Flemings, P.B., Behrmann, J.H., John, C.M., and the Expedition 308 Scientists
Proceedings of the Integrated Ocean Drilling Program, Volume 308

Data report: isotope compositions of sedimentary organic carbon and total nitrogen from Brazos-Trinity Basin IV (Sites U1319 and U1320) and Ursa Basin (Sites U1322 and U1324), deepwater Gulf of Mexico[1]

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Chapter contents

Abstract

Organic carbon and total nitrogen stable isotopes are reported for sediments drilled during Integrated Ocean Drilling Program Expedition 308. Brazos-Trinity Basin IV sediments exhibited a broad range in organic carbon $\delta^{13}C$ ranging between –27‰ and –20‰ ($\delta^{13}C$ average = –24.1‰) compared to Ursa Basin sediments that are generally more depleted in ^{13}C ($\delta^{13}C$ average = –25.7‰). Bulk $\delta^{15}N$ values across all basins ranged from –2.7‰ to 8.2‰ ($\delta^{15}N$ average = 3.7‰) and showed no obvious trend. The relative contribution of marine and terrestrial detrital material deposited within these sediments was inferred by comparing isotopic compositions to C/N values. The significant contribution of inorganic nitrogen (N_{bound} average ≈ 75%), as estimated from total organic carbon/total nitrogen plots, likely lowered the observed C/N values.

Introduction

Pleistocene and Holocene sediments within the Brazos-Trinity and Ursa Basins (northwestern Gulf of Mexico) were largely deposited by turbidity currents and have been deformed by a number of mass transport events (Winker and Booth, 2000). Sediment sequences recovered from Brazos-Trinity Basin IV are typified by turbidites deposited over the last 112 k.y. (see the **"Expedition 308 summary"** chapter). The Ursa Basin sediments are levee-channel remnants of the ancient Mississippi River that were deposited within the last 68 k.y. (see the **"Expedition 308 summary"** chapter). In this study, the isotope compositions of sedimentary organic carbon and total nitrogen (TN), coupled with carbon to nitrogen molar ratios, were determined in order to assess the provenance of organic matter within these respective basins and to determine if the organic matter signature would allow for observation of a record of turbidite events in these basins.

Carbon to nitrogen molar ratios (C/N) are an index with which to determine the relative contributions of marine or terrigenous organic matter to the sedimentary record. Typically, marine organic matter C/N values range between 5 and 8 and terrestrial ratios are generally >20 (Emerson and Hedges, 1988; Meyers, 1997; Bouloubassi et al., 1999). Caveats to the use of C/N values as organic geochemical proxies include preferential nitrogen enrichment from

[1]Gilhooly, W.P., III, Macko, S.A., and Flemings, P.B., 2008. Data report: isotope compositions of sedimentary organic carbon and total nitrogen from Brazos-Trinity Basin IV (Sites U1319 and U1320) and Ursa Basin (Sites U1322 and U1324), deepwater Gulf of Mexico. *In* Flemings, P.B., Behrmann, J.H., John, C.M., and the Expedition 308 Scientists, *Proc. IODP,* 308: College Station, TX (Integrated Ocean Drilling Program Management International, Inc.). doi:10.2204/iodp.proc.308.208.2008
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clay sorption or nitrogen loss during microbial decomposition (Pimmel and Claypool, 2001). Organic geochemical results indicate the potential for preferential preservation of organic matter, whether terrestrial or marine, within the sediment as a response to sea level change. Organic carbon $\delta^{13}C$ depletions of up to 6‰ are attributed to enhanced terrigenous supply during the Last Glacial Maximum (20 ka) and glacial periods throughout the Pleistocene (Newman et al., 1973; Jasper and Gagosian, 1990). Initial shipboard carbon and nitrogen elemental analyses suggested sedimentary organic matter is primarily derived from algal sources in Brazos-Trinity Basin IV, whereas organic precursors in Ursa Basin are hemipelagic to terrestrial. Proportionation of the inputs to these sediments, based on carbon isotope end-members ($\delta^{13}C_{marine} \approx -20‰$; $\delta^{13}C_{terrestrial} \approx -27‰$), should elucidate potential sources and relative contributions of organic matter to these Gulf of Mexico sediments.

Methods and materials

Sediments from Brazos-Trinity Basin IV (Sites U1319 and U1320) and Ursa Basin (Sites U1322 and U1324) were sampled from cores taken during Integrated Ocean Drilling Program (IODP) Expedition 308. A total of 92 intervals were sampled for bulk chemical analysis from Brazos-Trinity Basin IV sediments, and 114 intervals were analyzed from Ursa Basin. Sediment whole rounds were sampled approximately every 1.5 m above 50 meters below seafloor and every 10 m to terminal depth. Sediments were freeze-dried and then homogenized with an agate mortar and pestle. The total organic carbon (TOC) composition of the sediment was determined from elemental analysis of total carbon (TC) and coulometric analysis of total inorganic carbon (TIC) on board the R/V *JOIDES Resolution*. TOC was calculated as the difference between TC and TIC (TOC = TC – TIC). Weight percent TN was also determined by shipboard elemental analysis. C/N values were calculated as the molar ratio of TOC to TN.

Carbon and nitrogen isotopic analyses were conducted at the University of Virginia Stable Isotope Laboratory. Sediment splits for organic carbon isotope analysis were directly acidified with 2N HCl to remove carbonates. The carbonate-free residues were then dried at 50°C and homogenized. Bulk sediment $\delta^{15}N$ was reported for nonacidified sediments to preclude potential nitrogen isotope effects during the carbonate removal procedure. Bulk isotope ratios were determined on a Carlo-Erba elemental analyzer coupled under continuous flow with an OPTIMA isotope ratio mass spectrometer (GV, Manchester, UK). Carbon and nitrogen isotope values are reported according to the equation $\delta^{x}E$ (‰) = $R_{sample}/R_{standard} - 1) \times 10^3$, where x is the heavy isotope of the respective element (E) and R is the ratio of the heavy to light isotope (e.g., $^{13}C/^{12}C$). Internal laboratory reference gases were calibrated against international standards for carbon (NBS-19) and nitrogen (atmospheric N_2). Analytical precision for replicate analyses of standard materials was typically ±0.2‰ for both $\delta^{13}C$ and $\delta^{15}N$.

