Supporting information for

Size-fraction specific isotopic variations as a framework for interpreting early Paleogene bulk sediment carbon isotope records

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Supplementary Table 1. Change in weights of sediments before and after wet sieve separation process.

Sample ID	MBSF m	rmcd m	Age (Ma)	Sediment loss upon rinsing (wt %)
198-1209-A-19-5-121	176.56	194.26	50.68	7.43
198-1209-A-19-5-146	177.16	194.86	50.72	8.65
198-1209-A-19-6-38	177.17	194.87	50.78	8.53
198-1209-A-19-6-86	177.88	195.58	50.87	-0.89
198-1209-A-19-7-26	178.26	195.96	50.93	8.62
198-1209-C-9-4-11	178.86	197.05	51.09	-3.70
198-1209-A-20-1-6	179.56	198.72	51.22	3.22
198-1209-A-20-2-21	181.06	200.22	51.50	0.33
198-1209-C-9-6-17	181.31	199.50	51.51	2.84
198-1209-A-20-2-111	182.36	201.52	51.74	3.32
198-1209-C-9-7-41	182.64	200.83	51.87	9.59
198-1209-A-20-3-136	183.56	202.72	52.09	-0.15
198-1209-A-20-4-11	183.81	202.97	52.15	9.29
198-1209-A-20-6-39	187.09	206.25	52.76	2.20
198-1209-A-20-6-74	187.44	206.60	52.81	23.00
198-1209-A-20-6-106	187.76	206.92	52.89	4.90
198-1209-A-21-1-19	188.89	208.99	53.33	7.44
198-1209-A-21-1-81	189.51	209.61	53.46	9.59
198-1209-A-21-1-121	189.91	210.01	53.54	8.66
198-1209-A-21-1-127	189.97	210.07	53.55	4.38
198-1209-A-21-1-143	190.13	210.23	53.58	7.07
198-1209-A-21-2-66	190.86	210.96	53.76	2.17
198-1209-A-21-2-106	191.26	211.36	53.87	1.84
198-1209-A-21-3-4	191.74	211.84	53.96	4.29
198-1209-A-21-3-33.5	192.04	212.14	54.01	4.65
198-1209-A-21-3-62	192.32	212.42	54.08	9.77
198-1209-A-21-3-92	192.62	212.72	54.21	9.26
198-1209-A-21-3-116	192.86	212.96	54.32	7.00
198-1209-A-21-4-7	193.27	213.37	54.49	7.73
198-1209-A-21-4-46	193.66	213.76	54.65	6.73
198-1209-A-21-4-68	193.88	213.98	54.73	4.94
198-1209-A-21-4-103	194.23	214.33	54.89	6.90
198-1209-A-21-5-11	194.81	214.91	55.04	5.18
198-1209-A-21-5-83	195.53	215.63	55.25	1.24
198-1209-A-21-5-123	195.93	216.03	55.37	0.81
198-1209-A-21-6-31	196.51	216.61	55.57	2.62
198-1209-A-21-6-116	197.36	217.46	55.78	2.43
198-1209-A-21-6-143	197.63	217.73	55.83	2.20
198-1209-A-21-7-4	197.74	217.84	55.86	5.24
198-1209-A-21-7-11	197.81	217.91	55.89	5.76
198-1209-A-21-7-13	197.83	217.93	55.89	6.70
198-1209-A-21-7-32	198.02	218.12	55.94	3.69
198-1209-A-22-1-10	198.30	219.74	56.46	3.61
198-1209-A-22-1-25	198.45	219.89	56.73	0.43
198-1209-A-22-1-50	198.65	220.09	57.11	4.80

Supplementary Table 2. Abundance by weight percent of the five size fractions.

