	24
U/Ca-[O_2]						
C. wuellerstorfi	Cd-cleaning	-0.007	8.096	0.105	0.008	67
C. wuellerstorfi	Mg-cleaning	-0.013	11.801	0.103	0.001	111
C. mundulus	Cd-cleaning	-0.036	14.167	0.322	0.002	26
C. mundulus	Mg-cleaning	-0.014	9.952	0.011	0.628	24
U/Mn-[O_2]						
C. wuellerstorfi	Cd-cleaning	-0.004	1.544	0.229	4.12E-05	67
C. wuellerstorfi	Mg-cleaning	-0.004	1.795	0.072	0.005	111
C. mundulus	Cd-cleaning	-0.012	4.103	0.104	0.116	25
C. mundulus	Mg-cleaning	-0.007	2.554	0.025	0.458	24

Table S8. Summary of regression analyses.