50. NEOGENE PALEOCLIMATE DEVELOPMENT OF THE ANTARCTIC WEDDELL SEA REGION: ORGANIC GEOCHEMISTRY[1]

Stephen A. Macko[2] and Christopher P. G. Pereira[3]

ABSTRACT

Stable carbon and nitrogen isotopic compositions as well as organic carbon and total nitrogen contents of cored material are reported for the Weddell Sea, Ocean Drilling Program (ODP) Sites 689 and 690 (Maud Rise), Site 693 (continental margin), and Site 694 (abyssal plain). Results from both high resolution sampling (up to six samples per section) and low resolution (one sample per section) are documented. In general, these results indicate large changes in the types and amounts of carbon and nitrogen preserved in the sediments of the Weddell Sea region during the past 25 m.y., with an especially important and dramatic event coinciding with the western Antarctic ice-sheet becoming a semi-permanent or permanent feature about 5 Ma.

The overall results may be correlated with the onset of major ice-sheets on West Antarctica, stabilization of the ice-sheet in the Pliocene and the intensified recycling of organic carbon and total nitrogen, which is possibly the result of increased ice cover. Evidence is also presented for either low production of organic carbon or the presence of a water column, in the eastern Weddell Sea during the early and middle Neogene, which was highly corrosive to organic matter. This condition, together with slow sediment accumulation rates, inhibited the preservation of carbon in the sediments.

INTRODUCTION

Holes were drilled at nine separate sites during Ocean Drilling Program (ODP) Leg 113 in the Weddell Sea, in order to yield information concerning: (1) the initiation of the formation of the Antarctic ice-sheets, and their permanency; (2) the variations in Antarctic Bottom Water as a result of cryospheric development; and (3) the evolution and history of primary productivity in the region and its linkages to climate. This paper reports on the results of stable carbon and nitrogen isotopic measurements and organic content analyses for samples collected at four sites from Leg 113 representing three distinct environments (Fig. 1).

The Maud Rise sites are located on the crest of the Rise in 2083 m of water (Site 689), and on the flank in 2914 m of water (Site 690). Holes were drilled at these sites, which are isolated from continental effects, to yield information on open ocean environments. Site 693, in 2359 m of water, on the East Antarctic continental margin, was drilled to investigate terrigenous influences on the Weddell Sea. Holes were drilled at Site 694, in the Weddell Sea basin at 4653 m to examine both the history of bottom water production, particularly the origin of the present day Weddell Sea Bottom Water and, through study of the distal turbidites, to establish a record of continental glaciation and pre-glacial vegetation.

This present study also sought to observe relationships between sedimentology and organic geochemical measurements, and relate those findings to productivity and changes in source materials, or variations in the biota and water masses influencing the sediment. Because of powerful feedback mechanisms which are related to ice albedo and deep-water formation, these results could aid in the understanding of glacial evolution in Antarctica as well as in the high Arctic (observed during ODP Leg 105; Macko, 1989), and could also be important in the evaluation of climatic change.

The organic contents and the isotopic compositions of sediments have been used to suggest the extent and timing of glacial influences in Quaternary marine sequences. These studies are based on the premise that the organic material found in sediments is reflective of the many biological and chemical transformations of the original source carbon or nitrogen. That organic material may have originated in the marine photic zone, or in nearshore environments as terrigenous debris, or more likely, as a mixture of the two. This study makes use of organic content and the stable isotopic compositions of carbon and nitrogen in the sediments to aid in the delineation of the origins and amounts of organics in the water column of the Weddell Sea.

In numerous marine environments, relative contributions of terrigenous and marine inputs have been documented through the use of stable carbon isotopes. For example, in the Gulf of Mexico, surficial sediments contain increasing amounts of the heavier isotope of carbon (^{13}C) with increasing distance from land, and yield evidence for decreasing influence of terrigenous carbon influences (Sackett and Thompson, 1963; Hedges and Parker, 1976; Gearing et al., 1977). In the deltas of both the Pedernales in Venezuela (Eckelman et al, 1962) and Niger rivers (Gearing et al., 1977) woody fragments and more finely disseminated terrestrial plant debris give a clear terrigenous isotopic signature to deltaic sediments. In more northern Arctic environments, the transport of terrigenous material may be more extensive. In the Beaufort Sea, lateral transport of terrestrial debris is enhanced by ice-rafting (Gearing et al., 1977). These variations in source are recorded in the sediments of an area. In the Gulf of Mexico, variations downcore have been correlated with glacial and interglacial episodes which are related to sea-level lowering and the changing influence of the Mississippi River (Parker et al., 1972; Newman et al., 1973). In systems which are exclusively or heavily dominated by marine productivity, other environmental parameters such as temperature, growth rate, species distribution, and CO_2 availability may affect carbon isotopic composition (Sackett et al., 1965; Degens et al., 1968; Gearing et al., 1977; Fontugne and Duplessy, 1978; 1981; Degens, 1969). In Baffin Bay and the Labrador Sea, large-scale changes in $\delta^{13}C$ were interpreted to be strongly influenced by changes in marine

[2] Department of Earth Sciences, Memorial University, St. John's, Newfoundland, Canada A1B 3X5.
[3] Department of Earth Sciences, Memorial University, St John's, Newfoundland, Canada A1B 3X5.
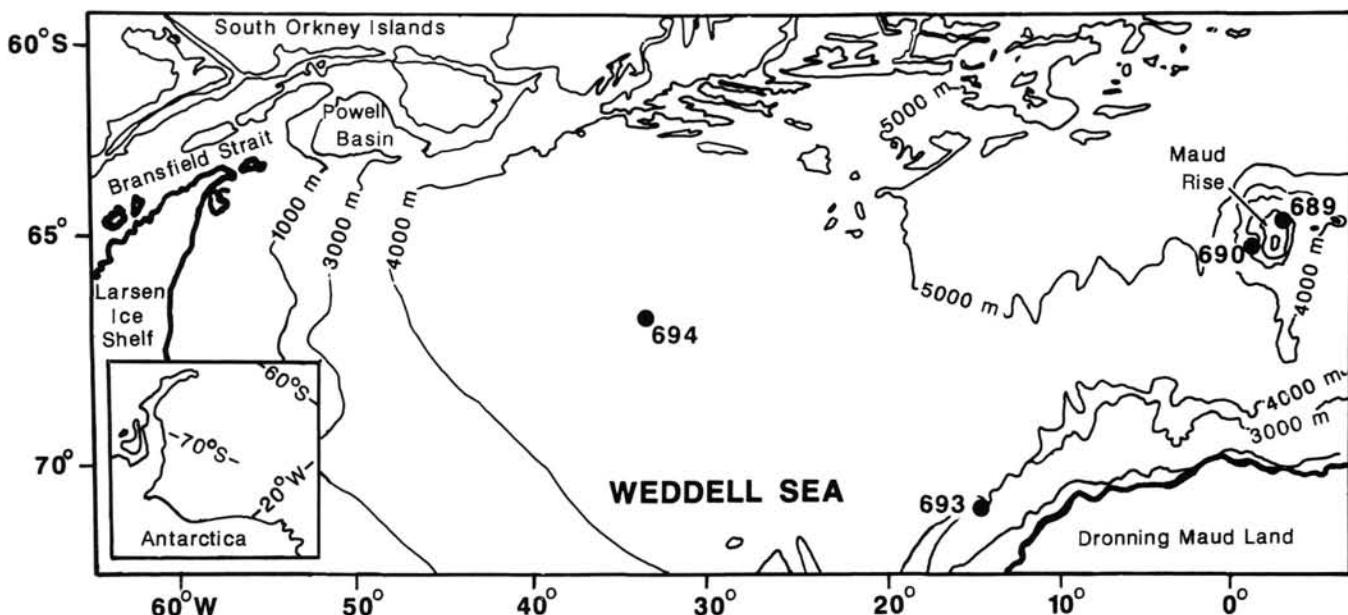
Figure 1. Map showing locations of Leg 113 Sites in this study.

planktonic productivity, and by the effect of ice-rafted debris on the overall accumulation of organic matter in sediments of the region (Macko, 1989).

Cooler temperatures in water masses have been correlated with planktonic organic material which is depleted in ^{13}C. This observation and interpretation is based on the premise that the isotopic fractionation by phytoplankton growing in the open ocean will be affected by temperature. These temperature-induced signatures have been interpreted to be the cause for carbon isotopic variations observed in high latitude deep-sea sediments (Sackett, 1986a; 1986b; Sackett et al., 1974; Rogers et al., 1972). However, carbon isotopic variations may also be associated with changing populations of phytoplankton. For example, in the Antarctic, the transition of a diatom ooze to a dinoflagellate/coccolithophore dominated sediment at the Antarctic Convergence is associated with a decrease in the carbon isotopic signature (Sackett et al., 1974). Isotopic differences exist among phytoplankton of different size classes (hence different species) from the same bloom (Gearing et al., 1984). Such variability would certainly have impact on the organic isotopic record preserved in a sediment (Macko et al., 1987b).

In similar fashion, stable nitrogen isotopes may be useful indicators of the source of organic material entering the marine environment. Peters et al. (1978) correlated nitrogen isotope signatures with relative contributions of terrigenous and marine inputs into a sediment. Such contributions of organics can be quantified by simple mass balance calculations from which source estimates can be made (Macko 1981; 1983).

Because the major source of nitrogen utilized in terrestrial systems (N_2 via nitrogen fixation) is isotopically distinguishable from marine systems (oceanic nitrate through nitrate reduction), these sources may be resolved in many instances. Furthermore, in purely marine environments, the processes through which phytoplankton (or bacteria) incorporate nitrogen may be resolved if one can eliminate sources of nitrogen from land. The process of nitrogen fixation has a small isotopic fractionation associated with the utilization of molecular nitrogen. Such a process is easily distinguished from the more common mode of nitrate reduction in which phytoplankton fully utilize dissolved nitrate and reflect its isotopic signature (Macko et al., 1984). When algae

are only able to use a small portion of the dissolved nitrate, more depleted ^{15}N values may be evident, reflecting the isotopic fractionation associated with that incorporation (Macko et al., 1987a). Such changes may then be useful in the interpretation of the paleoceanographic record of an area. Sediments formed during periods of higher productivity, in which phytoplankton fully utilized the oceanic nitrate, may be more enriched in ^{15}N than sediments associated with lower productivity in which larger fractionations are possible.

However, the situation is complicated by factors which include microbial action, diagenesis, and recycling of organics. Variations in isotopic signature may occur as a result of deamination reactions associated with organic rich materials (Sigleo and Macko, 1985; Zieman et al., 1984; Wada, 1980). Such processes of alteration may be especially important in changing isotopic signatures below the euphotic zone (Altabet and McCarthy, 1986).

METHODS

Sediment samples collected for organic content and isotopic composition were kept frozen until analysis. Samples were initially lyophilized and then acidified with 30% HCl to remove carbonate. The carbonate-free residue was dried in order to preserve all soluble organic matter and porewater ammonium or nitrate. A portion of the dried material was then weighed and combusted in quartz for one hour at 850°C in the presence of purified cupric oxide wire and high purity granular copper, (Macko et al., 1984). The N_2 and CO_2 gases obtained were cryogenically isolated from other combustion products and analyzed on a V.G. Micromass PRISM stable isotope ratio mass spectrometer. On the basis of replicate analyses of samples, the reproducibility in combustion and measurement is within ± 0.2 ‰. Isotope data are presented as ‰:

$$\delta^N E = \left[\frac{R_{sample}}{R_{standard}} - 1 \right] * 10^3$$

where N is the isotope of the element E and R is the abundance ratio of the heavy to light isotope; the standard for ^{15}N is atmospheric nitrogen and the standard for carbon is the Chicago

PDB. For routine measurement, samples are analyzed versus a laboratory sub-standard tank of either pure nitrogen or carbon dioxide gas. Total nitrogen content was calculated from the ion intensity of the gas in a calibrated volume of the mass spectrometer; the organic carbon content was determined on a calibrated manometer in the vacuum purification line. Low resolution analysis would include one sample per 150 cm section while high resolution sampling could be as many as six samples per section. All data are presented in Table 1 in which the samples analyzed have been assigned Memorial University Newfoundland (MUN) numbers.

RESULTS

Site 689

At Site 689, high and low resolution sampling was undertaken with a total of 319 samples being analyzed from Holes 689B, 689C, and 689D. Organic contents are generally low, less than 0.1% carbon and 0.05% total nitrogen, and exhibit a decreasing trend from the Paleocene to the Pleistocene with occasional erratic excursions from the low levels (Figs. 2, 3). The levels of organic carbon and total nitrogen average 0.06% and 0.04%, respectively, and range from detection limits to 0.057% and detection limits to 0.38%. The atomic ratio of carbon to nitrogen, C/N, shows more variation and ranges from 0.1 to 15.0, with generally highest values during the Pliocene. Carbon isotopic values were typically $-27‰$ during the Paleocene and Eocene, diminished to $-30‰$ in the Oligocene and increased to values up to $-19‰$ during the Pliocene and Pleistocene. The nitrogen isotopic ($\delta^{15}N$) compositions show a general trend of decreasing from the Paleocene (approximately 7.8‰) to the Pleistocene. The lowest values ^{15}N (0.8‰) occur in samples from the Pliocene and Pleistocene. High resolution sampling for all types of analyses indicates that large excursions can occur within at least 0.1 m, (representing 25,000 to 10,000 yr at estimated sedimentation rates of 4–9 m/m.y.).

Significant correlations (Pearson R, p = 0.95) were observed between nitrogen content and both carbon content and C/N, and between $\delta^{13}C$ and either %C, %N, C/N, or ^{15}N. The best R^2 value for these correlations was 0.20 between %C and %N. The degrees of freedom used to determine significance levels were not corrected for any autocorrelation observed in these time series; with low R^2 values, the correlations may be significant but are relatively weak.

Site 690

Ninety samples from Holes 690A and 690B were analyzed from this site (Figs. 4, 5). The trends observed on the crest of Maud Rise (Site 689) are generally similar to results from Site 690 on the flank. Organic contents are generally low with respective ranges and average compositions for carbon and total nitrogen being detection limit to 0.48% (average 0.09) and limit of detection to 0.56% (average 0.14%). The carbon content is uniform with only a few excursions from low levels; nitrogen content is similar with the lowest values being recorded in the Pliocene-Pleistocene. The C/N data for these samples are fairly uniform during the Oligocene and Miocene with more excursions from the average (1.8) value in the Pliocene-Pleistocene (total range 0.1–10.6). The $\delta^{13}C$ content of these samples was near $-27‰$ during the Oligocene and Miocene, increased to $-20‰$ in the Pliocene and decreases to $-24‰$ in the Pleistocene. The nitrogen isotopic compositions of these samples were fairly uniform during the Oligocene and Miocene, near 5.5‰, and showed an increasing trend to 7.4‰ during the Pliocene-Pleistocene. Sedimentation rates for this site are of a similar magnitude to those observed on the crest, resulting in a sampling time resolution of similar length (25,000 to 10,000 yr/0.1 m sampling).

Total nitrogen content is significantly correlated with %C, while $\delta^{13}C$ variations correlate significantly with changes in %C and C/N. The only correlations with R^2 values greater than 0.1 are %C with %N (0.50) and %C with C/N (0.37).

Site 693

The continental margin site was sampled 275 times for this study, with collections coming from Holes 693A and 693B. A distinct change is seen in all parameters in the Pliocene (approximate age of 5 m.y. using estimated sedimentation rates of 10 m/m.y. for the Pleistocene, 20 m/m.y. for the Pliocene, and 5 m/m.y. for samples older than Pliocene in age; Figs. 6, 7). One sample, at 465 m, of Cretaceous age, contained the greatest amount of carbon for the entire study. This amount was recorded to be 1.75%; this sample also had six times as much nitrogen as the samples above it but it did not contain unusual ^{15}N or ^{13}C compositions nor C/N. Generally, the carbon contents at this site are about 0.2% below the above mentioned 5 m.y. boundary, and decrease to approximately 0.1% above the boundary. Nitrogen contents are typically 0.05% below the 5 m.y. boundary, and drastically increase to 0.5% above that. The C/N abundances average near six below the boundary and decline to less then one above the 5 m.y. depth. Nitrogen isotopic compositions at this site average approximately 4‰ during the Oligocene, increase to 6‰ in the early Miocene, and decline back to 3 to 4‰ in the late Miocene. From the Pliocene onward, the nitrogen isotopic values increase, with enrichments as high as 11.3‰ seen in the uppermost sediments of the Pleistocene. Carbon isotopic values of these sediments increase steadily from an average near $-25‰$ in the Oligocene to the Miocene level of $-23‰$. During the Pliocene-Pleistocene the compositions remain fairly constant near $-22‰$.

The correlation matrix observed for the data collected on this site is similar to that seen at Sites 689 and 690. Carbon-13 significantly correlates with %C, %N, C/N, and nitrogen isotopic levels. The organic carbon and total nitrogen contents significantly correlate with C/N, and have respective R^2 values of 0.21 and 0.44. As a consequence of the increased sedimentation rates in the Pliocene and Pleistocene, the minimum resolution in sampling decreases to between 10,000 and 5,000 yr in the high resolution samples from those periods.

Site 694

Recovery of sediments from Site 694 on the Weddell Sea abyssal plain was exceedingly poor. As a result, high resolution sampling was limited to a few short intervals in the Miocene section and one in the upper Pliocene (Figs. 8, 9). A total of 243 samples were analyzed from Holes 694A, 694B, and 694C. The levels of organic carbon preserved in the sediments were consistently higher than at all other sites in this study, with levels up to 1% being typical of the Miocene samples. The Pliocene samples average between 0.1% and 0.2%. The total nitrogen found in these samples is low, ranging from detection limit to approximately 0.1% for all samples. Miocene samples had C/N values which are fairly typical of marine sediments, between 10 and 15. The ratios decrease to five or less for the Pliocene age samples. The carbon and nitrogen isotopic compositions are relatively constant, with average values of $-22.9‰$ and 4.0‰, respectively. Excursions to more depleted carbon and more enriched nitrogen compositions are occasionally seen in the Miocene samples. Sedimentation rates for the Pliocene are similar in magnitude to those seen at Site 693 and result in a sampling resolution of 10,000 to 5,000 yr. The Miocene sediments are likely the result of sediment slumping from the adjacent

Table 1. ODP Leg 113: organic geochemistry results.