Sample ID	MBSF m	rmcd m	Age (Ma)	FF <25 µm wt %	IF 25-63 µm wt %	63-125 µm wt %	125-250 µm wt %	>250 µm wt %	CF >63 µm wt %
198-1209-A-19-5-121	176.56	194.26	50.68	97.02	0.370	0.49	2.09	0.03	2.61
198-1209-A-19-5-146	177.16	194.86	50.72	96.37	0.567	0.63	2.38	0.06	3.07
198-1209-A-19-6-38	177.17	194.87	50.78	98.09	0.383	0.40	1.13	0.00	1.52
198-1209-A-19-6-86	177.88	195.58	50.87	97.11	0.559	0.76	1.56	0.01	2.33
198-1209-A-19-7-26	178.26	195.96	50.93	97.50	0.506	0.82	1.18	0.00	2.00
198-1209-C-9-4-11	178.86	197.05	51.09	97.99	0.188	0.47	1.33	0.02	1.82
198-1209-A-20-1-6	179.56	198.72	51.22	96.18	0.430	0.79	2.60	0.00	3.39
198-1209-A-20-2-21	181.06	200.22	51.50	97.97	0.390	0.06	1.57	0.01	1.64
198-1209-C-9-6-17	181.31	199.50	51.51	96.55	0.728	0.84	1.86	0.02	2.72
198-1209-A-20-2-111	182.36	201.52	51.74	95.31	1.434	0.99	2.27	0.00	3.26
198-1209-C-9-7-41	182.64	200.83	51.87	93.88	1.538	1.65	2.90	0.03	4.58
198-1209-A-20-3-136	183.56	202.72	52.09	94.60	0.668	1.06	3.62	0.06	4.73
198-1209-A-20-4-11	183.81	202.97	52.15	96.01	1.101	0.98	1.90	0.01	2.89
198-1209-A-20-6-39	187.09	206.25	52.76	94.24	0.867	1.04	3.78	0.07	4.89
198-1209-A-20-6-74	187.44	206.60	52.81	90.34	1.720	2.21	5.10	0.64	7.94
198-1209-A-20-6-106	187.76	206.92	52.89	93.75	1.574	1.53	3.00	0.14	4.67
198-1209-A-21-1-19	188.89	208.99	53.33	92.34	1.208	1.05	5.35	0.05	6.45
198-1209-A-21-1-81	189.51	209.61	53.46	89.11	1.808	3.14	5.91	0.02	9.08
198-1209-A-21-1-121	189.91	210.01	53.54	93.39	1.075	1.86	3.64	0.03	5.53
198-1209-A-21-1-127	189.97	210.07	53.55	94.45	1.100	1.02	3.36	0.07	4.45
198-1209-A-21-1-143	190.13	210.23	53.58	93.21	1.241	1.39	4.08	0.08	5.55
198-1209-A-21-2-66	190.86	210.96	53.76	87.14	2.770	3.73	6.29	0.07	10.09
198-1209-A-21-2-106	191.26	211.36	53.87	93.02	1.077	2.39	3.48	0.04	5.90
198-1209-A-21-3-4	191.74	211.84	53.96	92.88	1.373	3.02	2.70	0.02	5.74
198-1209-A-21-3-33.5	192.04	212.14	54.01	91.35	1.648	1.88	5.05	0.06	7.00
198-1209-A-21-3-62	192.32	212.42	54.08	92.29	0.979	1.72	4.89	0.13	6.73
198-1209-A-21-3-92	192.62	212.72	54.21	83.74	2.627	3.51	9.91	0.22	13.63
198-1209-A-21-3-116	192.86	212.96	54.32	81.55	3.467	3.67	11.26	0.06	14.98
198-1209-A-21-4-7	193.27	213.37	54.49	89.32	1.506	2.75	6.38	0.04	9.18
198-1209-A-21-4-46	193.66	213.76	54.65	83.11	2.662	4.80	9.39	0.03	14.23
198-1209-A-21-4-68	193.88	213.98	54.73	82.51	3.414	4.81	9.21	0.06	14.07
198-1209-A-21-4-103	194.23	214.33	54.89	84.84	2.911	4.28	7.88	0.09	12.25
198-1209-A-21-5-11	194.81	214.91	55.04	79.86	3.976	5.41	10.71	0.04	16.17
198-1209-A-21-5-83	195.53	215.63	55.25	85.92	3.120	4.32	6.61	0.03	10.95
198-1209-A-21-5-123	195.93	216.03	55.37	87.98	2.315	3.66	6.01	0.03	9.71
198-1209-A-21-6-31	196.51	216.61	55.57	88.23	2.305	3.71	5.73	0.02	9.46
198-1209-A-21-6-116	197.36	217.46	55.78	87.99	2.192	3.91	5.88	0.03	9.82
198-1209-A-21-6-143	197.63	217.73	55.83	87.73	2.630	4.09	5.43	0.13	9.64
198-1209-A-21-7-4	197.74	217.84	55.86	84.54	3.637	4.88	6.78	0.17	11.82
198-1209-A-21-7-11	197.81	217.91	55.89	78.15	3.908	7.84	9.90	0.20	17.94
198-1209-A-21-7-13	197.83	217.93	55.89	75.63	4.130	8.63	11.59	0.01	20.23
198-1209-A-21-7-32	198.02	218.12	55.94	90.24	2.005	2.72	5.02	0.01	7.75
198-1209-A-22-1-10	198.30	219.74	56.46	98.70	0.589	0.43	0.27	0.00	0.71
198-1209-A-22-1-25	198.45	219.89	56.73	99.23	0.415	0.19	0.16	0.01	0.36