Results

Organic carbon, total nitrogen, and C/N ratios

TOC content was generally low throughout all sites, averaging 0.7 wt% with a maximum concentration of 2.2 wt% (Table T1; Fig. F1). Minimal downcore variations were observed in TOC of Brazos-Trinity Basin IV. TOC concentrations (~1.5 wt%) at Ursa Basin Sites U1322 and U1324 exhibited a systematic decrease in organic carbon to ~0.5 wt% at terminal depth. TN concentrations were largely uniform across all basins and sites at <0.2 wt%.

The remarkably low C/N values at Sites U1319, U1320, and U1324 (average = 4.7 ± 1.9) are suggestive of sedimentary organic matter derived from algal marine sources (Table T1). Substantially elevated C/N values at Ursa Basin Site U1322 (average C/N = 13.1) imply a more significant input from terrestrially derived organic matter.

The presence of inorganic nitrogen bound to the sediment matrix may explain the C/N values less than the Redfield ratio. The positive y-intercepts in plots of TOC versus TN indicate that a significant fraction of the bulk nitrogen pool is inorganic (Fig. F2). Estimates calculated from TOC/TN regressions suggest the bulk nitrogen content from Brazos-Trinity Basin IV is at least 70% to completely comprised of inorganic nitrogen (Table T2). The inorganic nitrogen fraction was also a significant contribution to Ursa Basin sedimentary nitrogen, ranging from 56% to 90% in Holes U1322B, U1322C, and U1322D and from 9% to 48% in Holes U1324B and U1324C (Table T2). It should be noted that the accuracy of these estimates is prone to a considerable amount of error given the scatter within the data (see correlation coefficients, Fig. F2). Whether observed differences in atomic ratios are driven by changes in the relative contributions of terrestrial or marine end-members or other processes such as preferential loss of nitrogenous compounds during early diagenesis or incorporation of bound nitrogen were further addressed through dual isotopic analysis of bulk organic carbon and total nitrogen contained in the sediments.

Comparison of C/N with organic carbon and total nitrogen isotopic compositions

The carbon isotopic composition of organic matter isolated from Brazos-Trinity Basin IV sediments is widely variable (from –27‰ to –20‰; Table T1) and approximates the range expected of respectively isotopically depleted or enriched terrestrial and marine end-members (Macko et al., 1984). The pronounced shift toward isotopically lighter values (by up to 6‰) observed in lithologic Unit V of cores from Holes U1319A and U1320A records a transition from marine to terrestrially derived organic matter within Brazos-Trinity Basin IV sediments (Fig. F1). In contrast, $\delta^{13}C$ values of Ursa Basin TOC are more constrained (average $\delta^{13}C$ = –25.7‰ ± 1.0‰) and suggest significant input of terrestrial organic material. The proximity of Ursa Basin to the Mississippi River delta and the high supply of riverine sediment likely promote a near-continuous record of terrestrially sourced organic matter. Within both study locations, there is no clear relationship between isotopic excursions and the occurrence of turbidite deposits (Fig. F1).

C/N ratios plotted as a function of $\delta^{13}C$ reveal that Sites U1319, U1320, and U1324 fall well below the expected mixing line for an admixture of marine and terrestrial end-members (Fig. F3). Low C/N values (<5) suggest a marine end-member and are inconsistent with the broad ranges observed in $\delta^{13}C$. Paired isotopic and elemental data from Site U1322 more closely fit the proposed mixing model between isotopically light terrigenous debris and isotopically heavy marine organic matter. Alternative explanations for shifts observed in $\delta^{13}C$ and C/N include algal temperature-dependent carbon isotopic effects, diagenetic alteration, or substantial input from terrestrial C_4 vascular plants ($\delta^{13}C \approx -14‰$) (Jasper and Gagosian, 1990). Most likely, the observed trends are a reflection of low organic matter accumulation in deepwater sediments of the Gulf of Mexico coupled with significant incorporation of inorganic nitrogen during early diagenesis, which would artificially drive low C/N values (Bouloubassi et al., 1999; Schubert and Calvert, 2001). Shipboard analyses indicated significant production of ammonium in excess of 4 mM within Brazos-Trinity Basin IV and Ursa Basin pore fluids. Comparison of TOC/TN plots across all sites suggests a significant incorporation of inorganic nitrogen to the bulk nitrogen content (Fig. F2). Averaged across all sites, the bound nitrogen fraction is ~75% (Table T2). The presence of bound nitrogen coupled with the shift in C/N to lower values may explain discrepancies in the interpretation of the origins of sedimentary organic matter inferred from molar and isotopic data.

Nitrogen isotopic compositions across all sites ranged from –2.7‰ to 8.2‰ (Table T1). Average $\delta^{15}N$ values (3.7‰) are consistent with surficial marine sediments (Macko et al., 1984; Altabet and Francois, 1994). As with $\delta^{13}C$ values, Site U1322 exhibited a narrower range in $\delta^{15}N$ values (3.9‰ ± 1.3‰) relative to the other sites. A comparison of C/N values relative to $\delta^{15}N$ indicate Site U1322 sediments are more terrestrial in origin compared to inferred marine origins for Sites U1319, U1320, and U1324 (Fig. F4). Ammonium adsorbed to the sediment matrix may have shifted the $\delta^{15}N$ signature to isotopically lighter values (Schubert and Calvert, 2001). This potentially mixed nitrogen signal could be apportioned by isolation techniques, which operationally define the organic nitrogen fraction (Schubert and Calvert, 2001), or by direct extraction of the organics.

Acknowledgments

We thank the analytical expertise and tireless efforts of shipboard geochemical specialists Christopher Bennight and Lisa Brandt on IODP Expedition 308. Undergraduates Matthew McConnell and Angela Duong helped prepare sediments for shore-based analyses. Constructive reviews by C. John and S. Bernasconi greatly improved this data report. Sediment samples and shipboard data were provided by IODP. Funding was provided by Ocean Leadership Consortium/U.S. Science Support Program awards for postexpedition analysis and undergraduate supplemental support.