Table 1 (continued).

Leg	Hole	Mun#	Core	Depth	%C	%N	C/N	$\delta^{13}C$	$\delta^{15}N$
113	689B	1B3001	1H01	0.95	0.06	0.012	5.7	−23.2	1.8
113	689B	1B3003	1H03	3.01	0.06	0.013	5.5	−26.9	2.4
113	689B	1B3004	1H03	3.42	0.06	0.012	5.8	−25.8	4.0
113	689B	1B3005	1H03	4.05	0.04	0.010	4.8	−22.9	2.3
113	689B	1B3006	1H04	4.60	0.04	0.105	0.4	−23.9	1.5
113	689B	1B3008	2H01	5.49	0.02	0.024	1.1	−25.9	2.0
113	689B	1B3009	2H01	6.73	0.09	0.105	1.0	−25.8	1.8
113	689B	1B3010	2H02	6.84	0.12	0.081	1.7	−25.7	1.7
113	689B	1B3011	2H02	7.66	0.10	0.016	6.9	−25.4	1.1
113	689B	1B3012	2H02	8.23	0.19	0.039	5.7	−25.6	1.2
113	689B	1B3013	2H03	8.48	0.06	0.014	4.7	−27.2	3.7
113	689B	1B3014	2H03	8.79	0.13	0.025	6.0	−25.6	2.4
113	689B	1B3015	2H03	8.79	0.05	0.082	0.7	−26.7	3.1
113	689B	1B3016	2H03	9.54	0.02	0.072	0.4	−25.7	2.4
113	689B	1B3018	2H04	9.98	0.03	0.066	0.5	−26.0	2.4
113	689B	1B3019	2H04	10.27	0.02	0.011	1.6	−26.2	2.4
113	689B	1B3020	2H04	10.29	0.07	0.023	3.6	−25.3	5.2
113	689B	1B3021	2H04	10.42	0.10	0.033	3.5	−24.7	2.1
113	689B	1B3022	2H04	10.79	0.04	0.034	1.3	−24.1	1.7
113	689B	1B3023	2H04	11.21	0.07	0.043	2.0	−23.2	1.2
113	689B	1B3024	2H05	11.94	0.04	0.031	1.5	−20.9	2.1
113	689B	1B3025	2H05	12.63	0.05	0.022	2.6	−19.7	1.8
113	689B	1B3027	2H06	13.43	0.05	0.010	6.3	−21.7	2.9
113	689B	1B3029	3H01	15.12	0.05	0.024	2.2	−21.7	3.2
113	689B	1B3030	3H01	15.65	0.06	0.009	7.8	−25.1	2.9
113	689B	1B3031	3H01	16.18	0.03	0.022	1.5	−26.1	5.6
113	689B	1B3032	3H02	16.52	0.03	0.012	2.6	−25.2	3.7
113	689B	1B3033	3H02	16.69	0.05	0.013	4.7	−26.0	4.5
113	689B	1B3034	3H02	17.29	0.05	0.012	4.4	−26.6	2.7
113	689B	1B3035	3H02	17.54	0.06	0.085	0.9	−26.7	1.7
113	689B	1B3036	3H05	20.96	0.06	0.010	7.3	−23.2	2.8
113	689B	1B3037	3H05	21.52	0.04	0.026	1.8	−26.3	4.5
113	689B	1B3038	3H05	22.04	0.02	0.015	1.6	−27.2	4.7
113	689B	1B3039	3H06	22.80	0.06	0.007	10.0	−28.5	3.8
113	689B	1B3040	3H06	23.30	0.04	0.006	8.3	−24.3	3.0
113	689B	1B3041	4H01	24.51	0.00	0.008	0.6	−24.4	3.3
113	689B	1B3042	4H01	25.58	0.04	0.008	6.2	−21.6	3.3
113	689B	1B3043	4H02	25.99	0.04	0.007	6.3	−21.1	2.9
113	689B	1B3044	4H02	27.07	0.04	0.022	2.3	−23.4	3.0
113	689B	1B3045	4H03	27.49	0.04	0.009	4.8	−24.2	3.0
113	689B	1B3047	4H03	28.57	0.04	0.010	4.3	−24.7	2.9
113	689B	1B3048	4H04	29.00	0.06	0.009	6.8	−27.9	2.3
113	689B	1B3050	4H04	30.07	0.02	0.004	5.8	−23.3	2.2
113	689B	1B3051	4H05	30.50	0.05	0.014	3.8	−27.8	1.5
113	689B	1B3052	4H05	31.11	0.07	0.039	2.1	−24.4	4.3
113	689B	1B3053	4H05	31.57	0.16	0.382	0.5	−25.1	3.6
113	689B	1B3054	4H06	32.33	0.08	0.012	7.7	−24.7	4.1
113	689B	1B3055	4H06	33.07	0.12	0.067	2.0	−24.7	3.3
113	689B	1B3056	5H01	34.00	0.12	0.013	10.4	−24.9	3.5
113	689B	1B3057	5H01	34.59	0.18	0.014	15.0	−25.5	3.4
113	689B	1B3058	5H01	34.96	0.10	0.013	9.5	−26.5	3.0
113	689B	1B3059	5H03	37.00	0.11	0.017	7.6	−24.2	2.3
113	689B	1B3060	5H03	37.59	0.13	0.040	3.9	−24.0	2.9
113	689B	1B3061	5H03	37.96	0.05	0.021	2.6	−24.8	4.2
113	689B	1B3062	5H05	40.00	0.08	0.025	3.2	−24.6	3.9
113	689B	1B3063	5H05	40.59	0.09	0.026	4.0	−24.8	4.9
113	689B	1B3064	5H05	40.96	0.10	0.020	6.0	−24.9	4.0
113	689B	1B3065	6H01	44.16	0.01	0.002	5.8	−27.0	3.7
113	689B	1B3066	6H01	44.51	0.07	0.023	3.4	−27.3	3.8
113	689B	1B3067	6H03	46.52	0.11	0.010	13.9	−27.4	3.9
113	689B	1B3068	6H03	47.16	0.06	0.040	1.7	−27.1	3.4
113	689B	1B3069	6H03	47.51	0.03	0.007	4.3	−25.8	3.1
113	689B	1B3070	6H05	49.52	0.14	0.081	2.0	−27.8	2.8
113	689B	1B3071	6H05	50.16	0.06	0.020	3.9	−27.7	3.1
113	689B	1B3072	6H05	50.52	0.05	0.021	2.6	−28.1	3.1
113	689B	1B3073	7H01	53.10	0.06	0.017	4.2	−23.4	3.4
113	689B	1B3074	7H01	53.72	0.13	0.035	4.2	−24.7	3.5
113	689B	1B3075	7H01	54.08	0.12	0.024	5.8	−25.6	2.8
113	689B	1B3076	7H03	56.10	0.04	0.029	1.5	−27.7	4.4
113	689B	1B3077	7H03	56.72	0.04	0.013	3.6	−26.0	4.2
113	689B	1B3078	7H03	57.08	0.03	0.026	1.4	−25.9	3.9
113	689B	1B3079	7H05	59.10	0.01	0.029	0.1	−27.0	3.2
113	689B	1B3080	7H05	59.72	0.06	0.060	1.3	−29.1	2.8
113	689B	1B3081	7H05	60.08	0.06	0.016	4.1	−28.9	3.5
113	689B	1B3082	8H01	62.70	0.04	0.029	1.6	−28.2	3.2
113	689B	1B3083	8H01	63.28	0.01	0.021	0.6	−26.8	3.1
113	689B	1B3084	8H01	63.66	0.05	0.031	1.8	−25.9	2.9
113	689B	1B3085	8H03	65.71	0.06	0.029	2.5	−28.1	3.2
113	689B	1B3086	8H03	66.29	0.04	0.030	1.6	−27.1	2.8
113	689B	1B3087	8H03	66.66	0.06	0.046	1.5	−27.3	4.1
113	689B	1B3088	8H05	68.71	0.05	0.022	2.5	−28.4	4.5
113	689B	1B3089	8H05	69.29	0.00	0.021	0.3	−28.1	4.4
113	689B	1B3091	9H01	72.92	0.13	0.059	2.5	−28.5	4.6
113	689B	1B3092	9H01	73.25	0.12	0.020	7.1	−28.4	5.2
113	689B	1B3093	9H03	75.92	0.15	0.026	6.7	−28.1	4.9
113	689B	1B3094	9H03	76.25	0.07	0.035	2.3	−27.9	4.2
113	689B	1B3095	9H05	78.92	0.08	0.083	1.2	−28.9	2.8
113	6898	1B3096	9H05	79.25	0.08	0.075	1.3	−28.9	2.5
113	689B	1B3097	10H01	82.50	0.03	0.031	1.2	−28.7	2.9
113	689B	1B3098	10H01	82.86	0.11	0.018	7.6	−29.6	2.8
113	689B	1B3099	10H05	88.51	0.18	0.085	2.5	−28.5	2.6
113	689B	1B3100	10H05	88.86	0.01	0.019	0.8	−26.3	3.0
113	689B	1B3101	11H01	92.17	0.07	0.065	1.2	−28.5	3.9
113	689B	1B3102	11H01	92.50	0.03	0.012	3.3	−29.2	5.2
113	689B	1B3103	11H05	98.17	0.07	0.074	1.1	−29.1	3.4
113	689B	1B3104	11H05	98.50	0.06	0.025	2.8	−28.4	4.5
113	689B	1B3105	12H01	101.00	0.03	0.006	5.1	−29.1	4.4
113	689B	1B3106	12H01	102.21	0.07	0.027	2.8	−29.3	4.4
113	689B	1B3107	12H05	107.88	0.08	0.023	4.2	−28.6	4.5
113	689B	1B3109	13H01	111.48	0.07	0.060	1.5	−28.6	4.2
113	689B	1B3110	13H01	111.81	0.57	0.219	3.0	−27.9	2.7
113	689B	1B3111	13H05	117.53	0.11	0.092	1.4	−28.0	3.9
113	689B	1B3112	13H05	117.81	0.08	0.074	1.3	−28.9	4.7
113	689B	1B3113	14H01	121.03	0.11	0.022	6.0	−28.1	5.6
113	689B	1B3114	14H01	121.40	0.12	0.203	0.7	−27.3	4.9
113	689B	1B3115	14H05	127.03	0.13	0.023	6.7	−27.6	4.3
113	689B	1B3116	14H05	127.40	0.13	0.055	2.8	−28.1	5.1
113	689B	1B3117	15H01	130.67	0.10	0.039	2.2	−26.0	5.2
113	689B	1B3118	15H01	131.09	0.11	0.021	6.2	−25.9	5.4
113	689B	1B3119	15H03	133.67	0.09	0.062	1.7	−27.3	5.2
113	689B	1B3120	15H03	134.09	0.06	0.044	1.6	−27.6	5.5
113	689B	1B3121	15H05	136.67	0.15	0.020	8.9	−27.7	6.0
113	689B	1B3122	15H05	137.09	0.11	0.029	4.2	−29.4	5.2
113	689B	1B3123	16H01	140.17	0.12	0.172	0.8	−27.1	5.7
113	689B	1B3124	16H01	140.59	0.14	0.021	7.5	−25.2	4.3
113	689B	1B3125	16H01	143.17	0.14	0.024	6.7	−25.1	4.9
113	689B	1B3126	16H03	143.59	0.13	0.119	1.3	−25.0	3.3
113	689B	1B3128	16H05	146.59	0.15	0.160	1.1	−25.1	3.4
113	689B	1B3129	17H01	149.86	0.11	0.061	2.1	−25.0	4.8
113	689B	1B3130	17H03	152.86	0.08	0.090	1.0	−25.7	2.9
113	689B	1B3131	17H03	153.29	0.15	0.098	1.8	−26.7	3.1
113	689B	1B3132	17H05	155.86	0.01	0.048	0.3	−26.0	2.9
113	689B	1B3133	17H05	156.29	0.07	0.111	0.8	−27.9	5.5
113	689B	1B3134	18H01	159.56	0.15	0.029	6.2	−26.8	5.9
113	689B	1B3135	18H01	159.99	0.04	0.069	0.7	−27.0	5.8
113	689B	1B3136	18H03	162.56	0.23	0.291	0.9	−25.6	4.1
113	689B	1B3137	18H03	162.99	0.02	0.018	1.3	−26.4	3.8
113	689B	1B3138	18H05	165.56	0.27	0.073	4.3	−25.5	3.7
113	689B	1B3139	18H05	165.99	0.12	0.103	1.4	−26.0	4.0
113	689B	1B3141	19H01	169.70	0.03	0.036	0.9	−26.2	3.2
113	689B	1B3142	19H03	172.27	0.03	0.030	1.4	−25.9	4.8
113	689B	1B3143	19H03	172.70	0.09	0.046	2.2	−26.1	5.7
113	689B	1B3144	19H05	175.27	0.03	0.035	0.9	−25.7	3.6
113	689B	1B3145	19H05	175.70	0.06	0.082	0.8	−25.8	3.2
113	689B	1B3146	20H01	178.84	0.02	0.034	0.6	−25.1	3.7
113	689B	1B3148	20H03	181.84	0.22	0.098	2.6	−26.1	4.3
113	689B	1B3149	20H03	182.30	0.06	0.020	3.7	−25.7	5.4
113	689B	1B3150	21H01	188.54	0.02	0.005	5.1	−26.1	4.6
113	689B	1B3151	21H01	189.00	0.08	0.057	1.6	−26.4	4.4
113	689B	1B3152	21H03	191.54	0.04	0.010	5.4	−25.7	5.7
113	689B	1B3153	21H03	192.00	0.05	0.016	3.7	−25.4	6.2
113	689B	1B3154	22X01	198.24	0.10	0.070	1.5	−26.6	6.1
113	689B	1B3156	22X01	201.22	0.09	0.070	1.4	−25.1	7.5
113	689B	1B3157	22X05	204.22	0.13	0.024	6.1	−27.3	7.6
113	689B	1B3158	22X05	204.70	0.13	0.035	4.3	−26.4	6.4
113	689B	1B3159	23X01	207.98	0.18	0.042	4.7	−26.7	7.1
113	689B	1B3160	23X03	210.98	0.19	0.055	4.2	−26.4	6.4
113	689B	1B3161	23X03	211.39	0.09	0.073	1.4	−26.1	5.3
113	689B	1B3162	24X01	217.65	0.05	0.014	4.4	−26.6	6.0
113	689B	1B3163	26X01	237.21	0.03	0.018	1.7	−26.8	7.8
113	689C	1C3164	1H01	0.25	0.01	0.005	2.3	−27.3	6.7
113	689C	1C3165	1H01	0.50	0.05	0.140	4.5	−24.1	3.9
113	689C	1C3166	1H01	0.75	0.00	0.002	1.5	−22.6	3.1
113	689C	1C3167	1H01	1.00	0.07	0.008	9.3	−20.1	3.8
113	689C	1C3168	1H01	1.25	0.05	0.012	4.7	−20.4	1.7
113	689C	1C3171	1H02	2.00	0.02	0.002	7.8	−24.1	2.4
113	689C	1C3172	1H02	2.25	0.04	0.008	5.9	−22.0	2.9
113	689C	1C3173	1H02	2.50	0.04	0.035	1.5	−26.0	3.5
113	689C	1C3174	1H02	2.75	0.04	0.005	9.5	−22.7	2.0
113	689C	1C3176	1H03	3.25	0.03	0.003	10.5	−21.5	2.1
113	689C	1C3177	1H03	3.50	0.03	0.003	12.2	−20.4	2.3
113	689C	1C3178	1H03	3.75	0.04	0.010	4.9	−22.4	2.2
113	689C	1C3179	1H03	4.00	0.04	0.009	5.2	−21.7	0.8
113	689C	1C3180	1H03	4.25	0.05	0.011	5.0	−22.0	1.5
113	689C	1C3182	1H04	4.75	0.05	0.014	4.1	−21.9	2.9
113	689C	1C3183	1H04	5.00	0.05	0.010	5.8	−22.6	3.8
113	689C	1C3184	1H04	5.25	0.04	0.014	3.6	−23.0	3.1

Table 1 (continued).

Table 1 (continued).