198-1209-A-22-1-50	198.65	220.09	57.11	99.14	0.420	0.23	0.21	0.00	0.44

Supplementary Table 3. Bulk carbonate- and size fraction $\delta^{13}C$ composition.

MBSF m	rmcd m	Age (Ma)	CaCO3%	Measured Bulk δ13C (‰)	FF <25µm δ13C ‰	IF 25-63µm δ13C ‰	63-125µm δ13C ‰	125-250 µm δ13C ‰	>250 µm δ13C ‰	CF >63 µm δ13C ‰	Reconstructed Bulk δ13C (‰)
176.56	194.26	50.68	92.47	1.82	1.83	0.65	1.40	1.69	1.98	1.64	1.69
177.16	194.86	50.72	94.62	1.88	1.88	1.99	2.00	1.90	3.04	1.94	1.78
177.17	194.87	50.78	97.89	1.87	1.88	1.80	2.04	1.63	1.93	1.74	1.84
177.88	195.58	50.87	89.03	0.83	1.01	1.58	1.17	1.27	2.13	1.24	0.91
178.26	195.96	50.93	93.60	1.74	1.75	1.42	1.70	2.00	1.88	1.87	1.65
178.86	197.05	51.09	94.30	1.48	1.62	1.30	1.61	1.83	2.27	1.78	1.53
179.56	198.72	51.22	91.29	0.77	1.47	1.40	1.47	1.76	2.64	1.69	1.36
181.06	200.22	51.50	90.82	1.14	1.40	1.15	1.30	1.42	2.11	1.42	1.27
181.31	199.50	51.51	88.91	1.18	1.30	0.74	1.05	1.42	1.46	1.31	1.16
182.36	201.52	51.74	95.40	0.99	1.09	0.60	1.27	1.45	2.36	1.40	1.05
182.64	200.83	51.87	88.34	1.20	1.32	0.51	1.04	1.51	2.23	1.35	1.17
183.56	202.72	52.09	96.71	1.11	1.22	1.45	0.97	1.47	2.84	1.38	1.19
183.81	202.97	52.15	95.01	1.56	1.56	1.10	1.12	1.91	2.86	1.65	1.48
187.09	206.25	52.76	96.56	1.03	1.05	1.15	1.07	1.35	2.32	1.31	1.03
187.44	206.60	52.81	97.03	1.02	1.12	0.98	0.99	1.08	2.27	1.15	1.09
187.76	206.92	52.89	95.12	1.18	1.28	0.55	0.66	0.98	2.80	0.93	1.19
188.89	208.99	53.33	88.70	1.24	1.51	1.43	1.55	1.77	2.46	1.74	1.36
189.51	209.61	53.46	92.50	1.28	1.37	1.12	1.30	1.80	2.39	1.63	1.30
189.91	210.01	53.54	93.20	1.24	1.36	0.79	0.98	1.44	1.72	1.29	1.26
189.97	210.07	53.55	93.40	1.15	1.19	0.91	1.16	1.45	2.41	1.39	1.12
190.13	210.23	53.58	90.75	1.04	1.16	1.07	1.13	1.80	2.47	1.64	1.09
190.86	210.96	53.76	93.00	0.85	1.02	1.65	1.48	1.93	2.91	1.77	1.05
191.26	211.36	53.87	94.00	1.38	1.58	1.31	1.35	2.10	2.62	1.80	1.50
191.74	211.84	53.96	92.30	1.28	1.40	0.69	0.78	1.73	1.97	1.23	1.28
192.04	212.14	54.01	96.30	1.27	1.51	1.00	1.07	1.79	2.12	1.60	1.45
192.32	212.42	54.08	91.00	1.28	1.35	1.17	1.16	1.44	1.75	1.37	1.24
192.62	212.72	54.21	94.70	1.85	1.79	1.30	1.08	1.66	2.90	1.53	1.66
192.86	212.96	54.32	92.80	1.59	1.69	1.36	1.52	1.65	2.92	1.62	1.57
193.27	213.37	54.49	88.20	1.43	1.47	1.27	1.50	1.91	2.43	1.79	1.34
193.66	213.76	54.65	92.30	1.38	1.43	1.50	1.75	2.09	3.09	1.98	1.42
193.88	213.98	54.73	93.00	1.74	1.99	1.26	1.38	1.57	2.78	1.51	1.78
194.23	214.33	54.89	89.45	1.72	1.82	1.62	1.82	2.30	3.17	2.14	1.69
194.81	214.91	55.04	82.94	1.67	1.81	1.54	1.95	2.62	2.91	2.40	1.65
195.53	215.63	55.25	96.80	2.04	2.13	1.60	1.93	2.49	3.35	2.27	2.07
195.93	216.03	55.37	94.20	1.75	1.67	1.33	1.84	2.52	3.33	2.26	1.63
196.51	216.61	55.57	86.90	1.94	1.95	1.66	2.12	3.16	3.28	2.76	1.80
197.36	217.46	55.78	94.90	1.96	2.07	1.94	1.78	2.54	3.12	2.24	1.99
197.63	217.73	55.83	93.80	1.58	1.62	1.27	1.36	2.34	2.29	1.93	1.55
197.74	217.84	55.86	82.10	1.21	1.35	0.96	1.01	1.63	1.50	1.37	1.13
197.81	217.91	55.89	81.50	0.92	1.16	0.96	0.94	1.16	1.64	1.07	0.97
197.83	217.93	55.89	80.80	0.58	0.66	0.54	0.65	0.78	1.60	0.72	0.57
198.02	218.12	55.94	88.00	2.53	2.83	1.64	1.85	2.18	2.61	2.07	2.44
198.30	219.74	56.46	97.76	3.22	3.32	3.00	3.26	2.61	3.92	3.01	3.24
198.45	219.89	56.73	95.10	3.23	3.33	3.13	2.62	2.44	3.77	2.57	3.16
198.65	220.09	57.11	93.20	3.32	3.52	3.00	3.10	2.61	No sample	2.86	3.27