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Initial receipt: 7 March 2008
Acceptance: 21 May 2008
Publication: 3 September 2008
MS 308-208

Figure F1. Total organic carbon (TOC) and total nitrogen (TN) concentrations and isotopic composition (δ13C, δ15N). Carbon (solid symbols) and nitrogen (open symbols) data are presented as downcore profiles at (**A**) Brazos-Trinity Basin IV and (**B**) Ursa Basin sites. Diamonds = Hole A, circles = Hole B, squares = Hole C, triangles = Hole D. Lithologic units: green = clay/mud, yellow = sand, orange = silt, blue = foraminifer-bearing clay. (**Continued on next page.**)

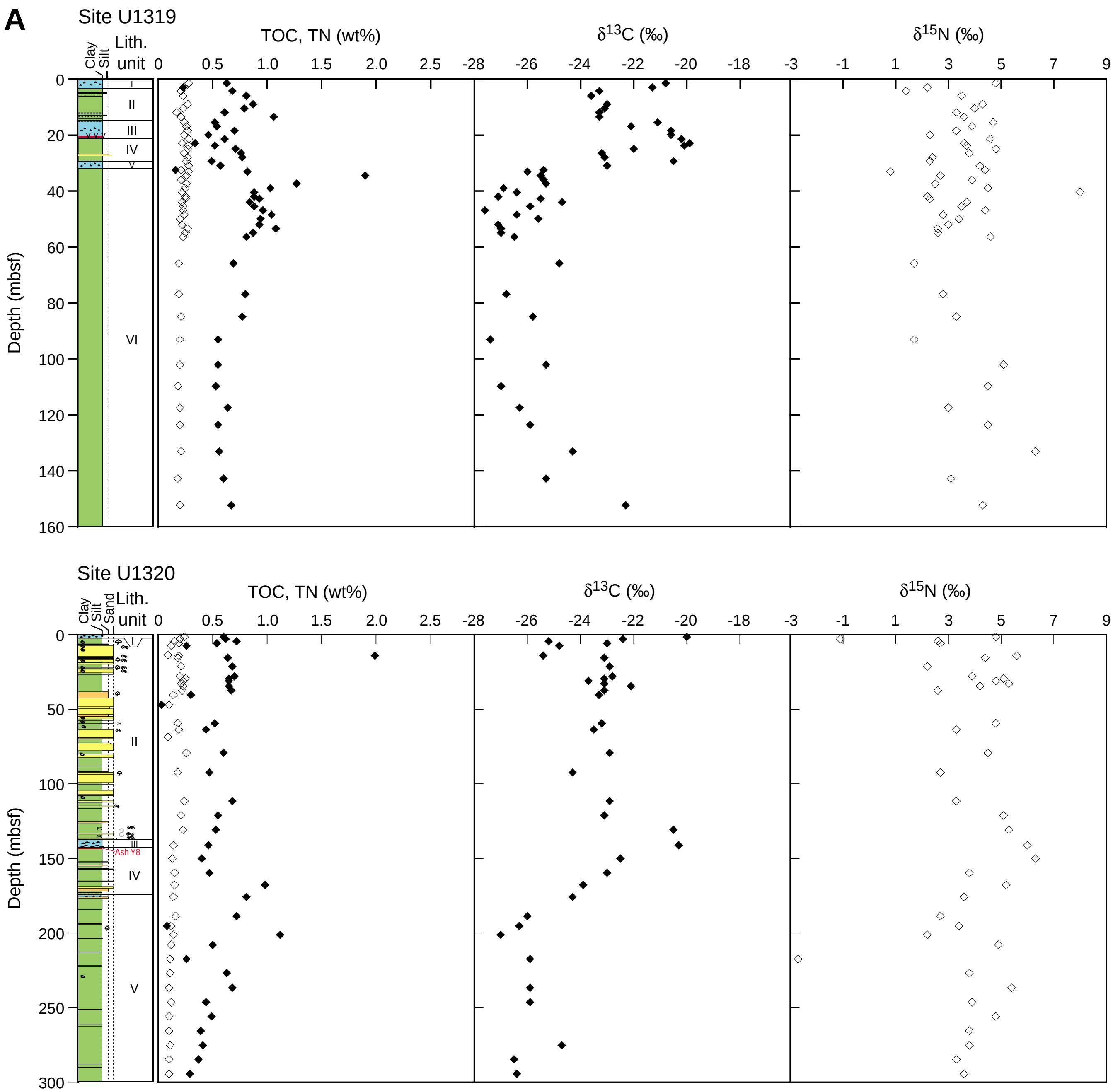

Figure F1 (continued).