Leg	Hole	Mun#	Core	Depth	%C	%N	C/N	$\delta^{13}C$	$\delta^{15}N$
113	689C	1C3185	1H04	5.50	0.04	0.014	3.4	-22.6	3.0
113	689C	1C3186	1H04	5.75	0.03	0.009	4.3	-22.0	2.2
113	689C	1C3188	1H05	6.25	0.04	0.010	5.0	-22.1	2.2
113	689C	1C3189	1H05	6.50	0.03	0.008	4.4	-23.2	2.3
113	689C	1C3190	1H05	6.75	0.04	0.011	4.2	-24.0	2.7
113	689C	1C3191	1H05	7.00	0.04	0.027	1.7	-24.2	3.1
113	689C	1C3192	1H05	7.25	0.04	0.024	2.0	-23.9	1.2
113	689C	1C3194	1H06	7.75	0.06	0.013	5.1	-24.2	3.0
113	689C	1C3195	1H06	8.25	0.05	0.011	5.8	-23.9	2.6
113	689C	1C3196	1H06	8.50	0.07	0.022	3.7	-25.3	1.9
113	689C	1C3197	1H06	8.75	0.05	0.011	4.8	-23.7	1.9
113	689C	1C3199	1H07	9.25	0.04	0.009	5.8	-23.1	0.8
113	689C	1C3200	1H07	9.50	0.05	0.013	4.7	-26.1	2.1
113	689C	1C3201	1H07	9.75	0.05	0.012	4.8	-23.3	2.0
113	689C	1C3202	2H01	9.87	0.05	0.020	2.6	-23.2	2.2
113	689C	1C3203	3H01	18.25	0.02	0.022	1.1	-23.2	2.6
113	689C	1C3204	3H01	18.54	0.06	0.011	6.5	-22.8	2.1
113	689C	1C3205	3H01	18.82	0.00	0.023	0.1	-21.6	2.7
113	689C	1C3206	3H01	19.02	0.07	0.043	2.0	-22.5	2.5
113	689C	1C3207	3H01	19.31	0.04	0.014	3.3	-22.4	3.0
113	689C	1C3208	3H02	19.75	0.03	0.011	3.8	-20.1	1.6
113	689C	1C3209	3H02	20.04	0.04	0.011	3.8	-20.7	1.8
113	689C	1C3210	3H02	20.32	0.04	0.007	6.5	-19.4	1.7
113	689C	1C3212	3H02	20.81	0.04	0.013	3.4	-21.1	1.9
113	689C	1C3213	3H03	21.25	0.04	0.012	3.5	-20.4	1.8
113	689C	1C3214	3H03	21.54	0.03	0.023	1.7	-21.1	2.4
113	689C	1C3215	3H03	21.82	0.07	0.021	3.7	-23.1	3.8
113	689C	1C3216	3H03	22.02	0.05	0.017	3.3	-25.2	4.4
113	689C	1C3217	3H03	22.31	0.03	0.009	4.2	-25.0	4.6
113	689C	1C3218	3H04	22.75	0.04	0.025	1.9	-25.4	4.1
113	689C	1C3219	3H04	23.04	0.00	0.011	0.3	-25.7	3.1
113	689C	1C3221	3H04	23.52	0.00	0.010	0.1	-24.4	3.1
113	689C	1C3222	3H04	23.81	0.00	0.018	0.1	-24.1	5.1
113	689C	1C3223	3H05	24.25	0.00	0.013	0.2	-26.2	3.3
113	689C	1C3224	3H05	24.54	0.03	0.023	1.8	-24.3	2.7
113	689C	1C3225	3H05	24.82	0.04	0.014	3.7	-24.8	3.1
113	689C	1C3226	3H05	25.02	0.01	0.011	0.6	-25.7	3.7
113	689C	1C3227	3H05	25.31	0.04	0.022	1.9	-24.9	3.6
113	689C	1C3228	3H06	25.75	0.03	0.018	1.9	-24.9	4.2
113	689C	1C3229	3H06	26.04	0.04	0.010	4.9	-24.7	4.0
113	689C	1C3230	3H06	26.32	0.04	0.011	4.1	-23.4	2.9
113	689C	1C3231	3H06	26.52	0.04	0.012	3.9	-24.5	2.2
113	689C	1C3232	3H06	26.81	0.04	0.011	4.7	-25.1	2.3
113	689C	1C3233	3H07	27.25	0.03	0.011	3.0	-23.7	2.9
113	689C	1C3234	3H07	27.54	0.03	0.019	2.1	-23.2	2.8
113	689C	1C3235	3H07	27.78	0.02	0.014	1.8	-23.4	2.4
113	689D	1D3236	1H01	18.61	0.01	0.004	0.8	-23.6	3.9
113	689D	1D3237	1H01	18.86	0.01	0.002	1.1	-23.7	3.8
113	689D	1D3238	1H01	19.11	0.04	0.004	11.7	-23.7	3.7
113	689D	1D3239	1H01	19.31	0.01	0.003	5.2	-23.6	4.6
113	689D	1D3240	1H02	20.11	0.04	0.004	9.7	-22.4	3.4
113	689D	1D3241	1H02	20.36	0.01	0.001	10.0	-23.1	3.5
113	689D	1D3242	1H02	20.61	0.06	0.010	6.5	-24.1	4.0
113	689D	1D3243	1H02	20.81	0.07	0.047	1.7	-23.9	3.6
113	689D	1D3244	1H03	21.35	0.06	0.007	5.7	-23.9	2.8
113	689D	1D3246	1H03	21.86	0.06	0.006	9.7	-24.5	3.4
113	689D	1D3247	1H03	22.11	0.05	0.005	10.2	-24.7	4.2
113	689D	1D3248	1H03	22.31	0.02	0.002	11.1	-25.1	4.4
113	689D	1D3249	1H04	22.85	0.00	0.001	2.2	-24.7	3.1
113	689D	1D3250	1H04	23.11	0.06	0.029	2.2	-23.6	3.3
113	689D	1D3251	1H04	23.36	0.11	0.029	4.5	-23.4	1.7
113	689D	1D3252	1H04	23.61	0.00	0.016	0.1	-23.3	4.9
113	689D	1D3253	1H04	23.81	0.06	0.009	7.8	-22.5	4.9
113	689D	1D3254	1H05	24.35	0.05	0.009	6.2	-22.1	3.6
113	689D	1D3255	1H05	24.61	0.11	0.041	3.2	-23.9	2.8
113	689D	1D3256	1H05	24.86	0.05	0.011	5.3	-23.7	4.5
113	689D	1D3257	1H05	25.11	0.03	0.003	10.2	-23.4	3.7
113	689D	1D3258	1H05	25.31	0.00	0.005	0.7	-22.1	3.4
113	689D	1D3259	1H06	25.85	0.06	0.024	3.0	-22.4	2.7
113	689D	1D3260	1H06	26.36	0.05	0.037	1.5	-24.5	1.2
113	689D	1D3262	1H06	26.81	0.09	0.031	3.6	-23.8	4.5
113	689D	1D3263	1H07	27.35	0.10	0.015	7.4	-23.4	2.7
113	689D	1D3264	2H01	27.85	0.05	0.007	7.2	-23.6	3.0
113	689D	1D3265	2H01	28.10	0.05	0.006	9.8	-24.7	2.0
113	689D	1D3267	2H01	28.57	0.05	0.009	5.6	-28.3	4.1
113	689D	1D3269	2H02	29.35	0.04	0.010	4.4	-28.4	4.2
113	689D	1D3270	2H02	29.60	0.05	0.014	3.9	-28.0	4.6
113	689D	1D3271	2H02	29.83	0.06	0.056	1.1	-27.7	4.4
113	689D	1D3272	2H02	30.07	0.03	0.010	3.8	-28.7	3.9
113	689D	1D3273	2H02	30.32	0.06	0.039	1.7	-28.2	4.7
113	689D	1D3274	2H03	30.85	0.03	0.041	0.9	-27.6	4.4
113	689D	1D3275	2H03	31.10	0.08	0.253	0.4	-27.4	4.6
113	689D	1D3276	2H03	31.33	0.01	0.009	0.7	-25.7	2.3
113	689D	1D3277	2H03	31.57	0.02	0.011	2.0	-26.5	4.9
113	689D	1D3278	2H03	31.82	0.00	0.009	0.6	-25.7	2.6
113	689D	1D3279	2H04	32.35	0.00	0.006	0.4	-25.1	4.4
113	689D	1D3280	2H04	32.60	0.06	0.012	5.2	-25.6	4.2
113	689D	1D3281	2H04	32.83	0.01	0.006	1.1	-25.7	3.6
113	689D	1D3282	2H04	33.07	0.20	0.049	4.7	-25.8	2.9
113	689D	1D3283	2H04	33.32	0.01	0.003	5.0	-25.1	3.7
113	689D	1D3284	2H05	33.85	0.01	0.085	0.1	-25.0	3.1
113	689D	1D3285	2H05	34.10	0.00	0.002	2.2	-24.7	3.6
113	689D	1D3286	2H05	34.33	0.13	0.084	1.8	-24.7	4.6
113	689D	1D3287	2H05	34.57	0.02	0.006	4.3	-25.1	4.2
113	689D	1D3288	2H05	34.82	0.01	0.021	0.6	-24.8	4.5
113	689D	1D3289	2H06	35.35	0.01	0.075	0.1	-25.1	2.8
113	689D	1D3290	2H06	35.60	0.12	0.050	2.8	-25.2	3.6
113	689D	1D3291	2H06	35.83	0.01	0.004	4.1	-25.4	3.2
113	689D	1D3292	2H06	36.07	0.10	0.090	1.2	-25.9	2.9
113	689D	1D3293	2H06	36.32	0.01	0.066	0.0	-26.0	3.6
113	689D	1D3294	2H07	36.85	0.01	0.074	0.1	-26.1	3.9
113	689D	1D3295	2H07	37.10	0.01	0.006	0.3	-24.2	4.3
113	689D	1D3296	2H07	37.33	0.09	0.074	1.4	-23.0	4.1
113	689D	1D3297	3H01	37.50	0.00	0.009	0.2	-24.1	4.6
113	689D	1D3298	3H01	37.75	0.00	0.006	1.0	-25.2	2.3
113	689D	1D3299	3H01	38.06	0.11	0.056	2.3	-26.1	2.4
113	689D	1D3300	3H01	38.31	0.01	0.030	0.2	-25.7	1.7
113	689D	1D3302	3H02	39.00	0.01	0.059	0.2	-25.9	4.0
113	689D	1D3303	3H02	39.25	0.20	0.092	2.5	-27.0	2.6
113	689D	1D3304	3H02	39.56	0.01	0.038	0.1	-26.0	3.8
113	689D	1D3305	3H02	39.81	0.00	0.004	0.5	-25.7	3.0
113	689D	1D3306	3H02	40.05	0.01	0.008	1.2	-24.1	2.9
113	689D	1D3307	3H03	40.50	0.01	0.004	0.5	-23.1	3.7
113	689D	1D3308	3H03	40.75	0.01	0.007	0.6	-24.7	3.4
113	689D	1D3309	3H03	41.06	0.01	0.008	0.2	-25.2	2.8
113	689D	1D3310	3H03	41.31	0.11	0.035	3.7	-25.8	4.2
113	689D	1D3311	3H03	41.55	0.01	0.005	0.6	-25.4	3.5
113	689D	1D3312	3H04	42.00	0.10	0.051	2.3	-25.0	4.1
113	689D	1D3313	3H04	42.25	0.06	0.038	1.7	-28.7	6.0
113	689D	1D3314	3H04	42.56	0.09	0.060	1.8	-27.4	4.5
113	689D	1D3315	3H04	42.81	0.01	0.029	0.2	-28.1	3.7
113	689D	1D3316	3H04	43.05	0.07	0.024	3.2	-29.1	4.7
113	689D	1D3317	3H05	43.50	0.07	0.050	4.6	-30.2	4.6
113	689D	1D3318	3H05	43.79	0.15	0.083	2.1	-29.8	4.4
113	689D	1D3319	3H05	44.06	0.08	0.096	1.0	-29.7	4.2
113	689D	1D3321	3H05	44.55	0.01	0.083	0.1	-27.4	3.9
113	689D	1D3322	3H06	45.00	0.05	0.043	1.4	-30.7	3.8
113	689D	1D3323	3H06	45.29	0.08	0.223	0.4	-29.2	4.0
113	689D	1D3325	3H06	46.05	0.06	0.251	0.3	-28.6	4.4
113	689D	1D3326	4H01	48.24	0.12	0.262	0.5	-30.8	3.3
113	689D	1D3328	4H02	48.78	0.08	0.052	1.7	-28.9	3.1
113	689D	1D3329	4H02	49.07	0.06	0.120	0.6	-25.9	3.6
113	689D	1D3330	4H02	49.27	0.08	0.132	0.7	-26.2	3.2
113	689D	1D3331	4H02	49.52	0.07	0.110	0.6	-23.6	3.4
113	689D	1D3333	4H02	49.98	0.05	0.084	0.6	-29.9	3.4
113	689D	1D3334	4H03	50.28	0.10	0.242	0.5	-29.8	3.3
113	689D	1D3335	4H03	50.57	0.06	0.221	0.3	-23.1	3.5
113	689D	1D3336	4H03	50.77	0.05	0.238	0.2	-22.6	3.8
113	689D	1D3338	4H03	51.24	0.03	0.197	0.2	-21.8	2.5
113	689D	1D3339	4H03	51.48	0.18	0.121	1.7	-22.7	2.1
113	689D	1D3342	4H04	52.23	0.20	0.109	2.1	-24.3	3.9
113	689D	1D3343	4H04	52.52	0.06	0.023	2.0	-25.9	3.2
113	689D	1D3344	4H04	52.71	0.12	0.054	2.6	-29.3	4.5
113	689D	1D3345	4H04	52.98	0.08	0.070	1.3	-28.6	4.4
113	689D	1D3346	4H05	53.28	0.09	0.130	0.8	-27.0	3.2
113	689D	1D3347	4H05	53.57	0.09	0.060	1.8	-24.1	3.4
113	689D	1D3350	4H05	54.21	0.04	0.016	2.6	-24.7	2.8
113	689D	1D3351	4H05	54.48	0.09	0.054	2.0	-25.9	2.9
113	689D	1D3352	4H05	54.78	0.03	0.046	0.9	-25.4	1.7
113	689D	1D3355	4H06	55.52	0.02	0.037	0.6	-26.7	3.6
113	689D	1D3357	4H06	55.98	0.09	0.055	1.9	-28.7	4.1
113	689D	1D3358	4H07	56.28	0.08	0.039	2.4	-28.1	3.9
113	690A	2A3360	1H01	0.15	0.17	0.112	1.8	-24.4	6.9
113	690A	2A3361	1H01	0.43	0.08	0.052	1.8	-24.8	7.3
113	690A	2A3362	1H01	0.68	0.20	0.079	2.9	-24.7	7.0
113	690A	2A3363	1H01	1.02	0.16	0.094	2.0	-24.8	6.5
113	690A	2A3364	1H01	1.37	0.03	0.010	3.4	-25.4	7.1
113	690A	2A3365	1H02	1.65	0.08	0.054	1.7	-24.5	6.3
113	690A	2A3366	1H02	1.93	0.10	0.041	3.0	-24.4	6.4
113	690A	2A3367	1H02	2.18	0.01	0.001	6.7	-24.1	6.4
113	690A	2A3368	1H02	2.52	0.11	0.066	2.1	-24.6	6.2
113	690A	2A3369	1H02	2.87	0.19	0.070	3.1	-24.2	6.8
113	690A	2A3370	1H03	3.15	0.26	0.249	1.2	-24.0	6.1
113	690A	2A3372	1H03	3.68	0.04	0.043	1.1	-23.7	6.0
113	690A	2A3373	1H03	4.02	0.01	0.032	0.3	-24.0	5.8
113	690A	2A3374	1H03	4.37	0.48	0.288	0.2	-25.1	6.8

Table 1 (continued).

