69. C_1-C_7 VOLATILE ORGANIC COMPOUNDS IN SEDIMENTS FROM DEEP SEA DRILLING PROJECT LEGS 56 AND 57, JAPAN TRENCH[1]

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ABSTRACT

Volatile C_1-C_7 components in sediments were examined for Japan Trench DSDP Sites 438, 439, 435, 440, 434 and 436, proceeding from west to east. Levels of all components are lowest in the highly fractured sediments of Sites 440 and 434. A number of alkenes, furans, and sulfur compounds were detected in concentrations higher than noted in any other DSDP sediments examined to date. The types, amounts, and specificity of occurrence are similar to those for 1-meter gravity cores we have examined which bear a significant biological imprint. Site 436 shows high levels of saturated and aromatic hydrocarbons, as well as olefins, including traces of dimethycyclopentanes and the highest level of cyclohexene detected in any DSDP sediment we have examined to date. The results from Site 436 were unexpected, considering the low organic-carbon content, absence of biogenic methane, and evidence of an aerobic depositional environment at this site.

INTRODUCTION

Examination of DSDP cores from a number of locations has shown the presence of small amounts of C_1-C_7 hydrocarbons (Hunt, 1975; Whelan and Hunt, 1978). In all cases, these compounds were found to be predominantly saturated alkanes or aromatic compounds, even in the shallowest samples examined (within the top 10 m in the case of the Black Sea, Leg 42B; Whelan and Hunt, 1978). Thus, the Japan Trench sediments examined in this work are unusual in showing compounds other than saturated and aromatic hydrocarbons—such as alkenes and furans—at depth.

METHODS AND RESULTS

Sediment C_1-C_7 hydrocarbons and other volatile compounds were examined by methods described previously (Whelan, 1979). Briefly, the technique involves sealing the frozen wet sediment in a can equipped with silicon-rubber septums. This can is shaken and heated after filling a volume of 450 ml with water and sediment (50–100 g) and a volume of 150 ml with helium. A gas sample is withdrawn from the headspace and examined by gas chromatography and gas chromatography-mass spectrometry. Identification of compounds is by comparison of mass spectra and GC retention times with authentic standards which were purchased or synthesized in our laboratory. Precision of the gas-chromatography analysis of 5 per cent (coefficient of variation) for amounts greater than 0.1 ng compound/g dry weight of sediment. Precision of duplicate sample analysis is 30 per cent (coefficient of variation) due to sample variation.

The results of analyses for standard and aromatic C_1-C_7 hydrocarbons are shown in Appendix 1. Appendix 2 shows C_1-C_7 components other than saturated and aromatic hydrocarbons—such as alkenes, furans, thiophenes, sulfides, and ketones. A summary of total amounts of various compound types—including C_1, C_2 + C_3, C_4-C_7, C_8, and other compounds—is also shown in Appendix 2.

Some of the results from Appendixes 1 and 2, shown graphically in Figures 1 through 5, are also summarized below, starting with sites farthest to the west and upslope, Site 438 and 439 on the western trench wall, and moving downslope to the east to Sites 435, 440, and 434. Finally, results from Site 436, on the east side of the trench, are shown.

Site 438

Site 438 primarily contained sediments described as "diatomaceous ooze," typical of most recovered from the Japan Trench area. The principal results obtained at this site are summarized in Figure 1. The sediments were predominantly anaerobic, as shown by the high methane levels throughout (see Figure 1 and Whelan and Sato, this volume). Organic-carbon levels were fairly uniform (0.5–1%) and showed little correlation with the other profiles shown in Figure 1.

Lithologically and geochemically, the hole can be divided into three distinct sections. The first, extending from 0 to 570 meters, contains undisturbed diatomaceous ooze and claystone. A second section extends from 570 to about 840 meters and is characterized by fractured, faulted sediments. In many of these, healed dewatering veins are evident (see Arthur, this volume;