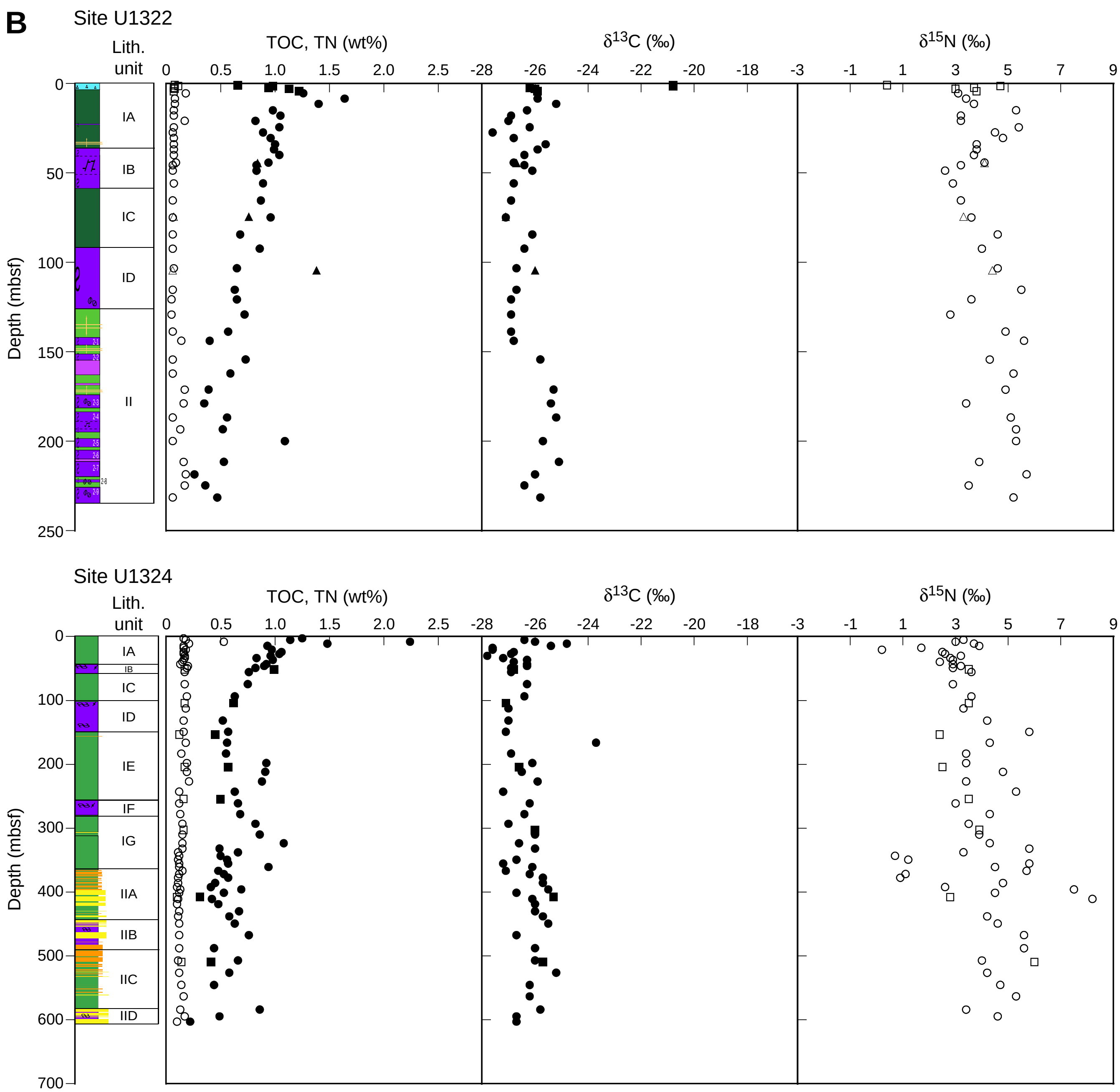

Figure F2. Total organic carbon (TOC) and total nitrogen (TN) regressions, Holes U1319A, U1320A, U1322B, U1322C, U1322D, U1324B, and U1324C.

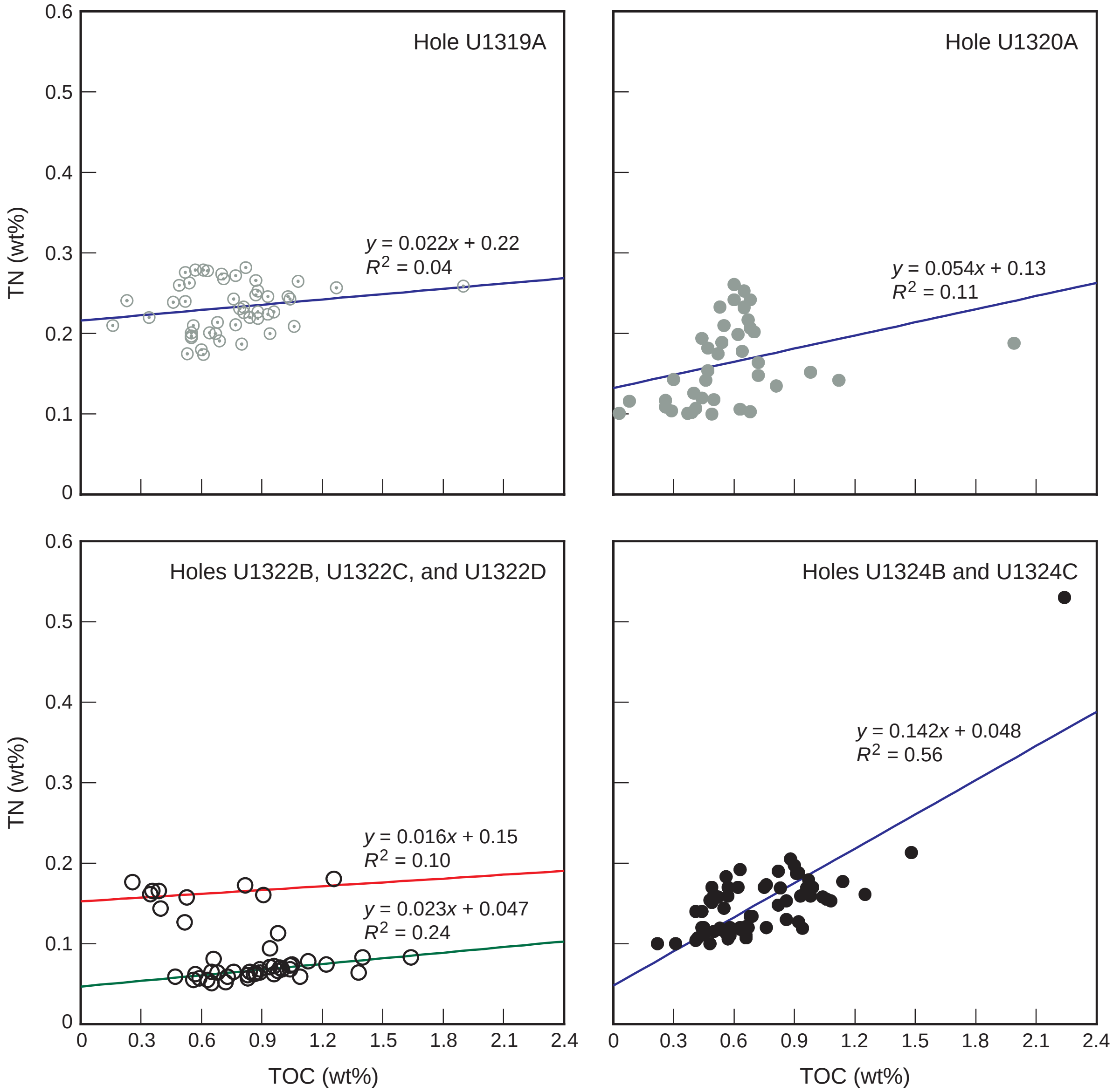

Figure F3. Comparison of organic carbon and total nitrogen molar ratios (C/N) to carbon isotopes. Dotted gray circle = Hole U1319A, solid gray circles = Hole U1320A, open black circles = Holes U1322B, U1322C, and U1322D, solid black circles = Holes U1324B and U1324C. Upper and lower dashed lines = typical C/N values for terrestrially derived organic matter and marine organics. A hypothetical mixing line connects marine (Mar; δ13C ≈ –20‰) and terrestrial (C3; δ13C ≈ –27‰) carbon isotopic end-members.