Leg	Hole	Mun#	Core	Depth	%C	%N	C/N	$\delta^{13}C$	$\delta^{15}N$
113	690A	2A3376	1H04	4.93	0.04	0.021	2.4	−25.4	4.5
113	690A	2A3377	1H04	5.18	0.06	0.034	2.2	−26.2	5.8
113	690A	2A3378	1H04	5.52	0.05	0.044	1.2	−24.5	7.4
113	690A	2A3379	1H04	5.87	0.04	0.030	1.6	−23.2	5.4
113	690A	2A3380	1H05	6.15	0.05	0.050	1.2	−22.9	5.0
113	690A	2A3381	1H05	6.43	0.06	0.022	3.4	−21.7	3.8
113	690A	2A3382	1H05	6.68	0.17	0.026	7.5	−23.1	5.0
113	690A	2A3383	1H05	7.02	0.12	0.011	9.7	−20.6	4.5
113	690A	2A3384	1H05	7.37	0.19	0.320	0.7	−21.5	4.4
113	690A	2A3385	1H05	7.65	0.04	0.036	1.4	−22.8	4.7
113	690A	2A3386	1H06	7.93	0.06	0.495	0.1	−22.3	5.0
113	690A	2A3388	1H06	8.52	0.05	0.010	4.7	−22.4	4.8
113	690A	2A3390	1H07	9.43	0.06	0.561	0.1	−22.3	3.8
113	690A	2A3391	1H07	9.68	0.06	0.029	2.5	−22.4	3.6
113	690B	2B3395	2H01	2.53	0.06	0.038	2.0	−24.0	6.5
113	690B	2B3397	2H02	4.03	0.06	0.028	2.4	−25.7	5.0
113	690B	2B3399	2H03	5.53	0.02	0.010	2.8	−21.5	4.1
113	690B	2B3400	2H04	6.12	0.04	0.185	0.2	−21.9	3.4
113	690B	2B3402	2H04	7.62	0.09	0.061	1.6	−23.8	4.7
113	690B	2B3403	2H05	8.53	0.06	0.213	0.3	−23.6	4.1
113	690B	2B3404	2H05	9.12	0.05	0.075	0.8	−23.8	3.9
113	690B	2B3405	2H06	10.03	0.06	0.040	2.1	−24.3	3.5
113	690B	2B3406	2H06	10.62	0.05	0.033	2.0	−24.6	5.8
113	690B	2B3407	2H07	11.53	0.04	0.004	10.6	−24.7	6.3
113	690B	2B3408	3H01	12.13	0.05	0.202	0.3	−24.7	5.6
113	690B	2B3409	3H01	12.72	0.46	0.159	0.3	−24.0	2.0
113	690B	2B3410	3H02	13.63	0.23	0.112	2.4	−26.0	3.9
113	690B	2B3411	3H02	14.22	0.03	0.049	0.7	−25.1	3.7
113	690B	2B3412	3H03	15.13	0.05	0.291	0.2	−23.8	4.5
113	690B	2B3413	3H03	15.72	0.13	0.025	6.1	−24.1	5.4
113	690B	2B3414	3H04	16.63	0.48	0.239	2.3	−24.2	5.3
113	690B	2B3415	3H04	17.22	0.06	0.257	0.3	−23.9	5.1
113	690B	2B3416	3H05	18.13	0.06	0.291	0.3	−27.0	5.0
113	690B	2B3417	3H05	18.72	0.05	0.289	0.2	−28.5	6.8
113	690B	2B3418	3H06	19.63	0.05	0.310	0.2	−29.0	4.9
113	690B	2B3419	3H06	20.22	0.04	0.193	0.3	−29.3	4.8
113	690B	2B3420	3H07	21.13	0.09	0.313	0.3	−29.4	3.4
113	690B	2B3421	4H01	21.83	0.05	0.146	0.4	−23.6	8.7
113	690B	2B3422	4H01	22.42	0.04	0.027	1.8	−26.0	5.0
113	690B	2B3423	4H02	23.33	0.04	0.269	0.2	−28.2	4.5
113	690B	2B3424	4H02	23.92	0.09	0.025	4.1	−26.9	5.7
113	690B	2B3425	4H03	24.83	0.04	0.008	5.8	−26.4	5.4
113	690B	2B3426	4H03	25.42	0.09	0.257	0.4	−26.6	5.1
113	690B	2B3427	4H04	26.33	0.06	0.180	0.4	−27.8	5.3
113	690B	2B3429	4H05	27.83	0.10	0.303	0.4	−27.2	3.0
113	690B	2B3430	4H05	28.42	0.08	0.249	0.4	−25.5	7.0
113	690B	2B3431	4H06	29.33	0.08	0.052	1.8	−27.8	3.7
113	690B	2B3432	4H06	29.92	0.14	0.113	1.5	−27.3	3.6
113	690B	2B3433	5H01	31.53	0.05	0.040	1.4	−26.8	3.9
113	690B	2B3434	5H01	32.12	0.02	0.244	0.1	−27.3	3.4
113	690B	2B3435	5H02	33.03	0.06	0.271	0.2	−28.1	5.0
113	690B	2B3437	5H03	34.53	0.06	0.183	0.4	−27.9	4.3
113	690B	2B3438	5H03	35.12	0.07	0.309	0.2	−28.7	5.4
113	690B	2B3439	5H04	36.03	0.06	0.184	0.4	−29.4	3.5
113	690B	2B3440	5H04	36.62	0.10	0.306	0.4	−26.4	1.7
113	690B	2B3441	5H05	37.53	0.07	0.309	0.3	−27.3	3.2
113	690B	2B3442	5H05	38.12	0.03	0.028	1.4	−29.8	4.6
113	690B	2B3443	5H06	39.03	0.05	0.267	0.2	−29.6	6.0
113	690B	2B3444	5H06	39.62	0.03	0.263	0.1	−24.4	2.7
113	690B	2B3445	6H01	41.81	0.08	0.418	0.2	−29.8	3.3
113	690B	2B3446	6H02	43.31	0.07	0.039	2.1	−27.4	5.8
113	690B	2B3447	6H03	44.81	0.12	0.344	0.4	−28.5	5.1
113	690B	2B3448	6H04	46.31	0.03	0.029	1.2	−29.1	5.2
113	690B	2B3450	6H06	49.31	0.06	0.281	0.3	−28.2	5.1
113	690B	2B3451	7H01	50.83	0.07	0.028	3.0	−27.7	5.7
113	690B	2B3452	7H02	52.33	0.08	0.026	3.7	−27.8	5.2
113	690B	2B3453	7H03	53.83	0.09	0.222	0.4	−26.6	5.2
113	690B	2B3454	7H04	55.33	0.09	0.222	0.4	−28.4	5.2
113	690B	2B3455	7H06	58.33	0.17	0.042	4.7	−28.4	5.3
113	690B	2B3456	7H07	59.83	0.06	0.009	6.9	−28.6	5.4
113	690B	2B3457	8H01	61.12	0.07	0.021	3.9	−28.7	5.3
113	690B	2B3458	8H02	62.62	0.08	0.184	0.5	−28.5	5.6
113	690B	2B3459	8H03	64.12	0.06	0.030	2.5	−28.4	5.6
113	690B	2B3460	8H04	65.62	0.05	0.035	1.6	−28.5	5.3
113	690B	2B3461	8H05	67.12	0.08	0.226	0.4	−28.6	5.3
113	690B	2B3462	8H06	68.62	0.07	0.034	2.4	−28.8	5.4
113	693A	3A3464	1R01	0.60	0.06	0.029	2.2	−23.5	5.7
113	693A	3A3465	1R01	0.90	0.22	0.433	0.6	−22.2	7.4
113	693A	3A3466	1R01	1.32	0.21	0.417	0.6	−22.1	3.4
113	693A	3A3467	1R02	1.82	0.19	0.322	0.7	−22.3	6.1
113	693A	3A3468	1R02	2.10	0.11	0.149	0.9	−22.9	8.7
113	693A	3A3469	1R02	2.40	0.12	0.321	0.4	−22.7	9.1
113	693A	3A3470	2R01	2.80	0.07	0.253	0.3	−22.8	7.2
113	693A	3A3471	2R01	3.10	0.06	0.218	0.3	−22.8	9.5
113	693A	3A3472	2R01	3.38	0.06	0.428	0.2	−22.6	8.4
113	693A	3A3473	2R01	3.82	0.04	0.149	0.3	−22.4	7.4
113	693A	3A3474	2R02	4.30	0.06	0.267	0.3	−22.7	7.5
113	693A	3A3475	2R02	4.60	0.06	0.214	0.4	−22.4	10.1
113	693A	3A3476	2R02	4.90	0.08	0.235	0.4	−22.6	8.1
113	693A	3A3477	2R02	5.32	0.10	0.192	0.6	−22.5	5.7
113	693A	3A3478	2R03	5.82	0.06	0.161	0.5	−22.6	5.6
113	693A	3A3479	2R03	6.10	0.06	0.148	0.5	−22.7	7.9
113	693A	3A3480	2R03	6.40	0.22	0.155	1.7	−22.3	7.7
113	693A	3A3481	2R03	6.82	0.07	0.182	0.4	−23.3	9.4
113	693A	3A3482	2R04	7.32	0.06	0.230	0.3	−22.7	11.3
113	693A	3A3483	2R04	7.60	0.06	0.233	0.3	−22.6	9.4
113	693A	3A3484	2R04	7.90	0.03	0.220	0.1	−23.2	10.0
113	693A	3A3485	2R04	8.32	0.06	0.142	0.5	−22.6	5.1
113	693A	3A3486	2R05	8.82	0.09	0.132	0.8	−22.8	5.4
113	693A	3A3487	2R05	9.10	0.08	0.197	0.5	−22.9	5.7
113	693A	3A3488	2R05	9.40	0.08	0.192	0.5	−22.6	2.8
113	693A	3A3489	2R05	9.82	0.08	0.187	0.5	−23.0	2.9
113	693A	3A3490	2R06	10.32	0.07	0.152	0.5	−22.5	2.6
113	693A	3A3491	2R06	10.60	0.05	0.141	0.4	−23.0	1.4
113	693A	3A3492	2R06	10.90	0.08	0.396	0.2	−21.4	3.1
113	693A	3A3493	2R06	11.32	0.08	0.423	0.2	−21.7	4.7
113	693A	3A3494	2R06	11.82	0.08	0.131	0.6	−22.7	4.4
113	693A	3A3495	3R01	12.52	0.07	0.180	0.4	−22.3	4.3
113	693A	3A3496	3R01	12.80	0.06	0.270	0.3	−23.1	6.3
113	693A	3A3497	3R01	13.10	0.07	0.210	0.4	−22.5	5.3
113	693A	3A3498	3R01	13.53	0.06	0.161	0.5	−22.9	5.0
113	693A	3A3500	3R02	14.30	0.06	0.010	6.4	−23.3	7.8
113	693A	3A3501	3R02	14.60	0.06	0.397	0.2	−22.5	5.1
113	693A	3A3502	3R02	14.91	0.06	0.321	0.2	−22.8	5.0
113	693A	3A3503	4R01	22.22	0.20	0.347	0.7	−23.2	4.3
113	693A	3A3504	4R01	22.50	0.11	0.346	0.4	−23.4	4.9
113	693A	3A3505	4R01	22.80	0.17	0.248	0.8	−23.6	5.2
113	693A	3A3506	4R01	23.22	0.09	0.152	0.7	−22.7	5.2
113	693A	3A3507	4R02	23.72	0.11	0.206	0.6	−23.0	5.9
113	693A	3A3508	4R02	24.00	0.09	0.169	0.6	−22.7	2.1
113	693A	3A3509	4R02	24.30	0.08	0.289	0.3	−23.0	4.7
113	693A	3A3510	4R02	24.72	0.10	0.235	0.5	−22.0	4.3
113	693A	3A3512	4R03	25.50	0.08	0.125	0.7	−22.9	3.8
113	693A	3A3513	4R03	25.80	0.11	0.201	0.6	−23.3	3.4
113	693A	3A3514	4R04	26.72	0.08	0.221	0.4	−22.9	3.2
113	693A	3A3515	4R04	27.00	0.08	0.166	0.5	−23.4	3.6
113	693A	3A3516	4R04	27.30	0.08	0.134	0.7	−22.3	3.0
113	693A	3A3517	4R05	27.72	0.10	0.226	0.5	−22.6	1.9
113	693A	3A3518	4R05	28.22	0.09	0.349	0.3	−23.0	3.7
113	693A	3A3520	5R01	31.73	0.10	0.229	0.5	−22.9	5.8
113	693A	3A3521	5R01	32.00	0.10	0.190	0.6	−23.2	4.8
113	693A	3A3522	5R01	32.29	0.11	0.199	0.6	−22.8	5.7
113	693A	3A3523	5R01	32.71	0.11	0.190	0.7	−22.9	4.1
113	693A	3A3524	5R02	33.23	0.10	0.255	0.5	−23.0	1.0
113	693A	3A3525	5R02	33.50	0.14	0.178	0.9	−22.5	1.5
113	693A	3A3526	5R02	33.79	0.12	0.263	0.5	−23.0	2.1
113	693A	3A3527	5R02	34.21	0.09	0.243	0.4	−22.1	2.6
113	693A	3A3528	5R03	34.73	0.10	0.320	0.3	−22.1	2.9
113	693A	3A3529	5R03	35.00	0.21	0.170	1.4	−22.9	4.7
113	693A	3A3530	5R03	35.29	0.14	0.235	0.7	−23.1	3.9
113	693A	3A3531	5R03	35.71	0.18	0.132	1.6	−22.8	5.2
113	693A	3A3532	5R04	36.23	0.12	0.286	0.5	−21.5	4.2
113	693A	3A3533	5R04	36.50	0.13	0.204	0.7	−23.5	6.4
113	693A	3A3534	5R04	36.79	0.10	0.419	0.3	−22.4	6.2
113	693A	3A3535	5R04	37.21	0.18	0.262	0.8	−23.2	3.2
113	693A	3A3536	5R05	37.73	0.10	0.115	1.0	−23.4	4.1
113	693A	3A3537	5R05	38.00	0.18	0.341	0.6	−22.9	4.6
113	693A	3A3538	5R05	38.29	0.19	0.314	0.7	−23.3	3.7
113	693A	3A3539	5R05	38.71	0.39	0.296	1.5	−23.1	3.0
113	693A	3A3540	5R06	39.23	0.10	0.261	0.4	−22.1	5.2
113	693A	3A3541	5R06	39.50	0.08	0.245	0.4	−22.5	3.2
113	693A	3A3542	5R06	39.79	0.10	0.151	0.7	−22.6	5.9
113	693A	3A3543	6R01	41.43	0.12	0.083	1.7	−22.9	5.3
113	693A	3A3544	6R01	41.70	0.13	0.309	0.5	−23.3	2.9
113	693A	3A3545	6R01	42.00	0.10	0.232	0.5	−22.3	4.1
113	693A	3A3546	6R01	42.42	0.13	0.227	0.6	−23.1	5.2
113	693A	3A3547	6R02	42.93	0.08	0.272	0.3	−24.6	3.2
113	693A	3A3548	6R02	43.20	0.12	0.275	0.5	−24.1	3.7
113	693A	3A3549	6R02	43.50	0.07	0.169	0.5	−22.7	5.0
113	693A	3A3550	6R02	43.92	0.07	0.141	0.5	−23.6	4.7
113	693A	3A3551	6R03	44.43	0.08	0.214	0.4	−22.3	6.7
113	693A	3A3552	6R03	44.70	0.10	0.100	1.1	−23.6	5.9
113	693A	3A3553	6R03	45.00	0.08	0.218	0.4	−23.3	7.0
113	693A	3A3554	6R03	45.42	0.07	0.179	0.4	−22.9	6.3
113	693A	3A3555	6R04	45.93	0.08	0.193	0.5	−23.4	5.5
113	693A	3A3556	6R04	46.20	0.09	0.135	0.7	−23.2	5.2

Table 1 (continued).

Leg	Hole	Mun#	Core	Depth	%C	%N	C/N	$\delta^{13}C$	$\delta^{15}N$
113	693A	3A3557	6R04	46.50	0.08	0.112	0.8	−23.1	5.0
113	693A	3A3558	6R05	47.43	0.08	0.157	0.6	−24.0	4.7
113	693A	3A3559	6R05	47.70	0.09	0.291	0.4	−21.9	6.7
113	693A	3A3560	6R05	48.00	0.06	0.275	0.3	−23.1	4.0
113	693A	3A3561	6R05	48.42	0.17	0.463	0.4	−22.4	2.9
113	693A	3A3562	6R06	48.93	0.13	0.276	0.6	−22.2	3.1
113	693A	3A3563	6R06	49.20	0.17	0.197	1.0	−22.9	6.6
113	693A	3A3564	7R01	51.12	0.09	0.208	0.5	−22.0	7.3
113	693A	3A3565	7R01	51.40	0.16	0.102	1.9	−22.3	4.0
113	693A	3A3566	7R01	51.70	0.23	0.249	1.1	−23.1	4.7
113	693A	3A3567	7R01	52.12	0.09	0.162	0.7	−23.3	2.7
113	693A	3A3568	7R02	52.62	0.09	0.162	0.6	−24.0	4.6
113	693A	3A3569	7R02	53.20	0.08	0.117	0.8	−23.4	6.4
113	693A	3A3570	8R01	61.16	0.09	0.266	0.4	−23.1	5.0
113	693A	3A3571	8R02	62.66	0.04	0.096	0.5	−22.5	3.5
113	693A	3A3572	8R03	64.16	0.12	0.348	0.4	−22.9	3.8
113	693A	3A3573	8R04	65.66	0.06	0.046	1.6	−23.4	4.4
113	693A	3A3574	8R05	67.16	0.05	0.127	0.5	−22.0	1.0
113	693A	3A3575	8R06	68.66	0.08	0.031	3.0	−23.5	1.3
113	693A	3A3576	9R01	70.87	0.08	0.040	2.0	−22.1	2.9
113	693A	3A3577	9R02	72.37	0.01	0.005	2.2	−22.4	3.8
113	693A	3A3578	9R03	73.87	0.15	0.150	1.1	−22.2	3.0
113	693A	3A3579	9R04	75.37	0.18	0.277	0.8	−21.7	2.2
113	693A	3A3580	9R05	76.87	0.11	0.295	0.4	−21.6	2.9
113	693A	3A3581	9R06	78.37	0.19	0.165	1.3	−21.9	2.0
113	693A	3A3582	10R01	80.45	0.05	0.031	2.0	−23.2	4.2
113	693A	3A3583	10R02	81.98	0.15	0.147	1.2	−23.2	4.5
113	693A	3A3584	10R03	83.47	0.10	0.162	0.7	−23.2	4.4
113	693A	3A3586	10R06	87.97	0.11	0.277	0.5	−23.3	6.1
113	693A	3A3587	11R01	90.02	0.16	0.150	1.1	−23.5	5.1
113	693A	3A3588	11R02	91.57	0.09	0.178	0.6	−23.3	3.6
113	693A	3A3589	11R03	93.07	0.10	0.264	0.4	−23.2	4.2
113	693A	3A3590	11R04	94.57	0.10	0.294	0.4	−23.6	4.3
113	693A	3A3591	11R05	96.07	0.01	0.032	0.4	−23.8	4.6
113	693A	3A3592	11R05	96.69	0.10	0.348	0.3	−23.2	4.1
113	693A	3A3594	11R06	97.57	0.14	0.273	0.6	−22.4	5.5
113	693A	3A3595	12R01	99.67	0.02	0.241	1.1	−23.4	3.6
113	693A	3A3596	12R02	101.17	0.18	0.148	1.4	−24.3	2.0
113	693A	3A3597	12R03	102.67	0.17	0.295	0.7	−25.1	3.3
113	693A	3A3598	12R04	104.17	0.19	0.210	1.1	−25.6	3.1
113	693A	3A3599	12R05	105.67	0.12	0.133	1.1	−22.9	3.2
113	693A	3A3600	12R06	107.17	0.34	0.450	0.9	−26.0	2.0
113	693A	3A3601	12R07	108.15	0.04	0.031	1.4	−24.0	2.8
113	693A	3A3602	12R07	108.39	0.09	0.040	2.8	−23.2	3.7
113	693A	3A3606	13R03	112.37	0.23	0.066	4.1	−22.8	3.8
113	693A	3A3607	13R03	112.55	0.20	0.071	3.1	−22.7	3.6
113	693A	3A3608	13R04	113.87	0.11	0.056	2.4	−22.7	3.8
113	693A	3A3610	14R01	118.97	0.17	0.057	3.4	−22.2	3.1
113	693A	3A3611	14R02	120.47	0.20	0.047	4.8	−23.4	2.9
113	693A	3A3612	14R03	121.97	0.08	0.036	2.5	−23.4	3.8
113	693A	3A3613	14R04	123.47	0.14	0.033	5.1	−22.9	3.8
113	693A	3A3615	14R05	124.97	0.12	0.047	3.1	−23.4	3.1
113	693A	3A3617	15R02	130.07	0.11	0.041	3.3	−23.6	4.5
113	693A	3A3618	15R03	131.57	0.08	0.031	3.0	−23.1	4.6
113	693A	3A3621	17R02	149.47	0.07	0.015	5.7	−22.5	3.2
113	693A	3A3622	17R02	149.69	0.54	0.099	6.4	−22.4	4.4
113	693A	3A3623	17R03	150.73	0.12	0.059	2.4	−22.1	3.4
113	693A	3A3624	18R01	157.67	0.19	0.053	4.3	−21.8	3.1
113	693A	3A3625	18R02	159.17	0.12	0.046	3.1	−22.1	4.2
113	693A	3A3626	18R03	160.67	0.08	0.021	4.6	−24.8	4.4
113	693A	3A3627	18R04	162.17	0.22	0.052	4.9	−24.9	4.8
113	693A	3A3628	19R01	167.37	0.11	0.043	3.1	−25.7	4.3
113	693A	3A3629	19R02	168.87	0.21	0.040	6.2	−22.8	4.5
113	693A	3A3630	19R03	170.37	0.07	0.034	2.4	−22.2	3.9
113	693A	3A3631	19R04	171.87	0.07	0.032	2.7	−22.6	4.2
113	693A	3A3632	19R05	173.42	0.07	0.027	2.8	−22.2	3.9
113	693A	3A3633	21R01	186.67	0.12	0.019	7.5	−22.6	4.7
113	693A	3A3634	21R02	187.92	0.18	0.057	3.6	−23.2	4.6
113	693A	3A3635	22R01	196.37	0.27	0.068	4.6	−22.8	4.6
113	693A	3A3636	22R02	197.87	0.10	0.039	3.0	−22.3	3.3
113	693A	3A3637	22R03	199.37	0.25	0.059	4.9	−22.1	4.7
113	693A	3A3638	22R03	199.42	0.04	0.016	3.4	−22.9	4.1
113	693A	3A3639	25R01	225.37	0.11	0.047	2.7	−23.1	4.7
113	693A	3A3640	25R02	226.87	0.21	0.080	3.0	−24.3	2.9
113	693A	3A3641	25R03	228.37	0.10	0.035	3.3	−23.2	4.7
113	693A	3A3642	25R04	229.87	0.08	0.034	2.8	−23.6	3.6
113	693A	3A3643	25R04	230.48	0.11	0.040	3.2	−25.1	3.4
113	693A	3A3644	26R01	235.07	0.10	0.034	3.3	−25.8	4.9
113	693A	3A3645	26R02	236.57	0.07	0.014	5.7	−25.5	4.6
113	693A	3A3647	26R04	239.57	0.09	0.035	3.0	−25.6	3.8
113	693A	3A3648	26R05	241.07	0.22	0.049	5.2	−24.8	3.5
113	693A	3A3649	27R01	244.68	0.13	0.050	3.1	−25.7	3.3
113	693A	3A3651	28R03	257.37	0.10	0.063	1.8	−24.8	3.2