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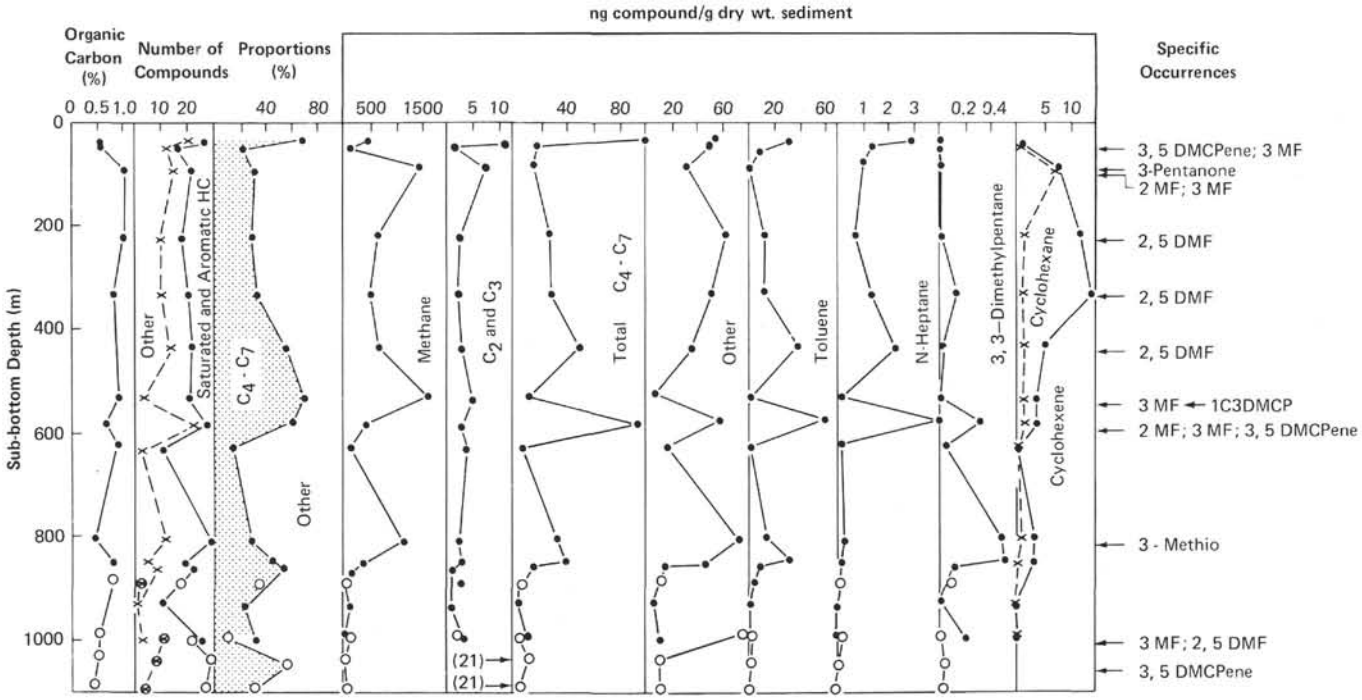

Figure 1. *Some C_1–C_7 volatile compounds in sediments from Sites 438 and 439. Open circles represent data from Site 439. "Specific Occurrences" shows depths at which the compounds indicated were detected. Abbreviations used: 3,5-dimethycyclopentene (3,5DMCPene); 2- and 3-methylfuran (2MF and 3MF); 2,5-dimethylfuran (2,5DMF); 3-methylthiophene (3 Methio); 1-cis-3-dimethylcyclopentane (1C3DMCP).*

Carson et al., this volume). A third section, from about 820 meters to the bottom of the hole at 888 meters in Hole 438A, no longer shows fractured sediments but is characterized by sandy and diatomaceous claystone. Sediments from Hole 438B commonly show locally developed veins and faults from 850 to 910 meters. Thus, all samples taken below 570 meters at this site show sedimentary evidence (fracturing, sand beds, etc.) of conditions which may have allowed greater water flow than normal in fine-grained, non-fractured sediments.

Sediments examined in the top, non-fractured, fine-grained section include the top seven shown in Figure 1. The deepest of these, 438A-50-4 (532 m) is about 50 meters above the fractured zone. Several trends can be seen in this section, Sample 438A-50-4 being anomalous. Methane appears to correlate fairly well with $C_2 + C_3$ content. A different pattern is seen for C_4–C_7, where toluene is a major contributor. The profiles of ΣC_4–C_7, toluene, and heptane all show a surface maximum followed by a sharp decrease and then a gradual increase. We have observed similar profiles for toluene in other DSDP sediments, as well as in a 1-meter gravity core taken from an organic-matter-rich, anaerobic diatom ooze from Walvis Bay. The profile for 3,3-dimethylpentane is also shown, because it has shown little or no correlation with other C_4–C_7 compounds. A similar result was found for the Black Sea (Leg 42B) by factor analysis (Whelan, unpublished results).