Supplementary Table 4. Bulk carbonate- and size fraction $\delta^{18}O$ composition.

Sample ID	MBSF m	rmcd m	Age (Ma)	CaCO3%	Measured Bulk δ18O (‰)	FF <25 µm δ18O ‰	IF 25-63µm δ18O ‰	63-125µm δ18O ‰	125-250 µm δ18O ‰	>250 µm δ18O ‰	CF >63 µm δ18O ‰	Reconstructed Bulk δ18O (‰)
198-1209-A-19-5-121	176.56	194.26	50.68	92.47	-0.59	-0.42	-1.71	-1.44	-1.20	-1.93	-1.17	-0.42
198-1209-A-19-5-146	177.16	194.86	50.72	94.62	-1.19	-1.09	-0.15	-0.54	-1.40	-0.65	-0.44	-1.03
198-1209-A-19-6-38	177.17	194.87	50.78	97.89	-0.60	-0.18	-1.25	-1.15	-0.84	-2.55	-0.85	-0.19
198-1209-A-19-6-86	177.88	195.58	50.87	89.03	-0.59	-0.21	-0.06	-0.37	-0.95	-2.27	-0.25	-0.20
198-1209-A-19-7-26	178.26	195.96	50.93	93.60	-0.38	-0.45	-0.18	-0.24	-0.84	-1.30	-0.14	-0.43
198-1209-C-9-4-11	178.86	197.05	51.09	94.30	-0.75	0.05	-0.62	-0.44	-0.61	-0.70	-0.33	0.04
198-1209-A-20-1-6	179.56	198.72	51.22	91.29	-1.31	-0.40	-0.64	-0.86	-0.86	-0.82	-0.66	-0.39
198-1209-A-20-2-21	181.06	200.22	51.50	90.82	-0.29	-0.09	-0.54	-1.74	-2.81	-0.75	-1.69	-0.13
198-1209-C-9-6-17	181.31	199.50	51.51	88.91	-1.46	-1.88	-0.67	-0.58	-1.47	-1.19	-0.41	-1.65
198-1209-A-20-2-111	182.36	201.52	51.74	95.40	-0.50	-0.37	-0.79	-0.44	-1.03	-1.00	-0.31	-0.37
198-1209-C-9-7-41	182.64	200.83	51.87	88.34	-1.02	-0.29	-0.57	-0.62	-1.39	-0.92	-0.40	-0.30
198-1209-A-20-3-136	183.56	202.72	52.09	96.71	-0.65	-0.62	-0.83	0.49	0.60	-0.72	0.38	-0.55
198-1209-A-20-4-11	183.81	202.97	52.15	95.01	-0.39	-0.10	-1.12	-0.46	-1.10	-1.31	-0.31	-0.13
198-1209-A-20-6-39	187.09	206.25	52.76	96.56	-0.68	-0.39	-0.23	-0.39	-0.77	-1.83	-0.31	-0.39
198-1209-A-20-6-74	187.44	206.60	52.81	97.03	-0.43	-0.23	-0.36	-0.22	-0.53	-0.91	-0.19	-0.25
198-1209-A-20-6-106	187.76	206.92	52.89	95.12	-0.49	-0.47	-0.77	-0.66	-1.44	-1.51	-0.47	-0.48
198-1209-A-21-1-19	188.89	208.99	53.33	88.70	-0.83	-0.10	-0.42	-0.18	-0.54	-1.38	-0.15	-0.12
198-1209-A-21-1-81	189.51	209.61	53.46	92.50	-0.41	-0.29	-0.05	-0.49	-1.37	-0.60	-0.32	-0.34
198-1209-A-21-1-121	189.91	210.01	53.54	93.20	-0.20	-0.04	0.28	0.33	-1.49	-0.50	0.21	-0.08
198-1209-A-21-1-127	189.97	210.07	53.55	93.40	-0.75	-0.98	-0.17	-0.69	-0.69	-0.72	-0.53	-0.90
198-1209-A-21-1-143	190.13	210.23	53.58	90.75	-0.37	-0.27	0.22	0.01	-0.77	-0.56	0.00	-0.25
198-1209-A-21-2-66	190.86	210.96	53.76	93.00	-0.45	-0.26	-2.91	-0.51	-2.58	-1.44	-0.33	-0.48
198-1209-A-21-2-106	191.26	211.36	53.87	94.00	-0.34	-0.22	-0.75	-0.08	-1.47	-0.80	-0.06	-0.25
198-1209-A-21-3-4	191.74	211.84	53.96	92.30	-0.54	-0.16	-0.12	-0.30	-0.88	-1.47	-0.14	-0.17
198-1209-A-21-3-33.5	192.04	212.14	54.01	96.30	-0.34	0.29	0.21	-0.17	-0.41	-0.57	-0.13	0.23
198-1209-A-21-3-62	192.32	212.42	54.08	91.00	-0.70	-0.52	-0.16	-0.45	-0.90	-1.63	-0.34	-0.50
198-1209-A-21-3-92	192.62	212.72	54.21	94.70	-0.48	-0.41	-0.17	0.07	-0.52	-0.85	0.05	-0.38
198-1209-A-21-3-116	192.86	212.96	54.32	92.80	-0.82	-0.84	-0.56	-0.54	-1.20	-1.13	-0.41	-0.81
198-1209-A-21-4-7	193.27	213.37	54.49	88.20	-0.81	-0.76	-0.88	-0.79	-1.52	-1.28	-0.56	-0.73
198-1209-A-21-4-46	193.66	213.76	54.65	92.30	-0.73	-0.83	-0.59	-0.52	-0.80	-1.02	-0.34	-0.75
198-1209-A-21-4-68	193.88	213.98	54.73	93.00	-1.06	-0.85	-1.76	-0.67	-1.74	-2.99	-0.45	-0.91
198-1209-A-21-4-103	194.23	214.33	54.89	89.45	-0.90	-0.78	-0.71	-0.82	-0.82	-1.12	-0.54	-0.71
198-1209-A-21-5-11	194.81	214.91	55.04	82.94	-0.73	-0.56	-0.58	-0.84	-1.55	-0.60	-0.56	-0.60
198-1209-A-21-5-83	195.53	215.63	55.25	96.80	-0.91	-0.82	-1.01	-0.62	-0.97	-0.77	-0.38	-0.81
198-1209-A-21-5-123	195.93	216.03	55.37	94.20	-1.00	-0.78	-2.02	-0.91	-1.38	-1.77	-0.57	-0.81
198-1209-A-21-6-31	196.51	216.61	55.57	86.90	-1.06	-1.08	-0.21	-0.53	-1.13	-1.48	-0.33	-0.92
198-1209-A-21-6-116	197.36	217.46	55.78	94.90	-0.84	-0.92	-1.05	-0.07	-1.45	-1.69	-0.05	-0.88
198-1209-A-21-6-143	197.63	217.73	55.83	93.80	-0.60	-0.57	0.34	-0.06	-0.72	-0.60	-0.05	-0.51
198-1209-A-21-7-4	197.74	217.84	55.86	82.10	-0.70	-0.70	-0.40	0.01	-0.42	-1.07	0.00	-0.53
198-1209-A-21-7-11	197.81	217.91	55.89	81.50	-0.96	-1.21	-0.48	-1.01	-0.82	-1.30	-0.57	-0.95
198-1209-A-21-7-13	197.83	217.93	55.89	80.80	-1.09	-0.98	-0.47	-1.14	-2.08	-2.29	-0.66	-0.96
198-1209-A-21-7-32	198.02	218.12	55.94	88.00	-0.20	-0.41	-0.34	-0.88	-0.65	-1.60	-0.57	-0.39
198-1209-A-22-1-10	198.30	219.74	56.46	97.76	-0.60	-0.69	-0.25	-0.90	0.04	-2.19	-0.34	-0.67
198-1209-A-22-1-25	198.45	219.89	56.73	95.10	-0.38	-0.55	-0.39	-0.44	-0.09	-1.02	-0.20	-0.52
198-1209-A-22-1-50	198.65	220.09	57.11	93.20	-0.35	-0.54	-0.17	-0.65	-0.10	No sample	-0.31	-0.50