Table 1 (continued).

Leg	Hole	Mun#	Core	Depth	%C	%N	C/N	$\delta^{13}C$	$\delta^{15}N$
113	693A	3A3652	28R04	258.87	0.11	0.035	3.6	−23.8	3.5
113	693A	3A3653	29R01	263.67	0.09	0.031	3.5	−23.0	3.8
113	693A	3A3654	29R02	265.17	0.14	0.054	3.0	−24.0	4.3
113	693A	3A3655	29R03	266.67	0.07	0.028	2.9	−24.5	4.1
113	693A	3A3656	29R04	268.17	0.08	0.039	2.4	−24.4	4.2
113	693A	3A3657	29R05	269.67	0.12	0.048	2.8	−22.9	4.3
113	693A	3A3658	31R01	282.96	0.06	0.017	3.9	−23.4	4.4
113	693A	3A3659	33R01	302.30	0.18	0.066	3.3	−22.9	2.4
113	693A	3A3660	34R01	311.97	0.09	0.044	2.5	−23.1	2.8
113	693A	3A3661	35R01	322.23	0.35	0.112	3.6	−24.0	2.4
113	693A	3A3663	36R01	331.27	0.12	0.045	3.2	−23.4	2.4
113	693A	3A3664	38R01	350.68	0.23	0.078	3.5	−24.1	2.3
113	693A	3A3665	39R01	360.33	0.32	0.079	4.7	−25.1	2.2
113	693A	3A3666	39R02	361.83	0.21	0.078	3.2	−24.4	3.4
113	693A	3A3667	40R01	369.66	0.21	0.049	5.0	−24.1	3.0
113	693A	3A3668	40R02	371.16	0.20	0.052	4.6	−24.0	3.0
113	693A	3A3669	40R03	372.66	0.20	0.028	8.3	−24.1	3.2
113	693A	3A3670	50R01	465.85	1.75	0.315	6.5	−25.0	2.8
113	693A	3A3971	50R02	466.40	0.24	0.026	10.7	−26.7	3.8
113	693B	3B3672	2X01	234.19	0.19	0.065	3.4	−25.7	3.2
113	693B	3B3673	2X01	234.42	0.03	0.017	1.9	−26.1	3.4
113	693B	3B3674	2X01	234.70	1.10	0.105	12.3	−26.2	3.7
113	693B	3B3675	2X01	235.14	0.02	0.003	6.1	−26.5	3.5
113	693B	3B3676	2X02	235.62	0.21	0.104	2.4	−26.4	3.7
113	693B	3B3677	2X02	235.92	0.08	0.044	2.1	−26.7	4.0
113	693B	3B3678	2X02	236.20	0.09	0.027	3.8	−25.9	3.6
113	693B	3B3680	2X03	237.12	0.12	0.035	3.9	−24.8	4.3
113	693B	3B3681	2X03	237.42	0.14	0.047	3.5	−24.8	3.6
113	693B	3B3682	2X03	237.70	0.08	0.021	4.7	−25.2	3.2
113	693B	3B3683	2X03	238.08	0.14	0.027	6.0	−24.3	2.9
113	693B	3B3684	2X04	238.62	0.10	0.019	6.5	−23.8	3.4
113	693B	3B3685	2X04	238.92	0.09	0.035	3.0	−24.1	5.0
113	693B	3B3687	6H01	268.12	0.35	0.050	8.1	−22.8	3.8
113	693B	3B3688	6H01	268.42	0.22	0.045	5.6	−23.1	5.6
113	693B	3B3689	6H01	268.69	0.24	0.082	3.4	−22.8	4.4
113	693B	3B3690	6H01	269.12	0.11	0.037	3.5	−23.5	4.1
113	693B	3B3691	6H02	269.62	0.21	0.122	2.0	−22.3	6.1
113	693B	3B3692	6H02	269.92	0.20	0.043	5.4	−22.9	6.0
113	693B	3B3693	6H02	270.19	0.23	0.101	2.7	−22.9	6.1
113	693B	3B3694	6H02	270.62	0.10	0.085	1.4	−22.6	5.8
113	693B	3B3695	6H03	271.12	0.22	0.096	2.7	−23.0	5.9
113	693B	3B3696	6H03	271.42	0.25	0.110	2.6	−23.1	4.2
113	693B	3B3697	6H03	271.69	0.09	0.032	3.4	−23.6	4.4
113	693B	3B3698	6H03	272.12	0.15	0.056	3.1	−23.2	3.8
113	693B	3B3699	6H04	272.62	0.11	0.036	3.5	−23.3	4.4
113	693B	3B3700	6H04	272.92	0.09	0.030	3.5	−23.4	5.7
113	693B	3B3701	6H04	273.19	0.04	0.033	1.4	−23.5	5.4
113	693B	3B3702	6H04	273.62	0.05	0.024	2.7	−23.0	5.2
113	693B	3B3703	6H05	274.12	0.09	0.049	2.2	−22.0	6.0
113	693B	3B3704	6H05	274.42	0.10	0.034	3.5	−22.3	6.0
113	693B	3B3705	6H05	274.69	0.15	0.064	2.7	−22.6	5.2
113	693B	3B3706	6H05	275.12	0.06	0.018	3.8	−22.8	4.9
113	693B	3B3707	6H06	275.62	0.14	0.063	2.6	−23.2	6.1
113	693B	3B3708	6H06	275.92	0.14	0.020	8.0	−23.0	5.0
113	693B	3B3709	6H06	276.19	0.13	0.040	3.9	−23.1	4.5
113	693B	3B3710	6H06	276.62	0.31	0.049	7.5	−23.1	5.3
113	693B	3B3711	7H01	278.27	0.21	0.051	4.7	−23.7	6.0
113	693B	3B3712	7H02	279.77	0.13	0.036	4.3	−23.6	5.1
113	693B	3B3713	7H03	281.27	0.13	0.027	5.8	−23.5	5.4
113	693B	3B3714	8X01	287.86	0.09	0.025	4.1	−23.7	5.3
113	693B	3B3715	8X03	290.86	0.07	0.032	2.6	−22.8	5.7
113	693B	3B3716	9X01	297.55	0.05	0.023	2.7	−22.0	6.0
113	693B	3B3717	9X02	299.05	0.20	0.057	4.1	−22.8	4.8
113	692B	3B3718	9X03	300.55	0.09	0.030	3.5	−22.5	4.5
113	693B	3B3719	9X04	302.05	0.07	0.019	4.1	−22.6	5.2
113	693B	3B3720	9X05	303.55	0.07	0.026	3.1	−22.8	5.7
113	693B	3B3721	10X01	307.25	0.14	0.037	4.6	−22.7	5.4
113	693B	3B3722	10X02	308.75	0.19	0.039	5.7	−22.4	5.3
113	693B	3B3723	10X03	310.25	0.06	0.025	2.9	−22.1	5.2
113	693B	3B3724	10X04	311.76	0.16	0.047	4.0	−22.7	5.3
113	693B	3B3725	11X01	316.87	0.07	0.044	1.9	−22.9	5.7
113	693B	3B3726	12X01	326.55	0.18	0.032	6.5	−23.3	5.6
113	693B	3B3727	12X02	328.05	0.10	0.033	3.7	−23.2	5.7
113	693B	3B3728	12X03	329.55	0.11	0.041	3.2	−22.4	6.0
113	693B	3B3729	12X04	331.03	0.10	0.033	3.4	−22.6	5.7
113	693B	3B3730	12X05	332.55	0.07	0.021	3.6	−23.4	5.4
113	693B	3B3731	13X01	336.15	0.14	0.031	5.2	−22.7	5.3
113	693B	3B3732	13X02	337.70	0.17	0.085	2.4	−23.2	5.6
113	693B	3B3733	14X01	345.86	0.05	0.046	1.3	−24.6	4.4
113	693B	3B3734	14X02	347.41	0.11	0.035	3.5	−24.4	4.1
113	693B	3B3735	14X03	348.88	0.19	0.055	4.1	−24.6	3.9
113	693B	3B3736	14X04	350.30	0.65	0.091	6.3	−24.0	3.9
113	693B	3B3737	14X05	351.79	0.34	0.071	5.6	−24.1	3.5

Table 1 (continued).