The "other compounds" shown in Figure 1 consist primarily of alkenes. The levels are much higher than observed at other DSDP sites, where only traces of these compounds have been detected below 100 meters. The amounts decrease with depth below a maximum at 223 meters (438A-18-3), with a concurrent increase in ΣC_4–C_7. A very unusual characteristic of sediments throughout this region is the high amount of cyclohexene, which shows an increase with depth to 332 meters. The levels detected here are much higher than observed in any other sediment we have examined—including both DSDP samples and 1-meter gravity cores. There seems to be no correlation of this compound with cyclohexane, which is shown in the same plot.

Specific occurrences of other compounds are also shown in Figure 1. These include 3,5-dimethylcyclopentane, 3-pentanone, 3-methyl furan, 2-methyl furan, and 2,5-dimethylfuran. These compounds have been observed in a diatomaceous, anaerobic 1-meter gravity core taken from Walvis Bay (Whelan and Hunt, 1978). They have not been detected in other DSDP cores.

Samples from below 570 meters show several differences from the shallower section. These include a drop in methane, except in 438A-79-3, at 806 meters. Toluene *n*-C_7 and ΣC_4–C_7 all show a marked increase in 438A-55-5, at 581.1 meters, followed by a sharp decrease and then a gradual increase below this level. In fact, the C_4–C_7 and toluene profiles look like a repeat of those found in the shallower section discussed above. The top sample in the lower section, 438A-55-5 (581 m), was taken at precisely the spot where dewatering structures first appeared at this site (see Arthur, this volume; Carson et al., this volume). Thus, the organic matter in

this middle section may have been subjected to some water flow, and possibly to partial bacterial degradation. The fractures in this section are described as rehealed; this rehealing may have prohibited total organic-matter breakdown. This hypothesis is supported by the low interstitial-water salinities detected in this section, which have been attributed to an ancient artesian flow (see von Huene, this volume; Nasu et al., this volume). These changes also correlate with the appearance of high levels of neopentane in core gas pockets (Whelan and Sato, this volume). The neopentyl skeleton probably has a bacterial source, possibly via bacterial degradation of terpenes (for discussion, see Whelan and Sato, this volume).

A decrease in levels of most compounds occurs below 840 meters. These sediments are described as more fractured or sandier than those above.

Compound diversity is also shown in Figure 1, as represented by the number of compounds detected. This parameter has been shown to have a high positive correlation with depth at most other DSDP sites we have examined. A similar trend is not obvious here.

Site 439

Site 439 can be considered to be a continuation of 438. The noted trends continue into Site 439, as shown by the open circles in Figure 1. Levels of methane remain low. There is some increase in C_2 and C_3 levels in the two deepest samples. C_4–C_7 levels remain low, as observed in the deeper sections of Site 438. Levels of "other" compounds also remain low, except in 439-21-2. Sporadic appearance of 3-methylfuran, 2,5-dimethylfuran, and 3,5-dimethylcyclopentene are also indicated in Figure 1. The paleontologists have correlated Section 438B-12-5 (936 m) with core 439-9-4 (893 m). The levels of C_1–C_7 organic components found here roughly agree with this correlation.

Site 435

Site 435 represents a non-fractured, generally diatomaceous sediment with a few thin vitric-ash beds. Only three samples were examined, in spite of generally good recovery, because of contamination of the core liners with grease. Results summarized in Figure 3 are from the three cores which showed no visual evidence of grease smears inside the core liner.

In spite of the small number of samples, some trends are apparent in Figure 2 which are similar to those for the other sites in this area. The sediments were anaerobic below 100 meters, as shown by recovery of cores with biogenic-methane pockets (Whelan and Sato, this volume). Methane levels seem to correlate with $C_2 + C_3$ levels. The C_4–C_7 levels do not correlate with C_1–C_3, and decrease with depth. The amount of "other" compounds (primarily representing low-molecular-weight alkenes) increases in the deepest section and represents over 90 per cent of the total. Toluene appears in higher concentration in the shallowest sample than in the two deeper ones, as observed for Site 438.

All these sediments are fairly shallow (sub-bottom depth less than 135 m) and relatively cold (less than 30°C; see Langseth, this volume), so that the observed trends probably are due predominantly to remnants of biological activity. This interpretation is supported by the core-gas-pocket data: C_1/C_2 showed a pronounced increase with depth (Whelan and Sato, this volume).