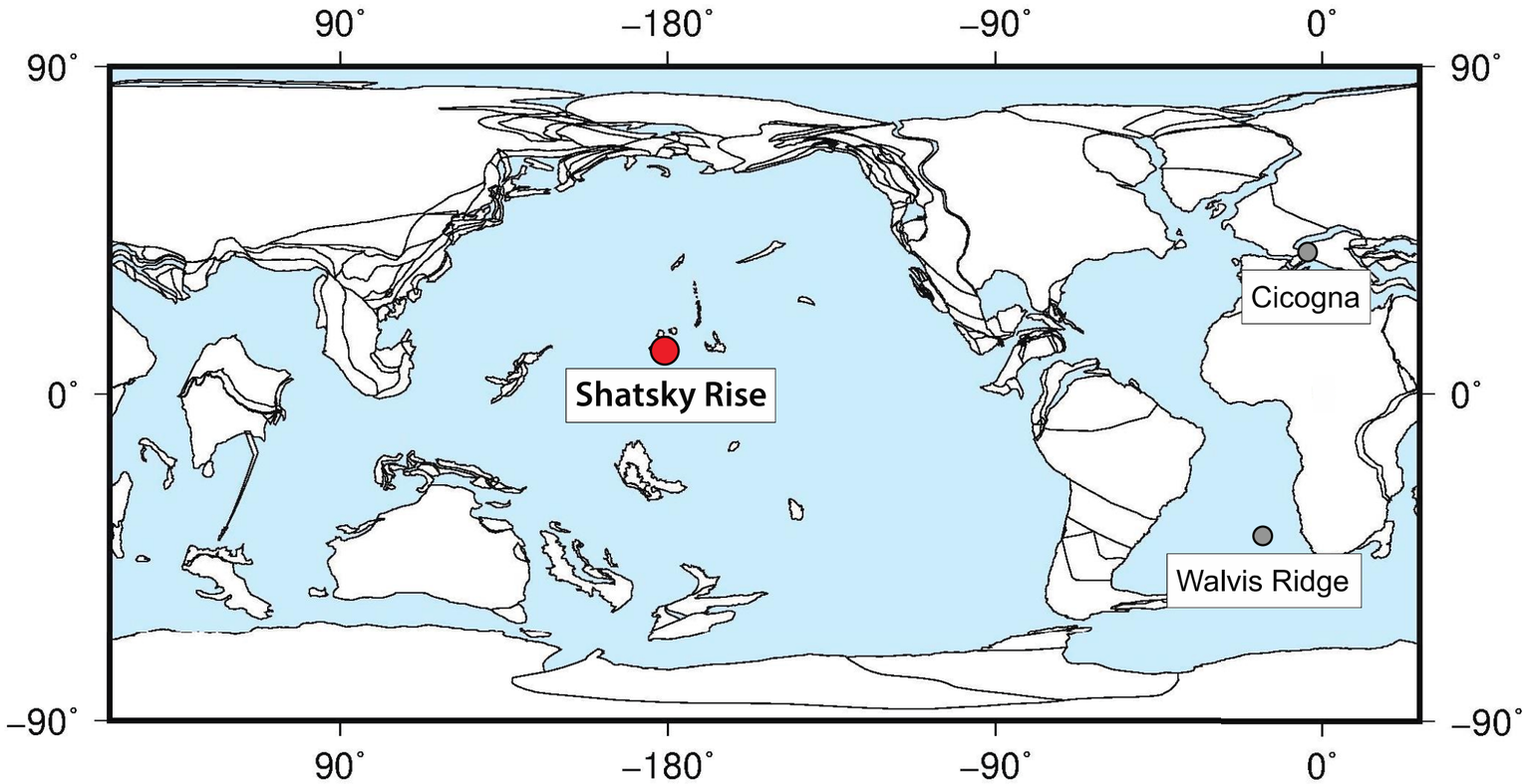
Supplementary Table 5. Correlation coefficient between isotope composition of bulk carbonates and size fractions.

r	Bulk vs (<25)	Bulk vs (25-63)	Bulk vs (63-125)	Bulk vs (125-250)	Bulk vs (>250)
$\delta^{13}C$	0.98	0.80	0.86	0.70	0.63
$\delta^{18}O$	0.70	0.20	0.23	0.15	0.19

Supplementary Table 6. Relation (r^2) between bulk carbonate- and size fraction $\delta^{13}C$ at three intervals, pre-PETM, at PETM and post-PETM.

r^2	Bulk vs (<25)	Bulk vs (25-63)	Bulk vs (63-125)	Bulk vs (125-250)	Bulk vs (>250)