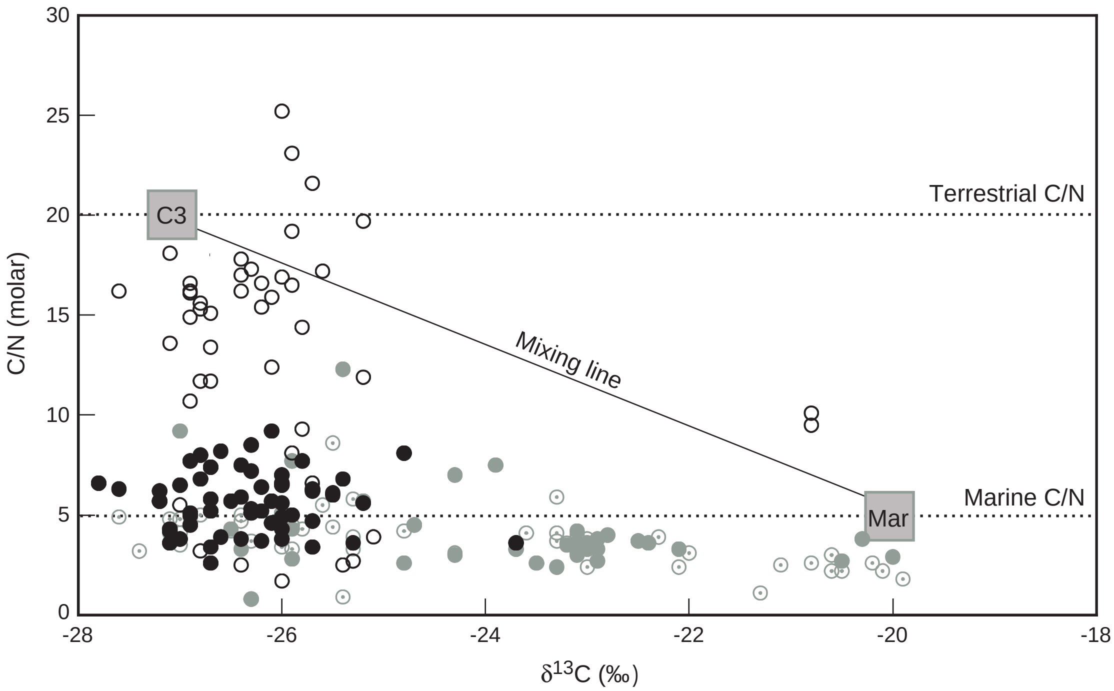

Figure F4. Comparison of organic carbon and total nitrogen molar ratios (C/N) to nitrogen isotopes. Gray dotted circles = Hole U1319A, gray solid circles = Hole U1320A, black open circles = Holes U1322B, U1322C, and U1322D, black solid circles = Holes U1324B and U1324C. Upper and lower dashed lines = typical C/N values for terrestrially derived organic matter and marine organics.