Leg	Hole	Mun#	Core	Depth	%C	%N	C/N	$\delta^{13}C$	$\delta^{15}N$
113	693B	3B3738	14X06	352.62	0.08	0.042	2.3	−23.2	3.5
113	693B	3B3739	15X01	355.42	0.07	0.034	2.5	−23.6	3.6
113	693B	3B3740	15X02	356.92	0.27	0.079	3.9	−23.8	3.4
113	693B	3B3741	15X03	358.42	0.27	0.061	5.1	−23.9	3.4
113	693B	3B3742	16X01	365.17	0.35	0.052	5.8	−24.2	3.0
113	693B	3B3743	16X02	366.67	0.27	0.061	5.1	−24.1	3.3
113	693B	3B3744	16X03	368.17	0.21	0.050	4.7	−23.7	3.2
113	693B	3B3745	17X01	374.82	0.21	0.061	4.1	−23.2	3.8
113	693B	3B3746	17X01	374.95	0.25	0.066	4.5	−24.8	3.1
113	693B	3B3747	17X02	375.69	0.27	0.042	4.6	−23.9	3.4
113	693B	3B3748	17X02	376.12	0.18	0.051	4.2	−23.7	3.4
113	693B	3B3749	18X01	384.60	0.19	0.051	4.4	−23.4	3.5
113	693B	3B3750	18X02	386.18	0.24	0.055	5.1	−23.9	3.3
113	693B	3B3751	18X02	386.35	0.11	0.045	2.8	−23.2	4.7
113	693B	3B3752	18X03	387.60	0.10	0.034	3.4	−23.9	3.4
113	693B	3B3753	18X04	389.23	0.06	0.033	2.1	−22.5	5.0
113	693B	3B3754	18X05	390.48	0.07	0.028	3.1	−23.2	4.4
113	693B	3B3755	18X06	392.09	0.18	0.064	3.4	−23.3	4.4
113	693B	3B3756	18X07	392.83	0.27	0.054	5.9	−23.6	4.2
113	694A	4A3758	1H02	2.40	0.04	0.030	1.7	−21.7	2.4
113	694A	4A3759	1H02	2.45	0.09	0.055	1.9	−21.8	2.8
113	694A	4A3760	1H02	2.50	0.06	0.041	1.8	−22.9	2.7
113	694A	4A3761	1H02	2.54	0.02	0.008	3.0	−22.0	2.9
113	694A	4A3762	1H02	2.59	0.03	0.009	4.1	−22.7	3.1
113	694A	4A3765	1H03	3.95	0.06	0.012	5.5	−21.5	3.8
113	694A	4A3766	1H03	4.20	0.08	0.017	5.7	−21.6	3.5
113	694A	4A3767	1H04	4.83	0.09	0.009	11.3	−22.1	4.9
113	694A	4A3768	1H04	5.16	0.07	0.013	6.3	−22.4	4.7
113	694A	4A3769	1H04	5.45	0.15	0.025	6.9	−21.6	4.4
113	694A	4A3770	1H04	5.70	0.05	0.015	4.0	−21.7	4.8
113	694A	4A3771	1H05	6.11	0.08	0.017	5.3	−22.2	3.7
113	694A	4A3772	1H05	6.31	0.02	0.008	2.5	−23.1	3.1
113	694A	4A3773	1H05	6.36	0.08	0.007	14.2	−23.7	4.1
113	694A	4A3774	1H05	6.66	0.09	0.011	9.4	−22.5	3.1
113	694A	4A3777	1H06	7.83	0.18	0.051	4.2	−21.8	2.6
113	694A	4A3778	1H06	8.16	0.11	0.044	2.9	−22.2	3.4
113	694A	4A3779	1H06	8.45	0.15	0.056	3.1	−22.4	3.7
113	694B	4B3780	1H01	0.34	0.15	0.064	2.7	−22.7	3.1
113	694B	4B3781	1H01	0.66	0.09	0.035	3.0	−22.9	3.5
113	694B	4B3782	1H01	0.94	0.11	0.043	3.1	−23.0	4.4
113	694B	4B3783	1H01	1.20	0.27	0.051	6.2	−22.5	3.8
113	694B	4B3784	1H02	1.84	0.12	0.102	1.4	−22.5	3.5
113	694B	4B3785	1H02	2.16	0.16	0.035	5.2	−22.2	4.5
113	694B	4B3786	1H02	2.44	0.10	0.029	4.1	−21.8	3.8
113	694B	4B3787	1H02	2.70	0.07	0.013	6.6	−22.2	3.5
113	694B	4B3788	1H03	3.34	0.12	0.039	3.5	−22.4	4.5
113	694B	4B3789	1H03	3.66	0.09	0.041	2.6	−22.6	4.6
113	694B	4B3790	1H03	3.94	0.29	0.089	3.9	−21.8	4.1
113	694B	4B3791	1H03	4.43	0.14	0.038	4.4	−21.8	4.1
113	694B	4B3792	1H04	4.84	0.10	0.028	4.1	−22.2	4.3
113	694B	4B3793	1H04	5.09	0.01	0.007	2.3	−22.0	4.0
113	694B	4B3794	1H04	5.43	0.12	0.029	4.8	−21.9	4.5
113	694B	4B3796	2H01	6.16	0.08	0.027	3.7	−22.5	4.6
113	694B	4B3798	2H01	6.69	0.09	0.059	1.7	−23.1	4.8
113	694B	4B3800	2H02	7.33	0.07	0.025	3.4	−23.0	3.3
113	694B	4B3801	2H02	7.66	0.05	0.017	3.6	−22.2	4.1
113	694B	4B3802	2H02	7.95	0.08	0.016	6.1	−22.1	4.3
113	694B	4B3803	2H02	8.18	0.09	0.019	5.7	−22.1	4.0
113	694B	4B3804	2H03	8.83	0.02	0.014	1.8	−22.3	3.7
113	694B	4B3805	2H03	9.14	0.21	0.044	5.6	−22.4	3.6
113	694B	4B3806	2H03	9.45	0.31	0.063	5.7	−21.2	4.2
113	694B	4B3807	2H03	9.69	0.17	0.034	5.8	−23.1	4.4
113	694B	4B3808	2H04	10.33	0.06	0.016	4.5	−22.3	4.4
113	694B	4B3809	2H04	10.64	0.13	0.033	4.6	−21.4	4.5
113	694B	4B3810	2H04	11.19	0.07	0.018	4.3	−22.5	4.3
113	694B	4B3812	2H05	11.96	0.08	0.017	5.2	−22.2	3.6
113	694B	4B3813	2H05	12.17	0.03	0.006	6.9	−22.2	3.7
113	694B	4B3814	2H05	12.38	0.16	0.026	7.1	−22.4	4.0
113	694B	4B3815	2H05	12.54	0.03	0.005	6.1	−22.5	3.4
113	694B	4B3816	2H05	12.70	0.06	0.012	5.4	−22.1	3.6
113	694B	4B3817	2H06	13.33	0.06	0.009	7.5	−22.6	4.6
113	694B	4B3818	2H06	13.64	0.09	0.016	6.6	−22.6	4.0
113	694B	4B3819	2H06	13.94	0.10	0.025	4.8	−22.1	2.8
113	694B	4B3820	2H06	14.19	0.07	0.016	4.7	−22.4	3.3
113	694B	4B3821	2H07	14.86	0.08	0.026	3.4	−22.6	3.1
113	694B	4B3822	3H01	15.43	0.11	0.021	5.9	−23.0	2.4
113	694B	4B3823	3H01	15.76	0.10	0.032	3.6	−22.6	2.6
113	694B	4B3824	3H01	16.05	0.15	0.043	3.9	−21.8	2.3
113	694B	4B3825	3H01	16.30	0.10	0.039	2.9	−22.3	2.5
113	694B	4B3826	3H02	16.93	0.02	0.005	4.2	−22.5	3.0
113	694B	4B3827	3H02	17.28	0.15	0.078	2.2	−22.2	2.2
113	694B	4B3828	3H02	17.55	0.19	0.051	4.2	−22.1	3.4
113	694B	4B3829	3H02	17.80	0.13	0.041	3.7	−21.9	3.7
113	694B	4B3832	3H03	18.76	0.01	0.007	1.8	−22.4	3.9
113	694B	4B3833	3H03	19.05	0.01	0.006	2.3	−23.8	3.2
113	694B	4B3834	3H03	19.22	0.15	0.044	4.0	−22.5	3.4
113	694B	4B3835	3H04	19.93	0.22	0.049	5.2	−22.6	3.3
113	694B	4B3836	3H04	20.26	0.26	0.095	3.1	−22.8	3.6
113	694B	4B3837	3H04	20.55	0.03	0.007	4.7	−23.1	3.4
113	694B	4B3838	3H04	20.80	0.28	0.067	4.8	−22.5	4.6
113	694B	4B3839	5X01	35.19	0.11	0.027	4.1	−22.5	3.9
113	694B	4B3840	5X02	36.14	0.18	0.074	2.8	−22.4	4.1
113	694B	4B3841	6H01	44.33	0.05	0.027	2.2	−22.9	3.6
113	694B	4B3842	6H01	44.66	0.09	0.042	2.5	−23.1	4.1
113	694B	4B3843	6H01	44.95	0.18	0.061	3.5	−23.3	4.3
113	694B	4B3844	6H01	45.20	0.16	0.052	3.6	−23.4	4.2
113	694B	4B3845	6H02	46.16	0.08	0.022	4.2	−23.3	4.1
113	694B	4B3846	6H02	46.45	0.10	0.021	5.5	−22.8	3.9
113	694B	4B3847	6H02	46.70	0.08	0.027	3.3	−23.1	3.4
113	694B	4B3848	6H03	47.33	0.08	0.017	5.7	−23.1	4.6
113	694B	4B3849	6H03	47.66	0.06	0.029	2.6	−23.3	4.1
113	694B	4B3850	6H03	47.95	0.04	0.019	2.5	−23.4	2.3
113	694B	4B3851	9H01	73.20	0.03	0.013	2.9	−23.3	3.1
113	694B	4B3852	10H01	83.33	0.04	0.018	2.6	−22.8	4.3
113	694B	4B3853	10H02	84.66	0.04	0.009	4.6	−24.5	3.2
113	694B	4B3855	14H01	112.07	0.23	0.058	4.7	−23.1	4.7
113	694B	4B3856	14H01	112.22	0.18	0.047	4.5	−23.3	5.0
113	694B	4B3857	15H01	121.52	0.64	0.099	7.6	−23.5	4.7
113	694B	4B3858	15H01	121.85	0.16	0.032	6.1	−22.7	4.4
113	694B	4B3859	15H01	122.16	0.19	0.036	6.2	−22.8	3.9
113	694B	4B3860	22X01	150.72	0.32	0.047	7.9	−22.5	4.3
113	694B	4B3861	22X01	151.05	0.30	0.054	6.4	−22.3	4.4
113	694B	4B3862	22X01	151.35	0.30	0.073	4.9	−22.9	4.6
113	694B	4B3863	22X01	151.60	0.32	0.079	4.6	−22.0	4.7
113	694B	4B3864	22X02	152.22	0.17	0.051	4.0	−23.3	4.7
113	694B	4B3865	22X02	152.55	0.15	0.035	4.8	−22.4	4.7
113	694B	4B3866	22X02	152.85	0.13	0.026	5.6	−23.4	4.7
113	694B	4B3867	22X02	153.10	0.05	0.032	2.0	−22.4	5.1
113	694B	4B3868	23X01	160.34	0.15	0.045	3.9	−21.8	4.0
113	694B	4B3869	23X01	160.65	0.14	0.042	3.8	−21.7	3.7
113	694B	4B3870	23X01	160.95	0.05	0.010	6.4	−22.6	2.9
113	694B	4B3871	23X01	161.23	0.06	0.010	6.9	−22.2	3.4
113	694B	4B3872	23X02	161.79	0.43	0.085	5.9	−24.1	4.3
113	694B	4B3873	23X02	162.14	0.13	0.060	2.5	−23.2	4.6
113	694B	4B3874	23X02	162.45	0.10	0.064	1.8	−23.9	4.1
113	694B	4B3875	23X02	162.70	0.12	0.060	2.3	−24.5	4.6
113	694B	4B3876	23X03	163.34	0.11	0.051	2.5	−23.3	4.4
113	694B	4B3877	23X03	163.66	0.12	0.054	2.5	−21.8	4.2
113	694B	4B3878	23X03	163.95	0.15	0.045	4.0	−22.2	4.1
113	694B	4B3879	23X03	164.19	0.08	0.034	2.7	−22.7	3.9
113	694B	4B3880	23X04	164.82	0.07	0.032	2.6	−23.5	4.7
113	694B	4B3881	23X04	165.16	0.07	0.022	3.9	−22.6	4.6
113	694B	4B3882	23X04	165.45	0.16	0.046	4.0	−22.4	4.4
113	694B	4B3883	23X04	165.70	0.08	0.028	3.4	−22.9	4.1
113	694B	4B3884	23X05	166.35	0.07	0.014	5.7	−22.9	3.7
113	694B	4B3885	23X05	166.66	0.21	0.062	4.0	−22.1	3.5
113	694B	4B3886	23X05	166.95	0.04	0.011	4.2	−22.6	3.8
113	694B	4B3887	23X05	167.23	0.07	0.025	3.3	−22.2	2.9
113	694B	4B3888	23X06	167.85	0.08	0.026	3.4	−22.4	2.4
113	694B	4B3889	23X06	168.16	0.12	0.017	7.9	−21.7	2.9
113	694B	4B3890	23X06	168.42	0.07	0.009	8.5	−23.9	3.4
113	694B	4B3891	24X01	170.25	0.04	0.011	4.9	−25.0	3.1
113	694B	4B3892	24X01	170.56	0.03	0.010	4.1	−24.1	3.7
113	694B	4B3893	24X01	170.80	0.11	0.027	4.5	−23.9	4.5
113	694B	4B3894	24X02	171.47	0.10	0.020	5.8	−22.6	4.8
113	694B	4B3895	24X02	171.80	0.11	0.029	4.4	−22.0	4.3
113	694B	4B3896	24X02	172.05	0.07	0.021	3.9	−22.3	4.1
113	694B	4B3897	24X02	172.22	0.05	0.018	3.0	−22.6	4.3
113	694B	4B3898	24X03	172.95	0.04	0.014	3.1	−25.5	2.9
113	694B	4B3899	24X03	173.30	0.06	0.032	2.3	−26.1	2.5
113	694B	4B3900	24X03	173.55	0.11	0.052	2.5	−22.9	4.1
113	694B	4B3902	24X04	174.45	0.04	0.014	3.7	−22.6	3.5
113	694B	4B3903	24X04	174.82	0.18	0.051	4.2	−22.8	4.9
113	694B	4B3904	24X04	174.95	0.07	0.024	3.4	−23.5	4.3
113	694B	4B3905	24X04	175.05	0.03	0.012	3.3	−22.4	4.1
113	694B	4B3906	24X04	175.21	0.02	0.016	1.8	−22.8	4.0
113	694C	4C3907	2X01	179.57	0.33	0.056	7.0	−22.7	4.4
113	694C	4C3909	2X01	180.14	0.47	0.045	12.1	−22.9	4.5
113	694C	4C3910	2X02	181.07	0.20	0.029	8.1	−23.0	3.0
113	694C	4C3911	2X02	181.35	0.24	0.026	10.8	−22.8	5.6
113	694C	4C3912	2X02	181.64	0.41	0.040	11.9	−22.3	6.7
113	694C	4C3913	2X02	181.88	0.26	0.023	12.1	−22.3	4.6
113	694C	4C3914	2X06	197.09	0.53	0.137	4.5	−22.3	5.4
113	694C	4C3915	2X06	197.46	0.13	0.040	3.7	−22.4	5.1
113	694C	4C3916	5X01	209.23	0.21	0.062	4.0	−22.3	4.7
113	694C	4C3917	5X01	209.56	0.30	0.052	6.7	−22.3	4.5

Table 1 (continued).

Leg	Hole	Mun#	Core	Depth	%C	%N	C/N	δ^{13}C	δ^{15}N
113	694C	4C3918	5X01	209.85	0.31	0.078	4.6	−22.4	4.0
113	694C	4C3919	5X01	210.10	0.08	0.037	2.6	−22.5	3.9
113	694C	4C3920	5X02	210.71	0.39	0.052	8.6	−22.9	3.8
113	694C	4C3921	5X02	211.06	0.41	0.083	5.8	−22.5	3.7
113	694C	4C3923	5X02	211.58	0.09	0.040	2.7	−22.8	4.0
113	694C	4C3924	6X01	218.23	0.62	0.101	7.1	−22.7	2.7
113	694C	4C3925	6X01	218.54	0.25	0.109	2.7	−22.6	3.0
113	694C	4C3926	6X01	218.85	0.23	0.056	4.7	−23.5	2.7
113	694C	4C3927	6X01	219.10	0.14	0.047	3.4	−23.0	3.1
113	694C	4C3928	6X02	219.73	0.25	0.034	8.7	−22.5	6.3
113	694C	4C3929	6X02	220.07	0.18	0.035	6.0	−23.4	6.8
113	694C	4C3930	6X02	220.35	0.11	0.018	7.1	−23.9	6.1
113	694C	4C3932	6X03	221.23	0.37	0.065	6.6	−23.7	4.5
113	694C	4C3933	6X03	221.56	0.14	0.020	8.1	−23.1	4.2
113	694C	4C3934	6X03	221.85	0.13	0.021	7.2	−22.3	4.3
113	694C	4C3935	6X03	222.10	0.11	0.019	6.8	−23.7	4.5
113	694C	4C3936	6X04	222.73	0.37	0.036	12.0	−22.8	4.2
113	694C	4C3937	6X04	223.06	0.32	0.038	9.9	−23.2	5.5
113	694C	4C3938	6X04	223.34	0.21	0.049	5.0	−23.6	4.7
113	694C	4C3939	6X04	223.60	0.24	0.055	5.1	−24.3	4.1
113	694C	4C3940	6X05	224.23	0.24	0.041	6.8	−23.5	3.7
113	694C	4C3941	6X05	224.56	0.21	0.043	5.5	−22.6	3.7
113	694C	4C3942	6X05	224.86	0.22	0.048	5.4	−22.3	4.6
113	694C	4C3943	7X01	227.95	0.12	0.024	6.0	−26.6	7.2
113	694C	4C3944	7X01	228.28	0.09	0.010	10.8	−23.1	4.0
113	694C	4C3945	7XCC	228.67	0.19	0.015	14.0	−23.5	5.4
113	694C	4C3946	8X01	237.23	0.74	0.055	14.7	−23.0	2.9
113	694C	4C3948	8X01	237.84	0.81	0.066	14.3	−22.8	5.3
113	694C	4C3949	8X01	238.10	0.53	0.048	13.0	−23.3	4.4
113	694C	4C3951	8X02	238.50	0.24	0.023	12.1	−23.2	4.2
113	694C	4C3952	8XCC	238.80	0.13	0.011	13.8	−23.8	3.0
113	694C	4C3953	9X01	246.85	0.11	0.009	14.3	−22.9	3.1
113	694C	4C3954	9X01	247.15	0.24	0.055	5.1	−23.1	4.7
113	694C	4C3955	9X01	247.45	0.25	0.053	5.6	−22.7	5.0
113	694C	4C3956	10X01	256.24	0.21	0.056	4.4	−22.4	3.4
113	694C	4C3957	10X01	256.48	0.69	0.109	7.0	−23.2	4.3
113	694C	4C3958	10X01	256.62	0.69	0.099	8.2	−22.9	4.1
113	694C	4C3959	10X01	256.75	0.26	0.025	12.0	−23.4	3.9
113	694C	4C3960	10X01	257.18	0.20	0.031	7.5	−23.5	4.1
113	694C	4C3961	10X02	257.78	0.44	0.054	9.5	−23.3	4.0
113	694C	4C3962	10X02	258.12	0.20	0.027	8.6	−24.1	5.1
113	694C	4C3963	10X02	258.25	0.20	0.023	10.1	−22.2	4.3
113	694C	4C3964	10XCC	258.62	0.14	0.019	8.6	−23.5	4.1
113	694C	4C3965	10XCC	258.81	0.06	0.007	10.0	−22.9	4.0
113	694C	4C3966	11X01	265.65	0.58	0.090	7.5	−23.5	4.2
113	694C	4C3967	11X01	265.85	0.29	0.041	8.3	−23.2	3.8
113	694C	4C3968	11X01	266.22	1.01	0.091	12.9	−23.4	3.6
113	694C	4C3969	11X01	266.44	0.40	0.039	12.0	−23.5	2.3
113	694C	4C3970	11X01	266.68	0.42	0.037	13.2	−23.9	3.0
113	694C	4C3971	11X02	267.03	0.36	0.029	14.5	−23.3	3.5
113	694C	4C3972	11X02	267.22	0.58	0.049	14.0	−22.7	3.6
113	694C	4C3974	11X02	267.61	1.38	0.111	14.5	−24.3	3.8
113	694C	4C3975	11XCC	268.25	0.43	0.044	11.4	−23.5	3.5
113	694C	4C3976	11XCC	268.38	0.25	0.020	14.8	−24.4	3.3
113	694C	4C3977	12X01	276.09	0.20	0.017	13.7	−22.1	4.5
113	694C	4C3978	12X01	276.44	0.18	0.026	8.0	−22.6	4.9
113	694C	4C3979	12X01	276.71	0.18	0.013	16.0	−23.3	3.4
113	694C	4C3980	13X01	285.43	0.55	0.039	16.5	−23.2	3.3
113	694C	4C3982	13X01	286.05	0.98	0.071	16.1	−23.2	3.1
113	694C	4C3984	14X01	295.03	0.96	0.082	13.7	−23.1	3.0
113	694C	4C3985	14X01	295.34	0.32	0.029	12.8	−23.1	4.2
113	694C	4C3986	14X01	295.68	0.65	0.112	6.8	−23.5	5.4
113	694C	4C3987	14X01	295.90	0.27	0.036	8.9	−23.3	4.3
113	694C	4C3988	14X02	296.53	0.69	0.092	8.8	−22.9	4.6
113	694C	4C3989	14X02	296.84	0.36	0.042	10.1	−23.3	4.8
113	694C	4C3990	14X02	297.16	0.23	0.030	9.0	−23.2	5.2
113	694C	4C3991	14X02	297.40	0.42	0.068	7.1	−23.6	4.3
113	694C	4C3992	14X03	298.03	0.23	0.027	9.6	−23.8	4.9
113	694C	4C3993	14X03	298.34	0.44	0.091	5.7	−23.1	4.5
113	694C	4C3994	14X03	298.66	0.43	0.051	9.5	−23.6	4.7
113	694C	4C3995	14X03	298.90	0.27	0.033	9.6	−23.4	4.7
113	694C	4C3996	14X04	299.53	0.03	0.013	2.8	−23.6	4.9
113	694C	4C3997	14X04	299.84	0.32	0.042	8.9	−23.3	4.3
113	694C	4C3998	14X04	300.16	0.57	0.062	10.7	−23.2	4.2
113	694C	4C3999	14X05	301.03	0.28	0.033	9.9	−23.2	4.5
113	694C	4C4000	14X05	301.34	0.32	0.040	9.4	−23.2	4.7
113	694C	4C4001	14X05	301.66	0.26	0.034	8.9	−22.8	4.3
113	694C	4C4002	14X05	301.90	0.32	0.055	6.8	−23.0	3.8
113	694C	4C4003	14X06	302.53	0.25	0.048	6.0	−23.0	3.9
113	694C	4C4004	14X06	302.84	0.29	0.030	11.1	−22.1	3.1
113	694C	4C4005	14X06	303.16	0.27	0.020	15.5	−23.5	2.9
113	694C	4C4006	14X06	303.40	0.34	0.028	14.1	−22.3	4.6
113	694C	4C4007	14X07	304.03	0.23	0.017	15.9	−23.1	4.4

Table 1 (continued).