Pre-PETM	0.98	0.14	0.01	0.13	1
PETM	1	1	1	1	1
post-PETM	0.95	0.85	0.76	0.44	0.97

34 **Supplementary Figure S1**



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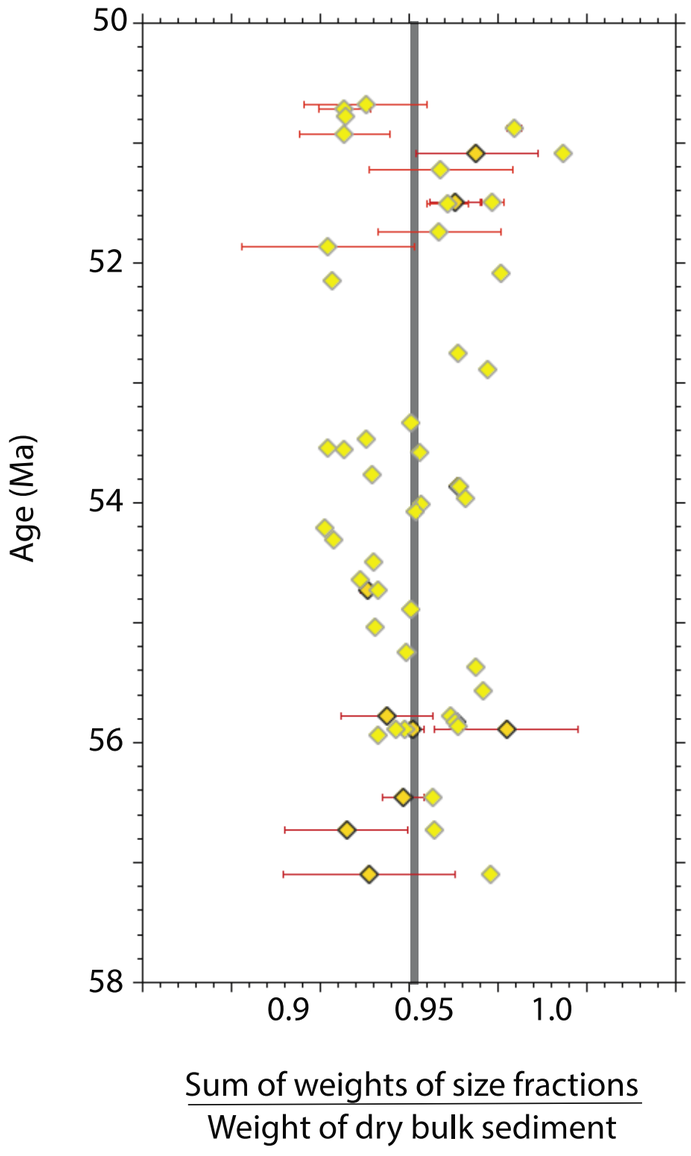
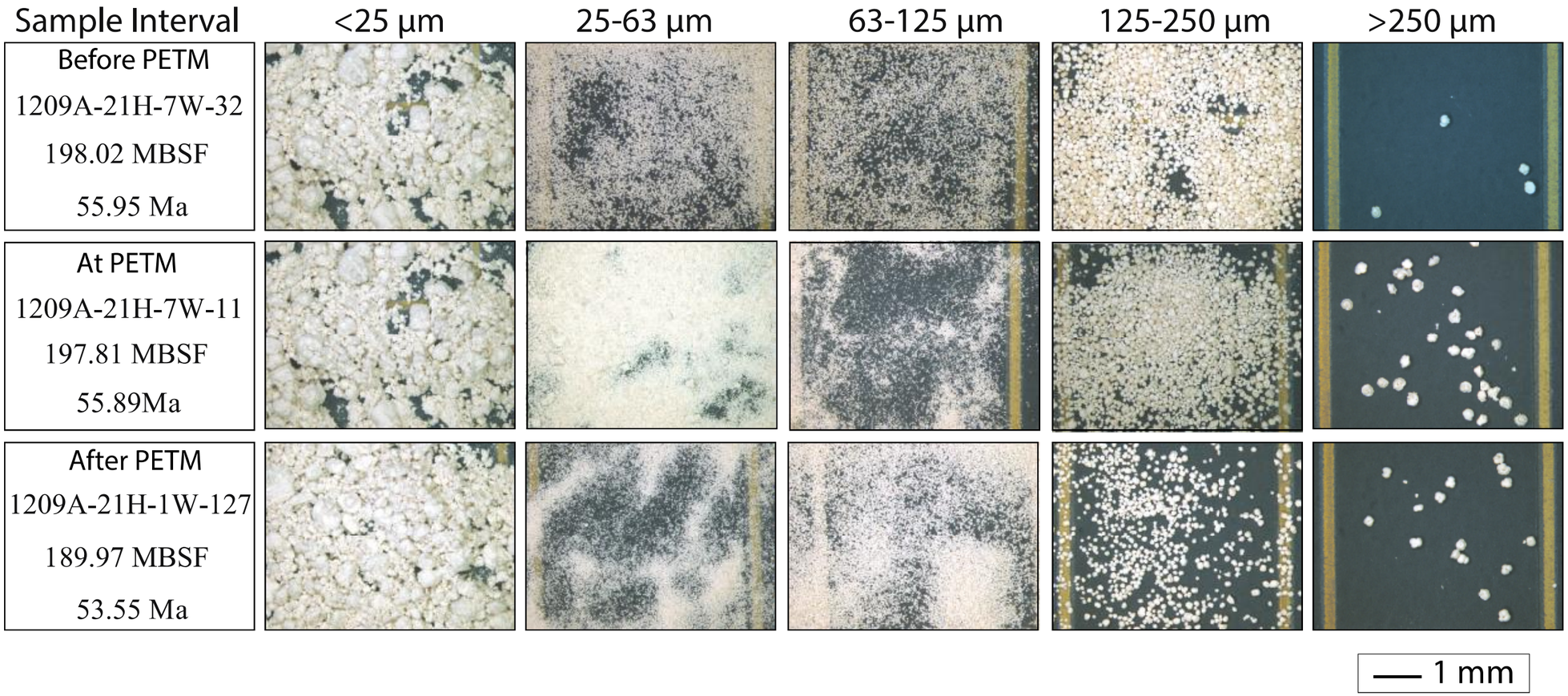
37 **S1**. Map showing location of Shatsky Rise in north-central Pacific, Walvis Ridge in south Atlantic and Cicogna section in Italy (paleo-Tethys). This map was generated at https://www.odsn.de/odsn/services/paleomap/paleomap.html.