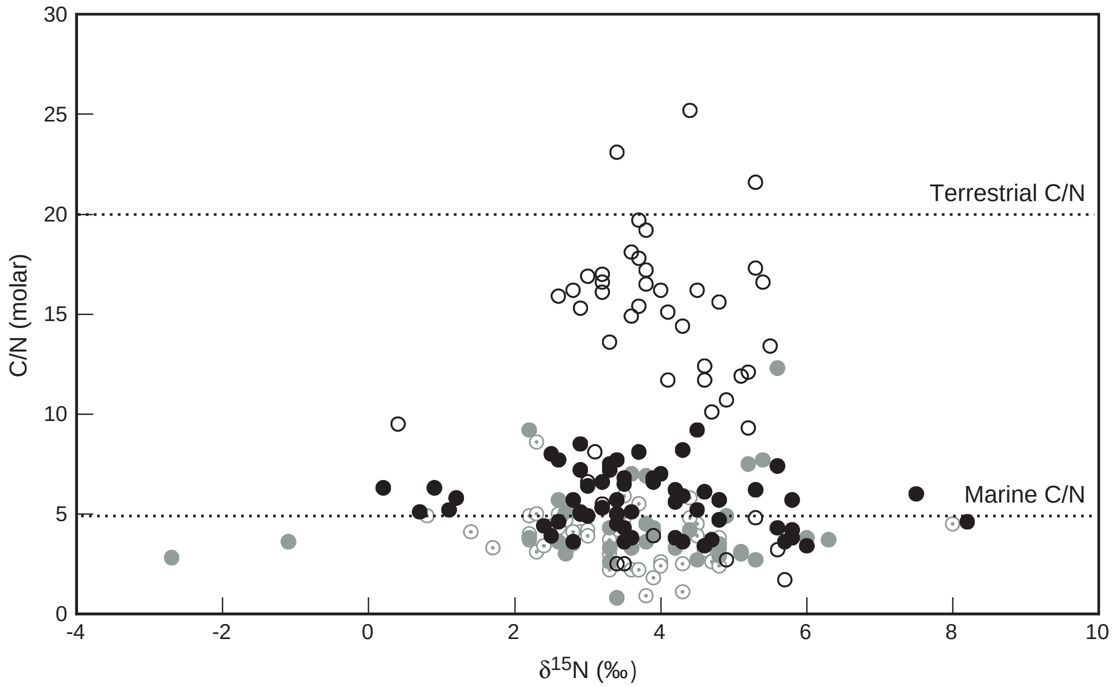

Table T1. Carbon and nitrogen isotopic compositions and concentrations for Sites U1319–U1324. (See table note.) (Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	TOC (wt%)	$\delta^{13}C$ (‰)	TN (wt%)	$\delta^{15}N$ (‰)	C/N (molar)
308-U1319A-						
1H-1, 145–150	1.45	0.63	–20.8	0.28	4.0	2.6
1H-2, 145–150	2.95	0.23	–21.3	0.24	4.3	1.1
1H-3, 127–132	4.27	0.68	–23.3	0.21	2.2	3.7
2H-1, 145–150	5.95	0.81	–23.6	0.23	2.9	4.1
2H-3, 145–150	8.95	0.87	–23.0	0.27	4.8	3.8
2H-4, 145–150	10.45	0.79	–23.1	0.23	2.2	4.0
2H-5, 137–142	11.87	0.61	–23.3	0.17	1.4	4.1
2H-6, 145–150	13.45	1.06	–23.3	0.21	3.5	5.9
3H-1, 145–150	15.45	0.52	–21.1	0.24	4.3	2.5
3H-2, 138–143	16.88	0.54	–22.1	0.26	4.0	2.4
3H-3, 145–150	18.45	0.70	–20.6	0.27	3.3	3.0
3H-4, 145–150	19.95	0.46	–20.6	0.24	3.6	2.2
3H-5, 138–143	21.38	0.61	–20.2	0.28	4.7	2.6
3H-6, 145–150	22.95	0.34	–19.9	0.22	3.9	1.8
3H-7, 74–79	23.74	0.52	–20.1	0.28	3.3	2.2
4H-1, 145–150	24.95	0.71	–22.0	0.27	2.3	3.1
4H-2, 145–150	26.45	0.76	–23.2	0.24	4.6	3.6
4H-3, 145–150	27.95	0.77	–23.1	0.27	3.6	3.3
4H-4, 137–142	29.37	0.49	–20.5	0.26	3.7	2.2
4H-5, 145–150	30.95	0.57	–23.0	0.28	4.8	2.4
4H-6, 145–150	32.45	0.16	–25.4	0.21	3.8	0.9
4H-7, 58–63	33.08	0.82	–26.0	0.28	2.4	3.4
5H-1, 145–150	34.45	1.90	–25.5	0.26	2.3	8.6
5H-2, 145–150	35.95		–25.4	0.21	4.2	
5H-3, 137–142	37.37	1.27	–25.3	0.26	4.4	5.8
5H-4, 145–150	38.95	1.03	–26.9	0.25	0.8	4.9
5H-5, 145–150	40.45	0.88	–26.4	0.22	2.7	4.7
5H-6, 145–150	41.95	0.88	–27.1	0.25	3.9	4.1
5H-7, 68–73	42.68	0.93	–25.5	0.25	2.5	4.4
6H-1, 145–150	43.95	0.84	–24.7	0.22	4.5	4.5
6H-2, 145–150	45.45	0.88	–25.9	0.23	8.0	4.5
6H-3, 137–142	46.87	0.96	–27.6	0.23	2.2	4.9
6H-4, 145–150	48.45	1.04	–26.4	0.24	2.3	5.0
6H-5, 145–150	49.95	0.94	–25.6	0.20	3.7	5.5
6H-7, 53–58	52.03	0.93	–27.1	0.22	3.5	4.8
7H-1, 145–150	53.45	1.08	–27.0	0.27	4.4	4.8
7H-2, 145–150	54.95	0.87	–27.0	0.25	2.8	4.1
7H-3, 137–142	56.37	0.81	–26.5	0.23	3.4	4.2
8H-3, 137–142	65.87	0.69	–24.8	0.19	3.0	4.2
9H-4, 137–142	76.87	0.80	–26.8	0.19	2.6	5.0
10H-3, 137–142	84.87	0.77	–25.8	0.21	2.6	4.3
11H-3, 145–150	93.07	0.55	–27.4	0.20	4.6	3.2
12H-2, 137–142	102.07	0.55	–25.3	0.20	1.7	3.3
13H-3, 77–82	109.72	0.53	–27.0	0.18	2.8	3.5
14X-2, 136–141	117.46	0.64	–26.3	0.20	3.3	3.7
15X-3, 145–150	123.55	0.55	–25.9	0.20	1.7	3.3
16X-3, 137–142	133.07	0.56	–24.3	0.21	5.1	3.1
17X-3, 145–150	142.75	0.60	–25.3	0.18	4.5	3.9
18X-3, 137–142	152.27	0.67	–22.3	0.20	3.0	3.9
308-U1320A-						
1H-1, 145–150	1.45	0.60	–20.0	0.24	4.8	2.9
1H-2, 137–142	2.87	0.62	–22.4	0.20	–1.1	3.6
1H-3, 132–137	4.32	0.72	–25.2	0.15	2.6	5.7
2H-1, 132–137	5.82	0.54	–23.0	0.19	2.7	3.3
2H-2, 132–137	7.37	0.26	–24.8	0.12		2.6
2H-6, 145–150	13.45			0.09		
2H-7, 49–54	13.99	1.99	–25.4	0.19	5.6	12.3
3H-1, 145–150	15.45	0.64	–23.1	0.18	4.4	4.2
3H-5, 127–132	21.27	0.68	–22.9	0.21	2.2	3.8
4H-3, 137–142	27.87	0.70	–22.8	0.20	3.9	4.0
4H-4, 145–150	29.45	0.65	–23.1	0.25	5.1	3.0
4H-5, 145–150	30.95	0.65	–23.7	0.23	4.8	3.3
4H-7, 45–50	32.8		–23.1	0.21	5.3	