Leg	Hole	Mun#	Core	Depth	%C	%N	C/N	δ^{13}C	δ^{15}N
113	694C	4C4008	15X01	304.64	0.52	0.073	8.3	−23.0	3.2
113	694C	4C4009	15X01	304.96	0.82	0.080	12.0	−23.4	3.8
113	694C	4C4010	15X01	305.27	0.70	0.059	13.9	−23.4	4.0
113	694C	4C4011	15X01	305.51	1.16	0.113	11.9	−23.5	3.3
113	694C	4C4012	15X02	306.14	0.57	0.073	9.1	−23.3	2.9
113	694C	4C4013	15X02	306.43	0.13	0.027	5.8	−22.4	3.2
113	694C	4C4014	15XCC	306.88	0.11	0.038	3.4	−23.1	3.7
113	694C	4C4015	19X01	343.41	0.32	0.073	5.1	−22.6	3.5
113	694C	4C4016	19X01	343.72	0.17	0.065	3.0	−23.5	4.1
113	694C	4G4017	19X01	343.95	0.20	0.045	5.2	−23.4	5.6
113	694C	4C4018	19X01	344.21	0.16	0.043	4.3	−22.9	5.7
113	694C	4C4019	19X01	344.40	0.27	0.073	4.3	−23.6	5.5
113	694C	4C4020	19X02	344.84	0.73	0.070	12.2	−23.2	4.8

continental slope, and have estimated maximum sedimentation rates of 180 m/m.y. over a 500,000 yr period.

Organic carbon and total nitrogen significantly correlate ($R^2 = 0.50$) as does C/N with %C and ^{13}C. The other parameters measured show no correlation at the 0.95 level.

DISCUSSION

With low sedimentation rates, as described above, preservation of organic matter is generally poor. In oxygenated waters, decreased sedimentation rates indicate enhanced time in the water column, and the greater likelihood of organic decomposition or alteration taking place (Muller and Suess, 1979; Muller et al., 1983). In biogenic sediments, productivity may be the principal control of the organic content of a sediment. Despite high abundances of microfossils in these sediments, the total organic loading associated with the productivity has not been preserved. These results would indicate that the rate of productivity over the sampling resolution time span (a minimum of 5,000 yr) was not high, and that what little material was produced, was recycled either in the water column or in the surficial sediments. Curiously, the total nitrogen in these sediments is high, often equal to or greater than the organic carbon loading, and is likely caused by the bonding of ammonium to the sediment particles, resulting in C/N near unity (Muller, 1977). This ammonium must have originated from organic production in the original water column and, in that sense, preserves evidence of a production rate greater than that seen in the organic carbon. Isotopic alteration may occur with diagenesis of the organic matter (Handa et al., 1972; Ittekkot et al., 1982; Entzeroth, 1982). In general, carbon isotopic compositions of organics in clastic sediments have been observed to be slightly (1‰) more enriched than overlying suspended particulate material. Particulate nitrogen isotopic compositions may be altered significantly during increased recycling or diagenesis (Altabet and McCarthy, 1986; Macko, 1983; 1989; Macko et al. 1986). The fact that %C and %N correlate significantly for all sites appears to indicate a mechanism maintaining a related preservation of the two elements. It is important to note, however, that not only in organic content, but also in isotopic compositions, inconsistencies between compositions of carbon and nitrogen may simply be the result of different origins for the majority of that element (Mayer et al., 1988).

The organic data indicate changes in the types and quantity of production occurring in the water column, and suggest an increased intensity in the recycling of nitrogen since the Pleistocene. These results give support for present models on the development of the Antarctic ice-sheet and cooling of the waters surrounding the continent (Barker, Kennett, et al., 1988). An important consideration in the evaluation of the isotopic signatures in such a model is the observation that present day particulate organic material, which was collected in sediment traps si-
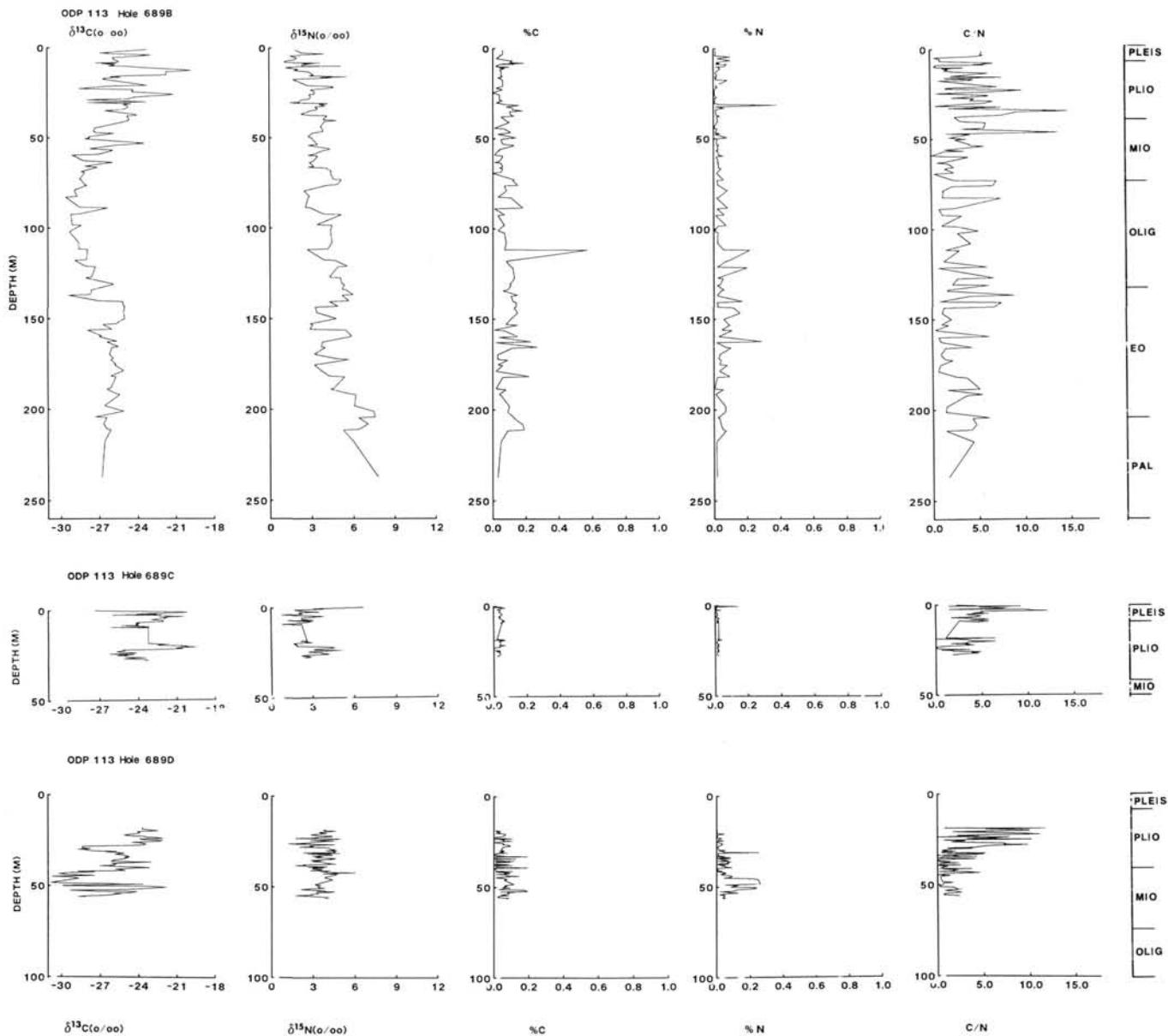
Figure 2. Site 689 individual core results: $\delta^{13}C$, $\delta^{15}N$, %organic C, %total N, and C/N vs. depth.

multaneously to the Leg 113 drilling operation, is depleted in both $\delta^{13}C$ and $\delta^{15}N$, relative to most marine sediments (Biggs et al., 1988). These depletions in the sediment trap samples are able to be associated with fresh, organic rich material and are likely the result of isotopic fractionations by the primary producers. Isotopic compositions similar to these modern values were seen in the erratic spikes of Miocene age sediments at Site 693; these sediments appear to be rich in diatoms, from smear slide analyses (Barker, Kennett, et al. 1988). Such depleted compositions appear to be an indicator of primary production, specifically diatoms, in nutrient rich, cooler waters. Such depleted signatures are common at Sites 689 and 690 in the Oligocene. It is believed that these depletions in isotopic signatures, from more enriched values of the Eocene and Paleocene, are an indication of the cooling of the waters, and as these sites are removed from continental influences, of the waters surrounding Antarctica in general. The fact that the fossils and the isotopes only occasionally show these anomalous compositions is an indication that the events which caused them in the Miocene were erratic and very isolated, perhaps like present-day polynya in the sea ice. Also notable is the fact that carbon and nitrogen isotopic compositions dramatically increase from the middle Miocene onwards at Sites 689 and 690. As noted above, such enrichments have been observed in modern settings associated with enhanced organic recycling. A further observation of the nitrogen isotopic changes at Site 690 is that a depletion occurs during the Pliocene, prior to the most enriched values of the Pleistocene. Those enriched values are not seen in the condensed Pleistocene section of Site 689, and could indicate that the section is not as complete as that at Site 690. A clear depletion of about 2‰ is also seen in carbon at Site 690 in the Pleistocene, which is not seen in the samples from Site 689. Isotopic compositions of the samples from Site 694 are similar to other reports of colder water carbon productivity; few nitrogen isotopic compositions exist for high latitude sediments. The values observed at Site 694 are similar to those seen in Recent sediments from the Bransfield Strait (Silfer et al., in press) and on the continental shelf of the modern Canadian Arctic Ocean. Since much of the sedi-
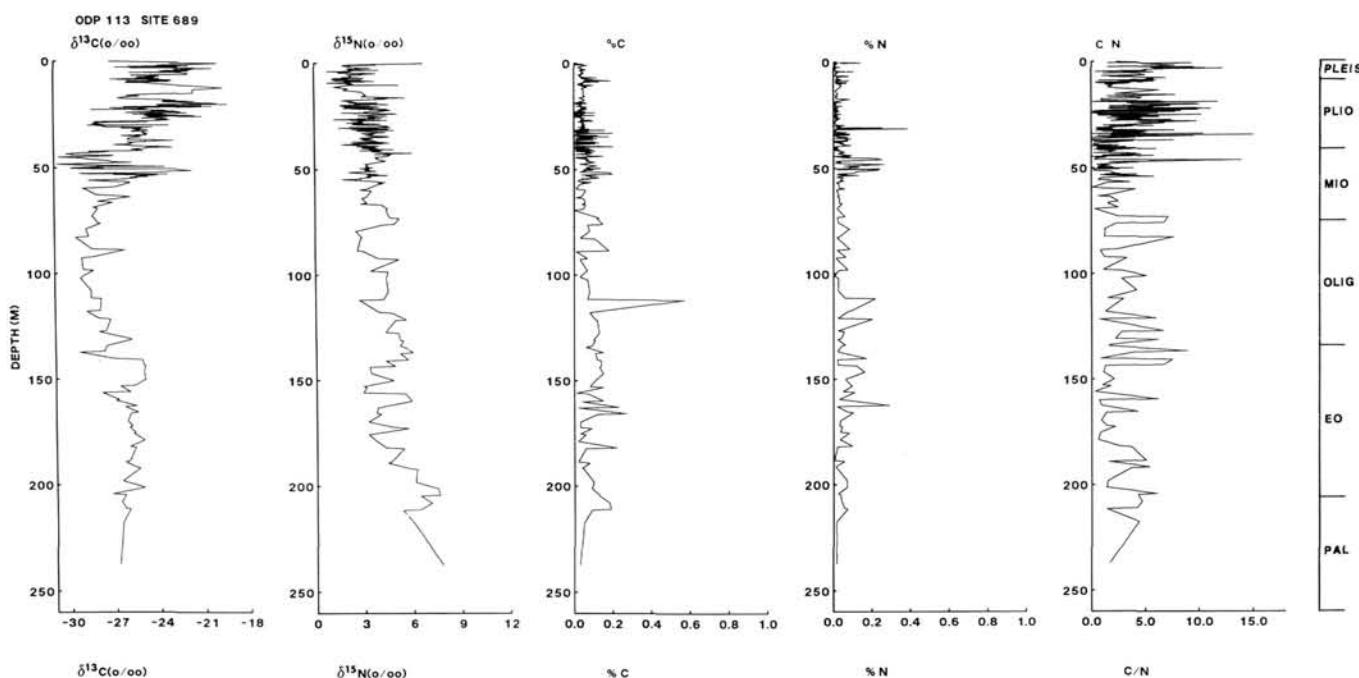
Figure 3. Site 689 composite core results: $\delta^{13}C$, $\delta^{15}N$, %organic C, %total N, and C/N vs. depth.
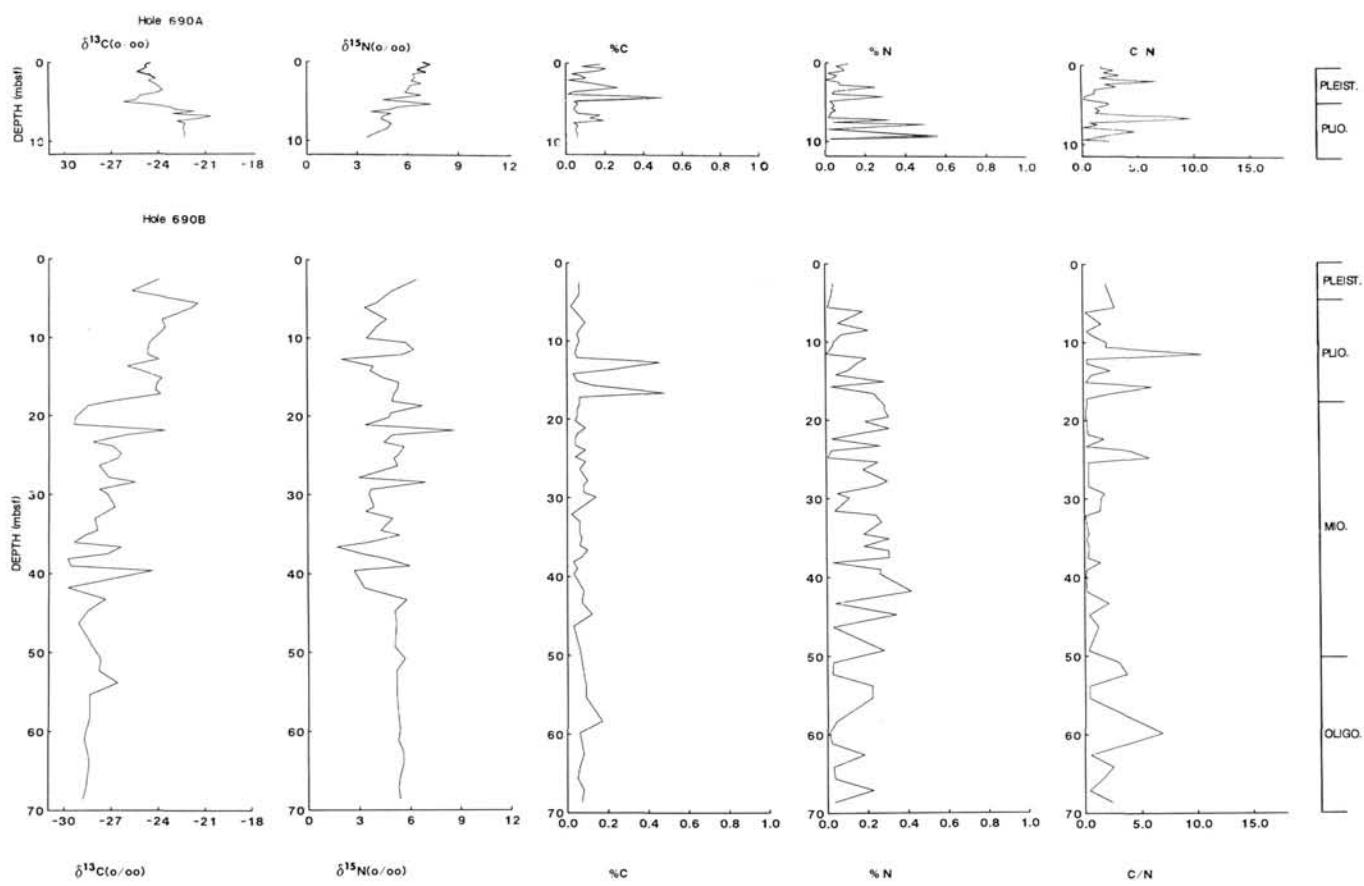
Figure 4. Site 690 individual core results: $\delta^{13}C$, $\delta^{15}N$, %organic C, %total N, and C/N vs. depth.
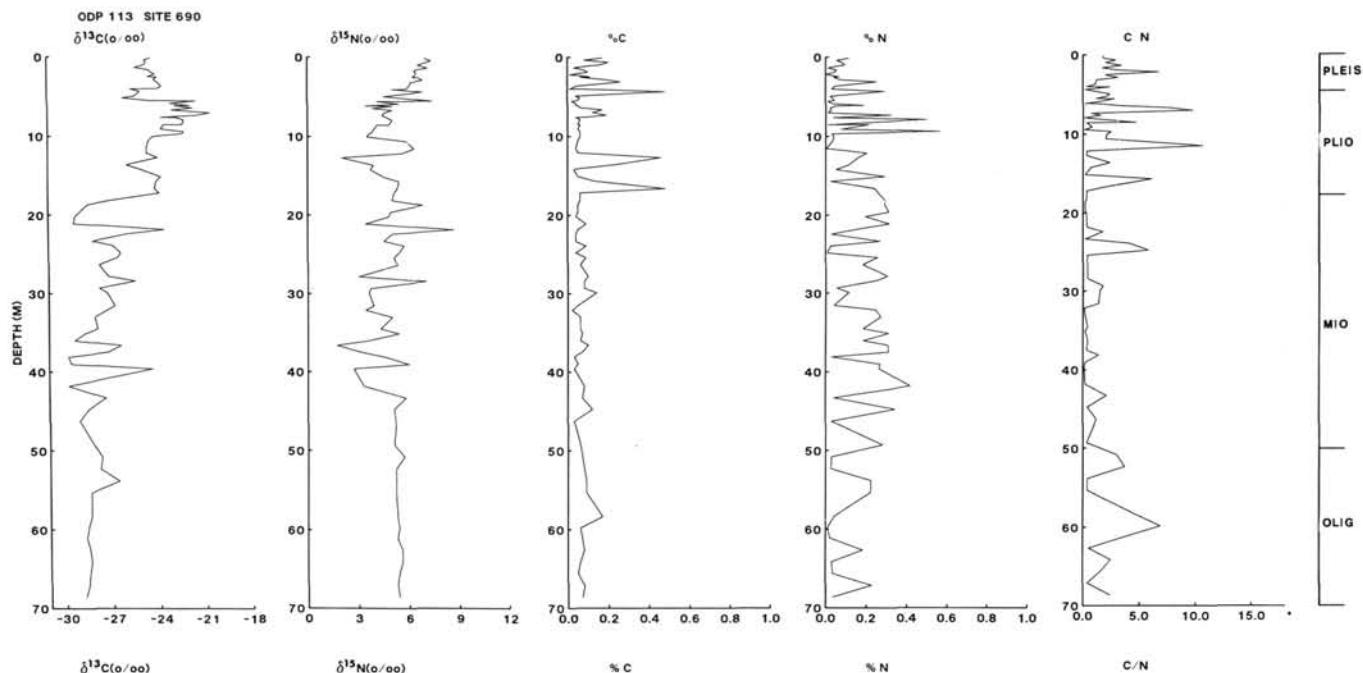
Figure 5. Site 690 composite core results: $\delta^{13}C$, $\delta^{15}N$, %organic C, %total N, and C/N vs. depth.

mentation at this site is the result of instabilities from the adjacent slope, these results suggest that the Site 694 sediments show compositions typical of ocean systems which are similar to those environments, and which were originally deposited on the slope and subsequently transported to the abyssal plain. The heightened organic composition of these Miocene sediments suggests higher production and preservation on the slope, perhaps prior to the Miocene events.