Supplementary Figure S2



S2. Difference between weight of original bulk sample and the summed weights of size fractions. Upon sample washing, sieving, drying and settling, there is an average sample loss of about 5%. Highlighted data points show error bars ranging 1σ, calculated from replicate analysis.

Supplementary Figure S3

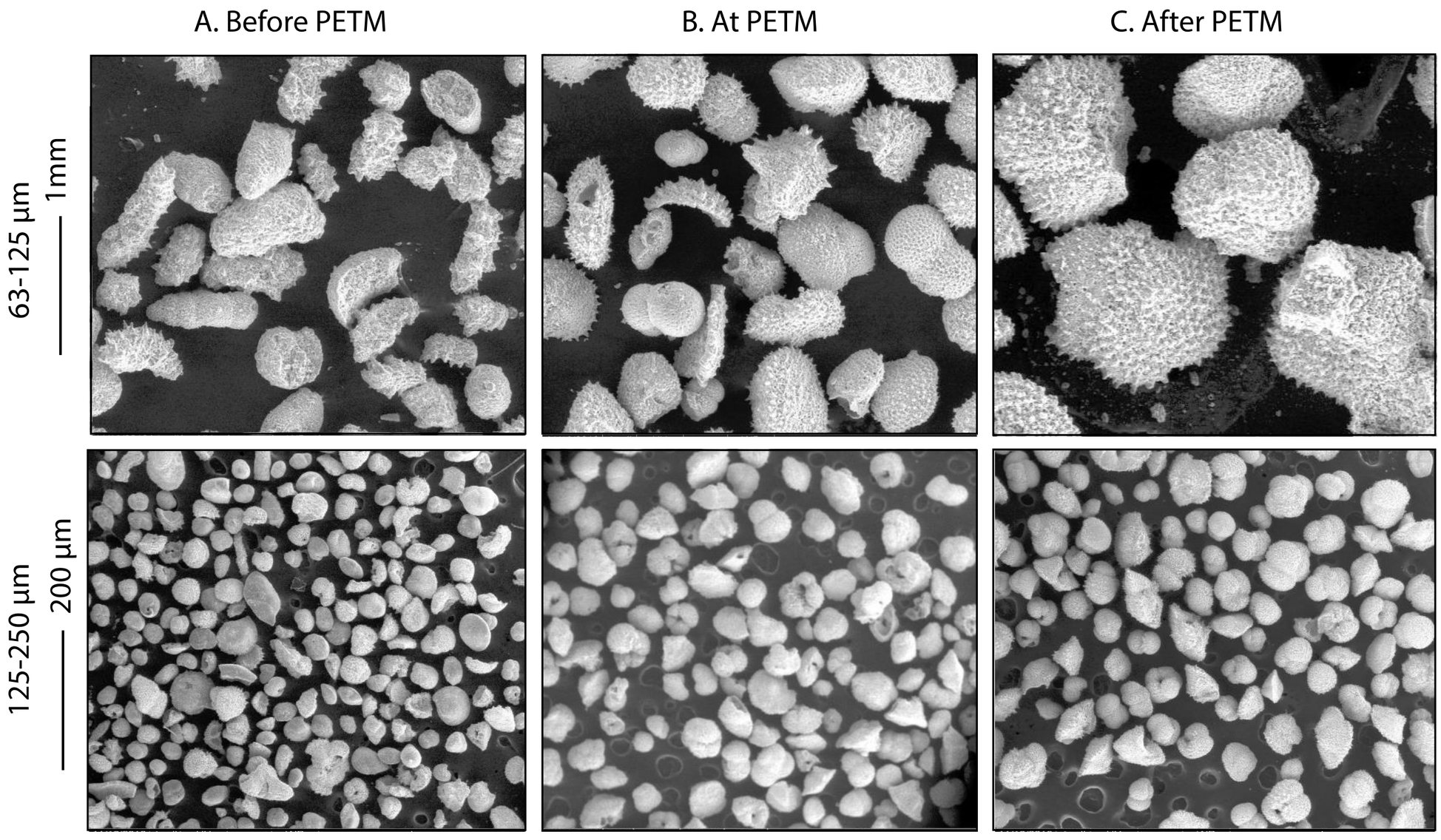


45

46

47 **S3**. Stereoscopic images of representative samples' size fractions. The fine fraction appears lumpy because they retain more moisture and have colloidal properties. (See Text T1).

48 **Supplementary Figure S4**



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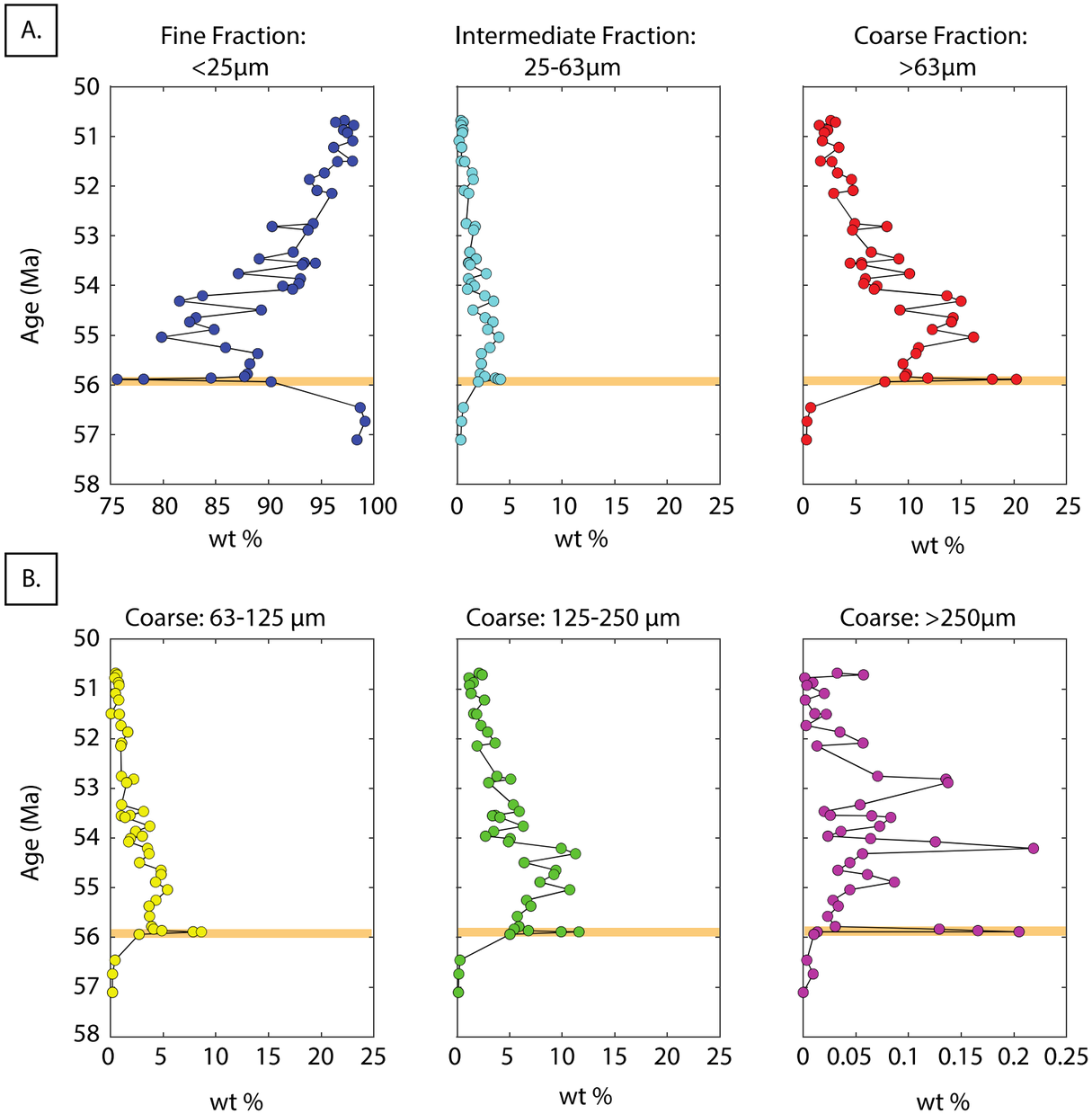
51 **S4.** SEM images of representative samples' size fractions as seen under scanning electron microscope. Three samples from before PETM, at PETM and after PETM intervals show the decrease in benthic foraminiferal abundance and increase

52 in spinose planktonic foraminiferal abundance across PETM.