5H-1, 145–150	34.45	0.65	–22.1	0.23	4.2	3.3
5H-3, 137–142	37.37	0.67	–23.1	0.22	2.6	3.6
5H-5, 145–150	40.45	0.30	–23.3	0.14		2.4
6H-3, 145–150	46.95	0.03		0.10		0.3
7H-5, 137–142	59.37	0.52	–23.2	0.18	4.8	3.5
8H-2, 145–150	63.55	0.44	–23.5	0.19	3.3	2.6
9H-1, 132–137	68.62			0.09		
11X-1, 95–100	79.25	0.60	–22.9	0.26	4.5	2.7
12X-3, 137–142	92.27	0.47	–24.3	0.18	2.7	3.0
14X-3, 145–150	111.55	0.68	–22.9	0.24	3.3	3.3
15X-3, 136–141	121.06	0.55	–23.1	0.21	5.1	3.1
16X-3, 145–150	130.75	0.53	–20.5	0.23	5.3	2.7
17X-4, 137–142	141.07	0.46	–20.3	0.14	6.0	3.8
18X-3, 145–150	150.05	0.40	–22.5	0.13	6.3	3.7
19X-3, 137–142	159.57	0.47	–23.0	0.15	3.8	3.6
20X-2, 145–150	167.75	0.98	–23.9	0.15	5.2	7.5
21X-1, 136–141	175.76	0.81	–24.3	0.14	3.6	7.0
22X-3, 145–150	188.55	0.72	–26.0	0.16	2.7	5.1
23X-1, 137–150	195.12	0.08	–26.3	0.12	3.4	0.8
23X-5, 137–142	201.17	1.12	–27.0	0.14	2.2	9.2
24X-3, 145–150	207.85	0.50		0.12	4.9	4.9
25X-3, 140–150	217.4	0.26	–25.9	0.11	–2.7	2.8
26X-3, 137–142	226.78	0.63		0.11	3.8	6.9
27X-3, 140–150	236.6	0.68	–25.9	0.10	5.4	7.7
28X-3, 140–150	246.3	0.44	–25.9	0.12	3.9	4.3
29X-3, 132–142	255.82	0.49		0.10	4.8	5.7
30X-3, 140–150	265.5	0.39		0.10	3.8	4.5
31X-3, 140–150	275.1	0.41	–24.7	0.11	3.8	4.5
32X-3, 132–142	284.62	0.37	–26.5	0.10	3.3	4.3
33X-3, 140–150	294.3	0.29	–26.4	0.10	3.6	3.3
308-U1322B-						
1H-3, 87–100	3.87	0.91	–25.7	0.16	3.0	6.6
2H-1, 145–150	5.45	1.26	–25.9	0.18	3.1	8.1
2H-3, 145–150	8.45	1.64	–25.9	0.08	3.4	23.1
2H-5, 137–142	11.37	1.40	–25.2	0.08	3.7	19.7
3H-1, 145–150	14.95	0.98	–26.3	0.07	5.3	17.3
3H-3, 145–150	17.95	1.05	–26.9	0.07	3.2	16.6
3H-5, 137–142	20.87	0.82	–27.0	0.17	3.2	5.5
4H-1, 145–150	24.45	1.04	–26.2	0.07	5.4	16.6
4H-3, 137–142	27.37	0.89	–27.6	0.06	4.5	16.2
4H-5, 145–150	30.45	0.96	–26.8	0.07	4.8	15.6
5H-1, 145–150	33.95	1.00	–25.6	0.07	3.8	17.2
5H-3, 137–142	36.87	0.99	–25.9	0.07	3.8	16.5
5H-5, 145–150	39.95	1.04	–26.4	0.07	3.7	17.8
6H-2, 145–150	44.21	0.94	–26.8	0.09	4.1	11.7
6H-3, 137–142	45.63	0.83	–26.4	0.06	3.2	17.0
6H-5, 145–150	48.71	0.83	–26.1	0.06	2.6	15.9
7H-3, 132–142	55.82	0.89	–26.8	0.07	2.9	15.3
8H-3, 137–142	65.37	0.87	–26.9	0.06	3.2	16.1
9H-3, 137–142	74.87	0.96	–27.1	0.06	3.6	18.1
10H-3, 137–142	84.37	0.68	–26.1	0.06	4.6	12.4
11H-3, 132–142	92.33	0.86	–26.4	0.06	4.0	16.2
12H-3, 128–138	103.28	0.65	–26.7	0.07	4.6	11.7
13H-5, 75–85	115.31	0.63	–26.7	0.06	5.5	13.4
14H-3, 140–150	120.7	0.65	–26.9	0.05	3.6	14.9
15H-3, 134–144	129.14	0.72	–26.9	0.05	2.8	16.2
16H-3, 140–150	138.7	0.57	–26.9	0.06	4.9	10.7
17H-2, 28–38	143.83	0.40	–26.8	0.14	5.6	3.2
18H-3, 140–150	154.3	0.73	–25.8	0.06	4.3	14.4
19H-3, 132–142	162.12	0.59		0.06	5.2	12.1
20H-3, 140–150	171.1	0.39	–25.3	0.17	4.9	2.7
21H-3, 132–142	178.82	0.35	–25.4	0.16	3.4	2.5
22H-3, 140–150	186.7	0.56	–25.2	0.06	5.1	11.9
23H-3, 132–142	193.32	0.52		0.13	5.3	4.8
24H-1, 140–150	199.9	1.09	–25.7	0.06	5.3	21.6
26H-1, 122–132	211.52	0.53	–25.1	0.16	3.9	3.9
27H-3, 140–150	218.5	0.26	–26.0	0.18	5.7	1.7
28H-3, 140–150	224.7	0.36	–26.4	0.17	3.5	2.5
29H-3, 132–142	231.42	0.47	–25.8	0.06	5.2	9.3