Some fairly specific compounds appear in these samples—for example, traces of cyclohexene in the middle section and traces of 3-methylfuran in all samples. One very interesting compound is 1-C-3-dimethylcyclopentane, which appears at a fairly high concentration in the shallowest section. This compound has been observed only rarely in other DSDP cores we have examined (Hunt, 1975; Whelan, 1979; Whelan and Hunt, 1978, and references cited therein). Appearance of very specific compounds is typical of shallow sediments (for example, in 1-meter gravity cores we have examined) where biological processes predominate over thermal ones.

Site 440

Site 440 represents a highly fractured diatomaceous section which is farther down the western Japan Trench wall slope than the sites described previously. Fracturing was more intense than at Site 438; the geophysical logs suggest that fractures from 400 to 600 meters were held open by high fluid pressure.

Some of the parameters measured at this site are summarized in Figure 3. Organic-carbon levels were fairly uniform—between 0.5 and 1 per cent. There appears to be fairly good correlation between C_1, $C_2 + C_3$, C_4–C_7, and toluene at this site. No correlation between C_1–C_3 and C_4–C_7 is observed at other sites in this area. In other DSDP sites we have examined (for example, the Black Sea, Leg 42B; the Canary Islands, Leg 47A; and Vigo, Spain, Leg 47B) it has been found that C_2–C_5 and C_6–C_7 hydrocarbons form two groups which show characteristic depth profiles.

Site 434 also represents a highly fractured section which is a little farther downslope than Site 440. The sediments at the two sites are very similar. Thus, if the sample from 434-1-3 (4 m, represented by open circles in Figure 3) is plotted in Figure 4 and is considered to represent a surface sediment for Site 440, it can be seen that both C_4–C_7 and toluene show higher levels in the surface sections than in deeper sections. The trend is similar to that seen at Site 438.

"Other compounds" consist primarily of low-molecular-weight alkenes and dimethyl sulfide. Concentrations are generally lower than those observed at Sites 438, 435, or 436. Of the total of the compounds measured, the percentage of C_4–C_7 increases to a maximum at 450 meters. At this depth, where the number of open fractures in the sediment increases (see Arthur and Carson, this volume), the per cent of "other compounds" increases.

A few profiles are shown in Figure 4 which do not seem to follow the ones mentioned before. These include 3,3-dimethylpentane, 2 methylpentane, 3-methylpentane, and, in the deeper part of the hole, *n*-heptane. Specific appearances of single compounds are also shown in Figure 4. Traces of cyclohexene were detected