53

54 **Supplementary Figure S5**

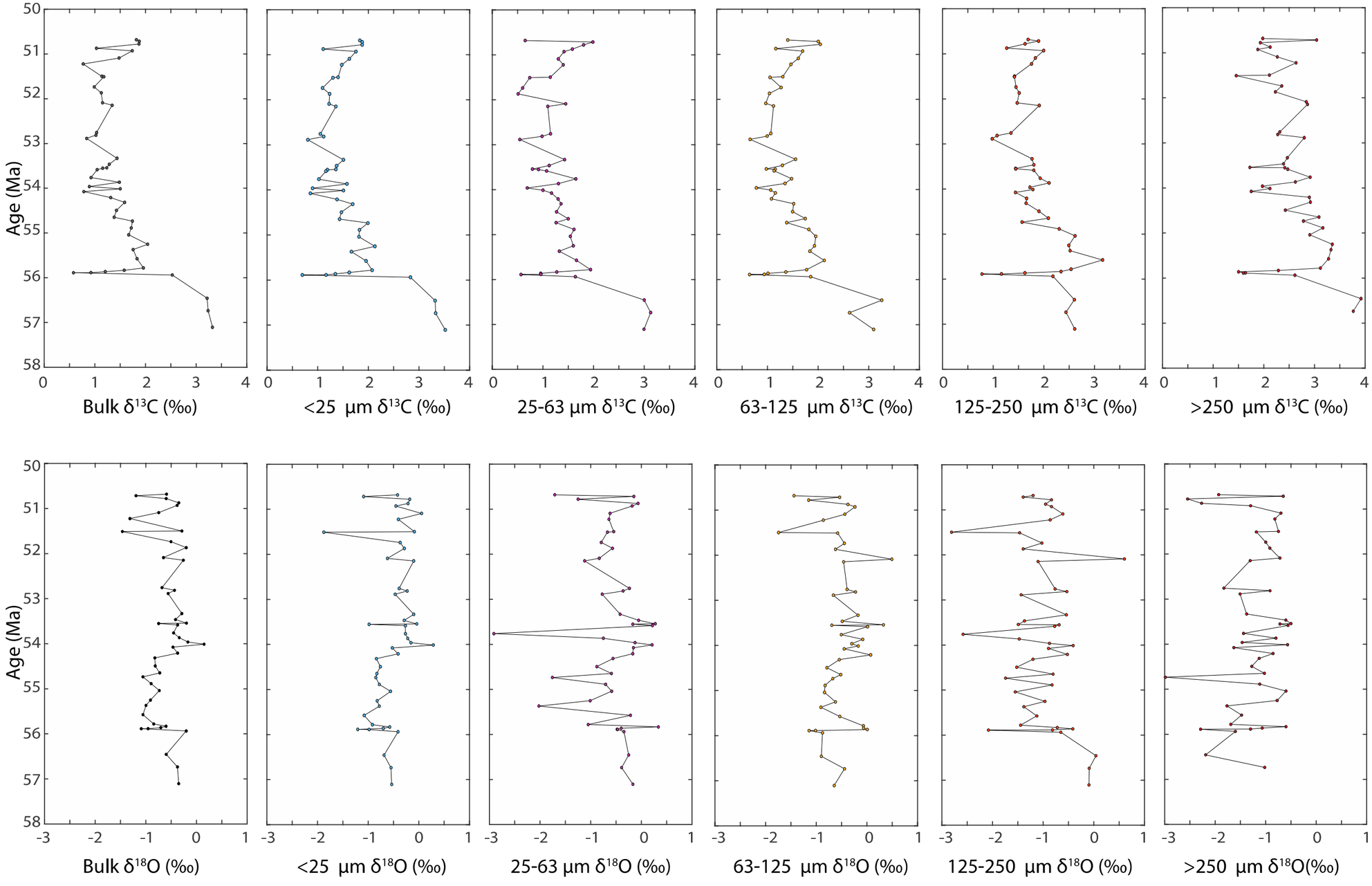


55

56 **S5**. Weight percent (WP) of size fractions. Panel A shows changes in WP fine fraction, intermediate Fraction and coarse fraction with time, between 58- and 50 Ma. Panel B similarly shows three subdivisions of WP of coarse fractions.

57

Supplementary Figure S6



S6. Carbon and oxygen isotope composition of bulk carbonate and individual size fractions.

Text T1

Change in mass after sediment rinsing

The weights of dry samples ($Wt_{dry\ sample}$) and individual size fractions after were measured. The sum of weights of five size fractions ($\Sigma_i\ Wt_i$) were then compared with starting weight for each sample, using the following relation:

Sample loss after rinsing= $Wt_{dry\ sample} - \Sigma_i\ Wt_i$ (1)

i= <25 µm, 25-63 µm, 63-125 µm, 125-250 µm and >250 µm

On an average 5% sample loss is recorded (**Supplementary Figure S2**). Wet sieve separation process of rinsing sediment samples inevitably always causes some sample loss. The loss is higher for fine fractions, because of their lower mass and higher settling times (Reghellin et al, 2015). Sample weight loss can also be attributed to presence of salts in marine sediments (Kendrick, 2018) which are dissolved during wet sieve separation process.

However, occasionally our data shows $\Sigma_i\ Wt_i > Wt_{dry\ sample}$. This is because extra moisture could have been present in the fine fractions during weight measurements. The fine fractions require more time for drying. This is because clays get incorporated in the fine fractions, whose colloidal properties results in moisture retention (Meyer, 1934).

Text T2

Correlation between bulk carbonate- and size fraction $\delta^{13}C$ and $\delta^{18}O$

The correlation coefficient (r) between bulk carbonate- and size fractions $\delta^{13}C$ and $\delta^{18}O$ are displayed in **Table 5**.

Readily clear, $\delta^{13}C$ values of bulk carbonate and size fractions show greater correlation than $\delta^{18}O$. Fine fraction and bulk carbonates show maximum correlation. Fine fractions comprise a major portion of bulk carbonates, and hence any change in $\delta^{13}C$ in the fines will be almost equally reflected in bulk carbonate, resulting in their excellent correlation.

Important to note here, that a study by Hupp et al. (2019) suggested a possible role of size dependent sediment mixing in controlling the stratigraphic position of CIE at Site 690. Such an effect is highly relevant when determining the precise timing of a CIE e.g. PETM, in the stratigraphic record at any open marine setting. In our study at Site 1209, such an effect is not altering any implications because, first, the study we present here extends from 58- to 50 Ma, with a much lower sampling resolution before, at and after the CIE, compared to that by Hupp et al. (2019), and do not emphasize on the exact timing of PETM here, rather we explore contributions of size fractions in controlling bulk carbonate $\delta^{13}C$ before, at and after PETM. Second, when we compare r^2 values of individual size fraction $\delta^{13}C$ and bulk carbonate $\delta^{13}C$ at three different intervals: before PETM, at PETM and after PETM (**Table 6**), we find that r^2 between bulk carbonate - fine fraction and bulk carbonate - >250 µm size fractions is significantly higher than the others. There is no gradational increase in r^2 values between bulk carbonate and increasing size of the sediment fractions. Therefore, for the scale and perspective at which we conduct this study, taphonomic effects are not being considered further.

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