Table T1 (continued).

Core, section, interval (cm)	Depth (mbsf)	TOC (wt%)	$\delta^{13}C$ (‰)	TN (wt%)	$\delta^{15}N$ (‰)	C/N (molar)
308-U1322C-						
1H-1, 90–95	0.9	0.66	–20.8	0.08	0.4	9.5
1H-1, 145–150	1.45	0.98	–20.8	0.11	4.7	10.1
1H-2, 90–95	2.4	0.94	–26.2	0.07	3.7	15.4
1H-2, 145–150	2.95	1.13	–26.0	0.08	3.0	16.9
1H-3, 128–133	4.28	1.22	–25.9	0.07	3.8	19.2
308-U1322D-						
1H-3, 140–150	44.4	0.84	–26.7	0.07	4.1	15.1
2H-3, 140–150	74.4	0.76	–27.1	0.07	3.3	13.6
3H-3, 140–150	104.4	1.38	–26.0	0.06	4.4	25.2
308-U1324B-						
1H-2, 135–140	2.85	1.25		0.16		9.1
2H-1, 145–150	5.25	1.14	–26.4	0.18	3.3	7.5
2H-3, 145–150	8.25	2.24	–26.0	0.53	3.0	4.9
2H-5, 135–140	11.15	1.48	–24.8	0.21	3.7	8.1
3H-1, 145–150	14.75	0.93	–25.4	0.16	3.9	6.8
3H-3, 145–150	17.75		–27.6	0.16	1.7	
3H-5, 137–142	20.67	0.97	–27.6	0.18	0.2	6.3
4H-1, 145–150	24.25	1.06	–26.8	0.16	2.5	8.0
4H-3, 137–142	27.17	1.04	–26.9	0.16	2.6	7.7
4H-5, 145–150	30.25	0.96	–27.8	0.17	3.2	6.6
5H-1, 145–150	33.75	0.83	–27.2	0.17	2.8	5.7
5H-3, 145–150	36.67	0.98	–26.3	0.16	2.9	7.2
5H-5, 145–150	39.75		–26.8	0.15	2.4	
6H-1, 145–150	43.25	0.92	–26.3	0.13	2.9	8.5
6H-3, 137–142	46.17	0.9	–26.3	0.20	3.2	5.3
6H-5, 145–150	49.25	0.82	–26.9	0.19	2.9	5.0
7H-3, 132–142	55.63	0.76	–26.9	0.17	3.6	5.1
9H-3, 132–142	74.62	0.75	–26.3	0.17	2.9	5.1
11H-3, 140–150	93.7	0.63	–26.4	0.19	3.6	3.8
13H-3, 132–142	112.62		–27.0	0.18	3.3	
15H-3, 132–142	131.62	0.52	–27.0	0.16	4.2	3.8
17H-3, 132–142	149.22	0.57	–27.1	0.16	5.8	4.2
19H-3, 132–142	166.32	0.56	–23.7	0.18	4.3	3.6
21H-3, 132–142	183.32	0.55	–26.9	0.14	3.4	4.5
23H-3, 132–142	198.12	0.92	–26.1	0.19	3.4	5.7
25H-3, 140–150	211.9	0.91	–26.5	0.19	4.8	5.7
27H-3, 140–150	226.9	0.88	–25.9	0.21	3.4	5.0
29H-3, 132–142	242.92	0.63	–27.2	0.12	5.3	6.2
31H-3, 140–150	261.2	0.66	–26.2	0.12	3.0	6.4
33H-3, 140–150	278	0.68	–26.4	0.13	4.3	5.9
35H-2, 132–142	293.22	0.82	–27.0	0.15	3.5	6.5
37H-3, 140–150	310	0.86	–26.0	0.15	3.9	6.6
39H-3, 140–150	323.6	1.08	–26.6	0.15	4.3	8.2
40H-3, 140–150	332	0.49	–26.0	0.15	5.8	3.8
41H-3, 132–142	337.82	0.66		0.11	3.3	7.2
42H-3, 140–150	343.4	0.5		0.12	0.7	5.1
43H-3, 140–150	349.4	0.56	–26.7	0.11	1.2	5.8
44H-2, 132–142	355.42	0.57	–27.2	0.12	5.8	5.7
45X-2, 140–150	360.8	0.94	–26.1	0.12	4.5	9.2
46X-3, 140–150	366.8	0.48	–27.1	0.15	5.7	3.6
47H-3, 88–98	371.88	0.53	–26.2	0.12	1.1	5.2
48H-3, 131–141	377.6	0.57	–25.7	0.11	0.9	6.3
49H-3, 131–141	385.81	0.45	–25.7	0.11	4.8	4.7
50H-3, 140–150	392.3	0.41		0.10	2.6	4.6
51X-1, 140–150	395.9	0.69	–25.5	0.13	7.5	6.0
52X-3, 140–150	401.2	0.53	–26.7	0.12	4.5	5.2
53X-3, 140–150	410.8	0.42	–26.1	0.11	8.2	4.6
54X-2, 140–150	418.9	0.48	–26.0	0.10		5.6
55X-3, 140–150	430.1	0.67	–26.0	0.12		6.5
56X-2, 132–142	438.12	0.58	–25.7	0.11	4.2	6.2
57X-3, 140–150	449.4	0.63	–25.5	0.12	4.6	6.1
59X-3, 132–142	467.46	0.76	–26.7	0.12	5.6	7.4
61X-3, 140–150	487.9	0.44	–26.0	0.12	5.6	4.3
63X-3, 140–150	507.1	0.66	–26.0	0.11	4.0	7.0
65X-3, 140–150	526.3	0.58	–25.2	0.12	4.2	5.6
67X-3, 140–150	545.5	0.44	–26.2	0.14	4.7	3.7
69X-2, 140–150	563.3		–26.2	0.16	5.3	
71X-3, 140–150	584	0.86	–25.8	0.13	3.4	7.7
73X-1, 140–150	594.6	0.49	–26.7	0.17	4.6	3.4
74X-3, 132–142	602.92	0.22	–26.7	0.10		2.6
308-U1324C-						
1H-1, 140–150	51.4	0.99	–26.8	0.17	3.5	6.8
2H-3, 140–150	104.4	0.62	–27.1	0.17	3.5	4.3
3H-3, 140–150	153.49	0.45		0.12	2.4	4.4
4H-3, 140–150	204.4	0.57	–26.6	0.17	2.5	3.9
5H-3, 140–150	254.4	0.5		0.16	3.5	3.6
6H-2, 140–150	302.9		–26.0	0.16	3.9	
7H-2, 140–150	407.9	0.31	–25.3	0.10	2.8	3.6
8H-3, 140–150	509.4	0.41	–25.7	0.14	6.0	3.4

Note: TOC = total organic carbon, TN = total nitrogen.

Table T2. Contribution of bound nitrogen (N_{bound}) estimated from TOC/TN regressions for Sites U1319–U1324. (**See table notes.**)

Hole	TOC (wt%)	TN (wt%)	*y*-intercept	N_{bound} (wt%)
U1319A	0.16	0.21	0.22	103
	1.90	0.26	0.22	83
U1320A	0.03	0.10	0.13	131
	1.99	0.19	0.13	70
U1322B, U1322C, and U1322D	0.26	0.18	0.15	85
	1.26	0.18	0.15	83
	0.47	0.06	0.047	79
	1.64	0.08	0.047	56
U1324B and U1322C	0.22	0.10	0.048	48
	2.24	0.53	0.048	9

Notes: N_{bound} contribution to total nitrogen (TN) content estimated across measured range of total organic carbon (TOC) observed within each site according to (*y*-intercept/TN) × 100. Estimates >100% reflect uncertainties in the regression (see correlation coefficients in Fig. **F2**).