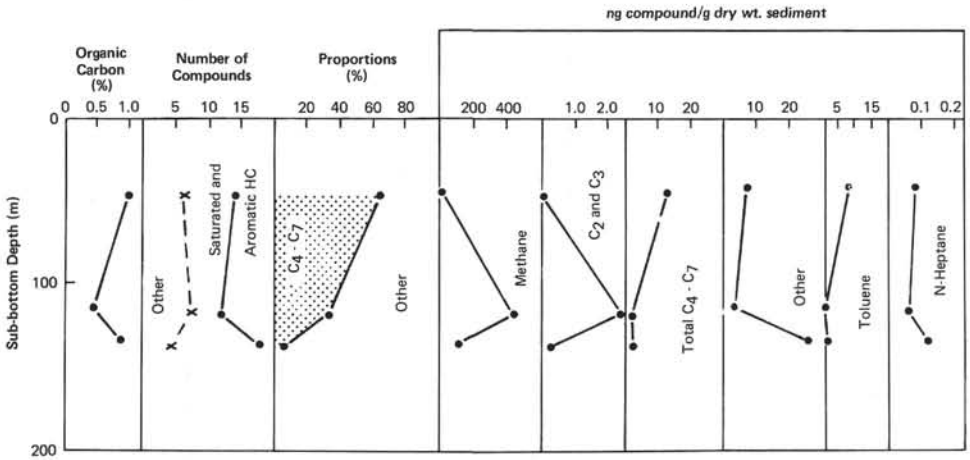

Figure 2. *Some C_1–C_7 volatile compounds from Site 435 sediments.*

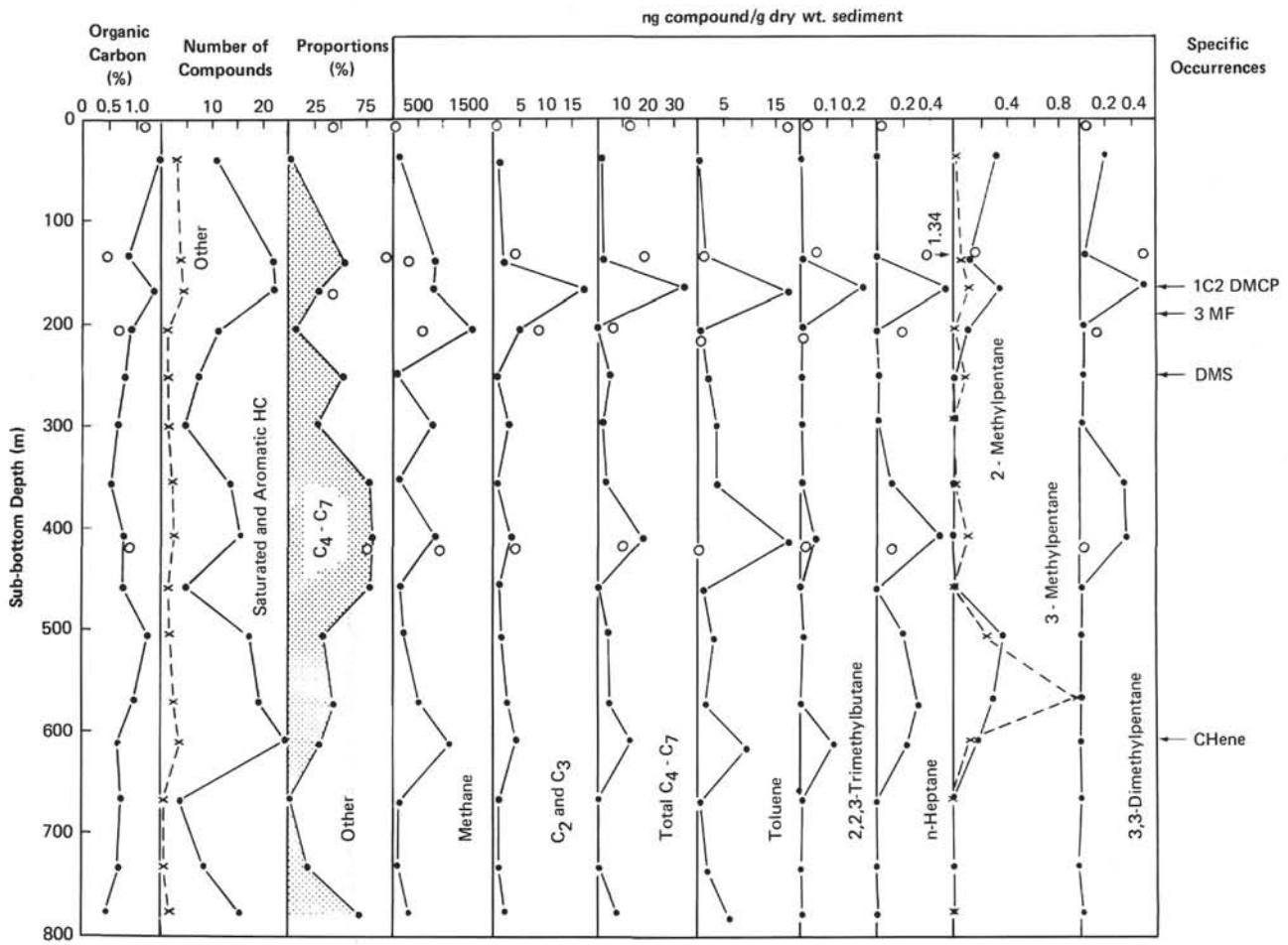

Figure 3. *C_1–C_7 volatile compounds from Site 440 sediments. Open circles indicate similar data for Site 434. Key to abbreviations: dimethylsulfide (DMS); cyclohexene (CHene); for others, see Figure 1.*