Finally, at Site 693 there is a major event, which is perhaps related to the progressive growth or the stabilization of the West Antarctic ice-sheet. At a depth of approximately 100 m, all indicators of the organics in the present study show this event, which is estimated to be about 5 Ma. It is suggested that with stabilization of the ice-sheet, and less loss of sediment, through ice rafting or instability, the waters below the sea-ice saw increased recycling of carbon and nitrogen with enhanced binding of ammonium to sediment particles, and diminished carbon preservation. As a result the nitrogen isotopic signatures are somewhat enriched in the Pliocene and show the most enrichment in the Pleistocene.

SUMMARY

These preliminary data on the organic compositions and analyses of carbon and nitrogen isotopic compositions of sediments from the Weddell Sea indicate:

1. Changes in the organic material preserved in the sediments record events in the waters surrounding Antarctica which may be attributed to the cooling of those waters and glacial advance.

2. An event related to the progressive growth or stabilization of the West Antarctic ice-sheet is recorded at approximately 5 Ma.

3. With increases in the ice cover and its permanency, intensification in the recycling of organics is observed.

4. Overall poor preservation of organic matter is seen for most sediments and this is probably the result of slow sedimentation rates; an oxygenated water column, which was corrosive to organic matter; and an overall low productivity. Much of the nitrogen preserved in the sediments is in the form of ammonium bound to sediment particles.

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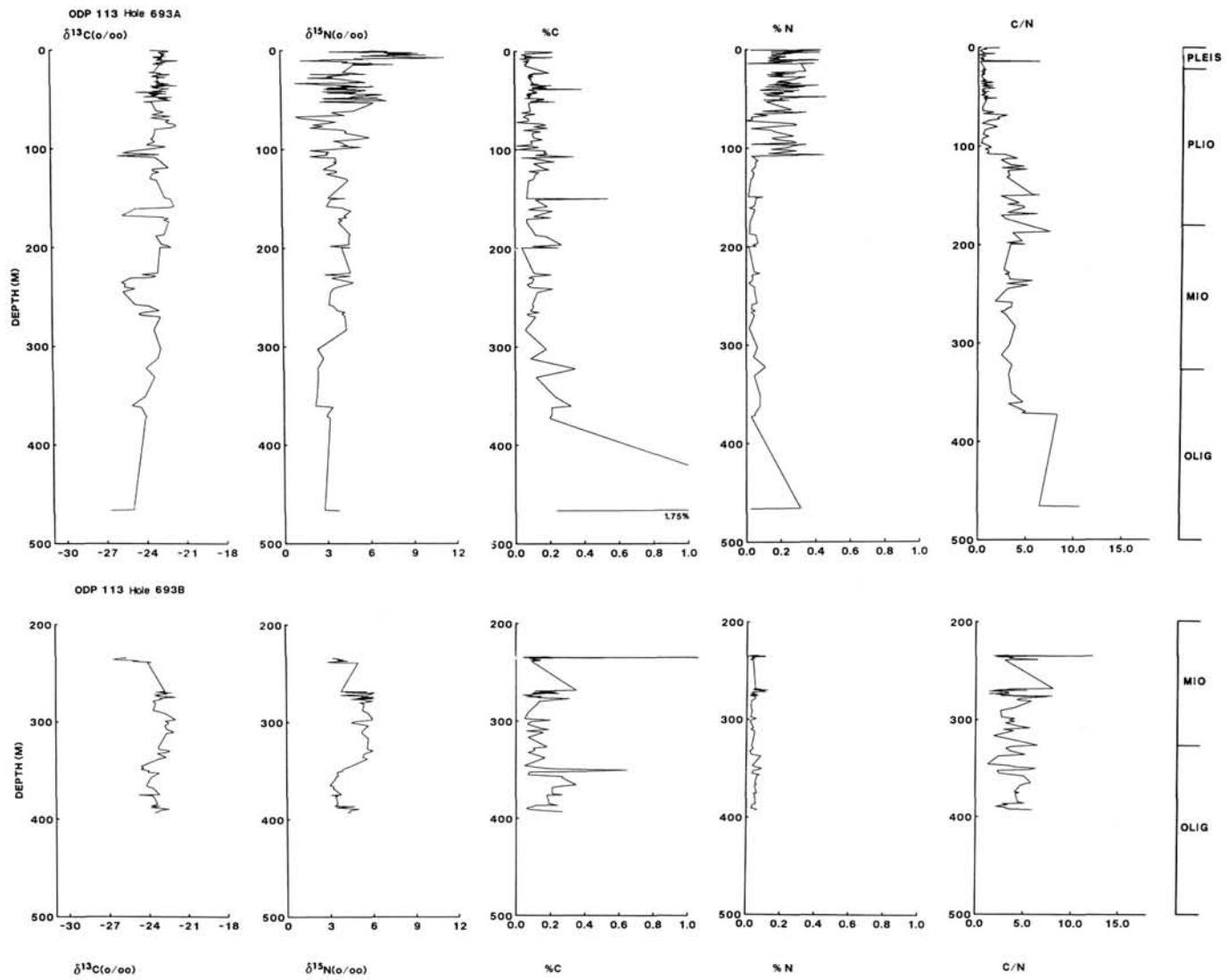
Figure 6. Site 693 individual core results: $\delta^{13}C$, $\delta^{15}N$, %organic C, %total N, and C/N vs. depth.
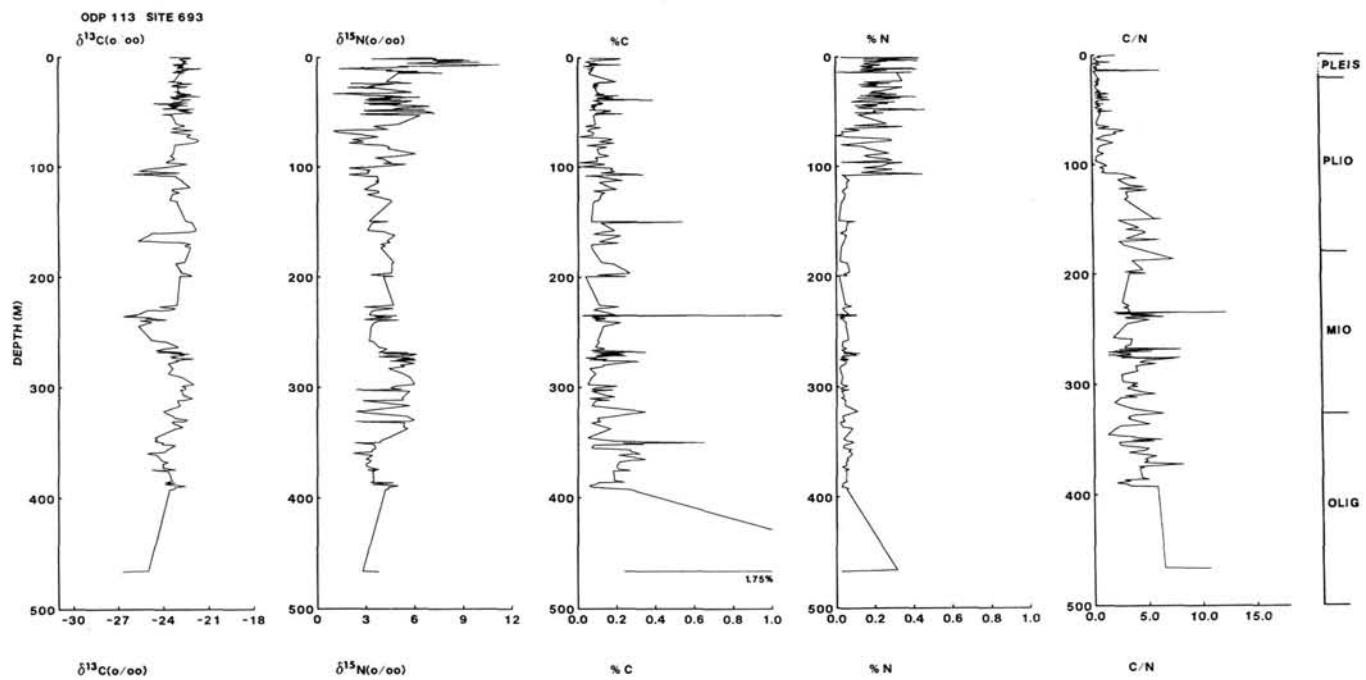
Figure 7. Site 693 composite core results: $\delta^{13}C$, $\delta^{15}N$, %organic C, %total N, and C/N vs. depth.
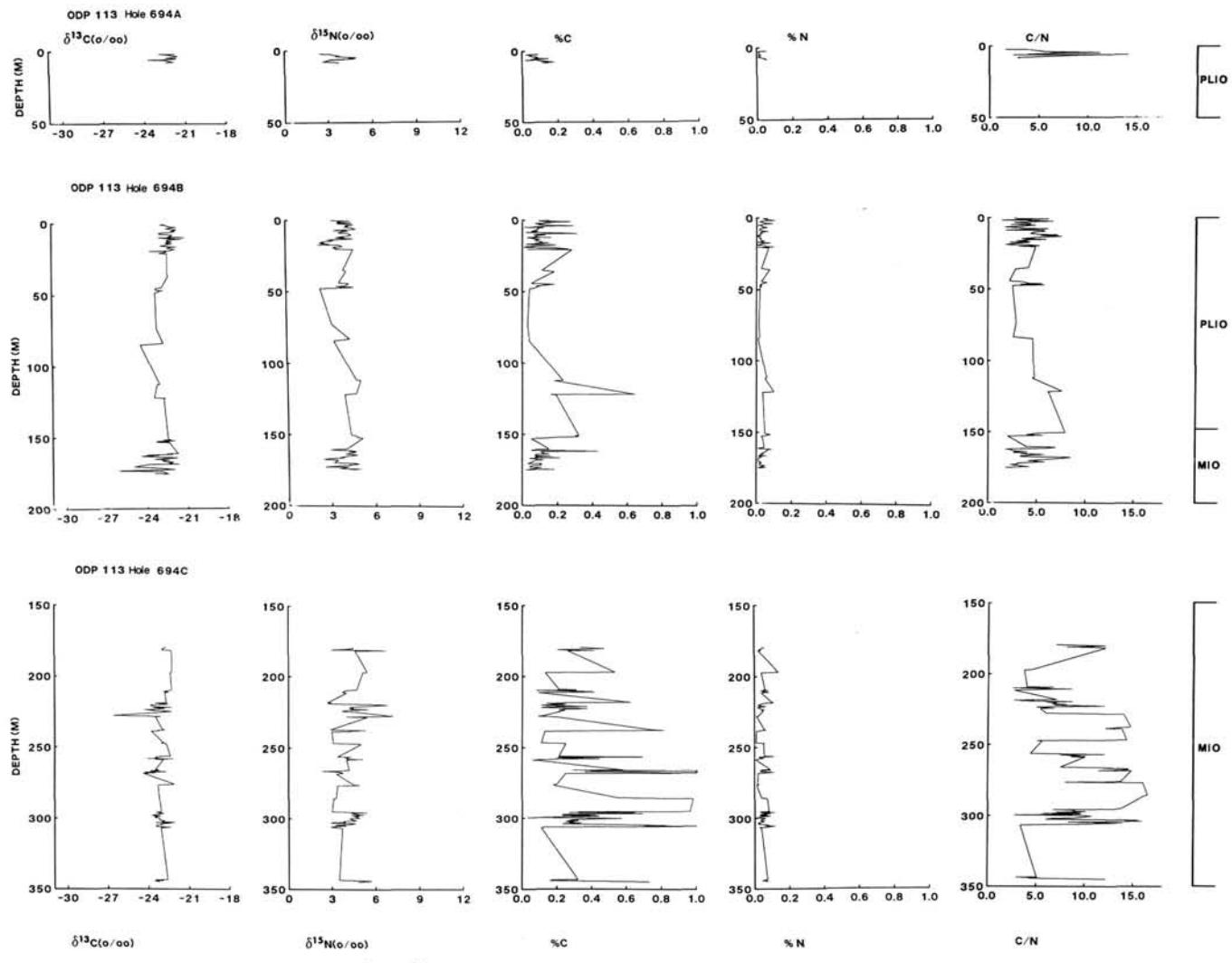
Figure 8. Site 694 individual core results: $\delta^{13}C$, $\delta^{15}N$, %organic C, %total N, and C/N vs. depth.
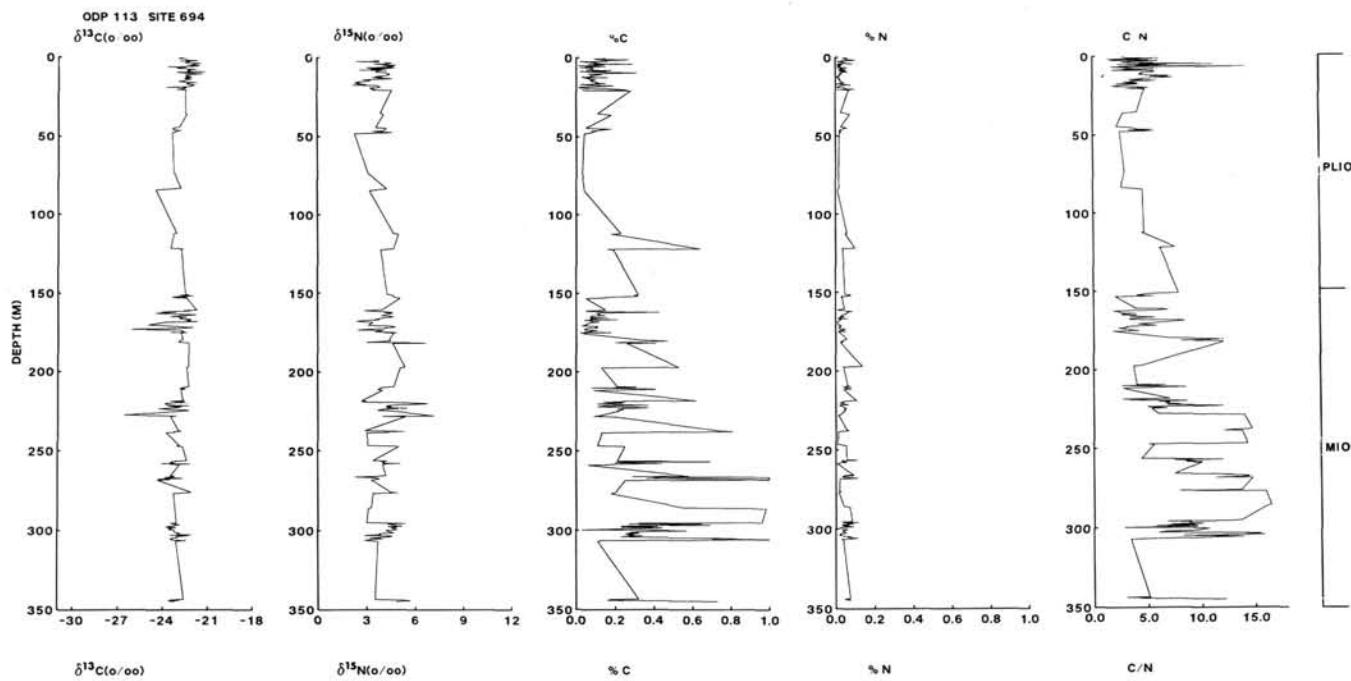
Figure 9. Site 694 composite core results: $\delta^{13}C$, $\delta^{15}N$, %organic C, %total N, and C/N vs. depth.