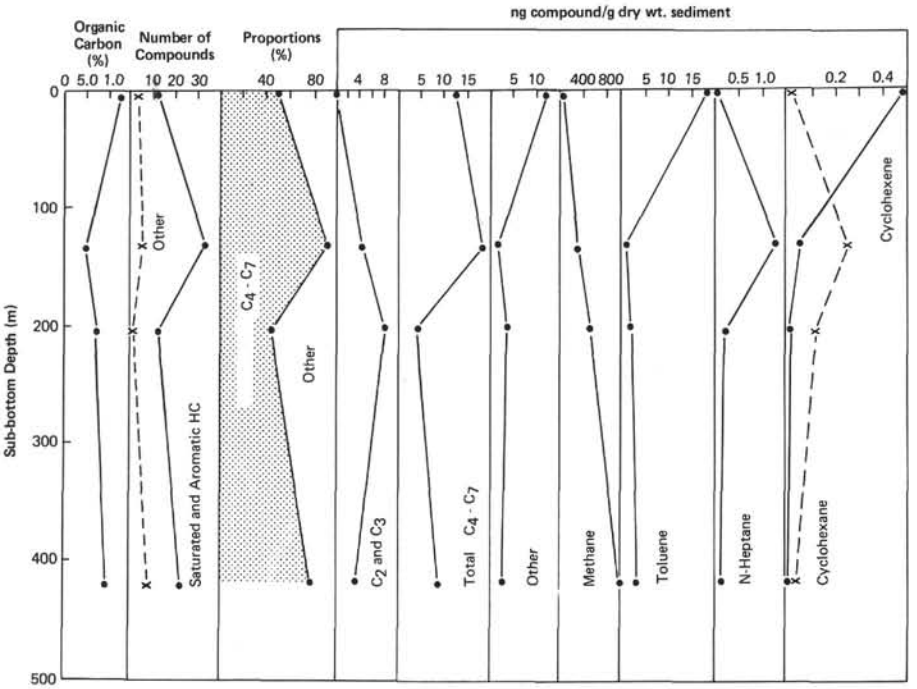

Figure 4. *C_1–C_7 volatile compounds from Site 434 sediments.*

in only one sample. Levels of all compounds decrease in 440B-56-3 (660 m), which is described as "highly fractured".

Site 434

Site 434 gave only a few samples, because of poor recover of the highly fractured sediments. Some of the results are shown in Figure 4, and together with the Site 440 data in Figure 3. It can be seen in Figure 4 that the concentrations of C_4–C_7 compounds generally correlate fairly well for the two sites.

In spite of the small number of samples, Figure 5 does show some of the trends seen at the other sites in this area. Toluene is high in the shallowest sample, drops, and then gradually increases with depth. It is the major C_4–C_7 component in the shallowest sample. The C_4–C_7 profile correlates with several other specific C_4–C_7 components, including *n*-C_7 and cyclohexane, which are shown in Figure 5. The C_1, C_2–C_3, and toluene profiles do not correlate with C_4–C_7. As mentioned before for Site 440, levels of all C_1–C_7 components and "other compounds" are generally lower than observed for Sites 438 and 436. The amount of "other compounds" (predominantly low-molecular-weight alkenes) is generally low, below the surface, as observed for other DSDP sites. Cyclohexene is present at the surface and then decreases with depth. Furans, thiophenes, and other volatile functionalized organic molecules were not detected in these samples.

Site 436

Site 436 is on the east wall of the Japan Trench, on the oceanic plate. The generally slower depositional rates are reflected in the common appearance of manganese nodules and small fish teeth, the low organic-carbon levels, and the absence of gas-pocket methane in the predominantly diatomaceous sediments. Sediment recoveries were generally excellent, little or no fracturing being evident.

Considering the low levels of organic carbon and the generally more-aerobic nature of these sediments compared to those from the west trench wall, surprisingly high levels and diversity of volatile organic components were detected, as shown in Figure 5 and Appendix 2. Levels of both C_4–C_7 and "other compounds" increase with depth, to a maximum at 172 meters, where levels of 40 ng/g and 120 ng/g, respectively, were found. These are comparable to the average values detected at Site 438, and to the highest values at Site 440. The profiles of individual components are different than observed for west-wall sites. For example, the profiles of toluene, 2,2-dimethylpentane, and *n*-heptane are similar and show an initial increase with depth, a leveling off, and then a decrease. Benzene and 2,2-dimethylbutane show different profiles, a maximum appearing deeper in the sediment column. Levels of C_1–C_3 were much lower than for west-wall sediments, as expected from the absence of gas pockets at this site. Compound diversity (number of "other" compounds in Figure 5) decreases with depth, in contrast to most other DSDP sites examined to date.

Both the absolute level and percentage of the total represented by "other compounds" are high as compared to other DSDP sites. "Other compounds" are generally 70 to 80 per cent of the total below 100 meters, and they increase with depth. This contrasts sharply with other DSDP sites, where saturated and aromatic compounds predominate in all sediments deeper than

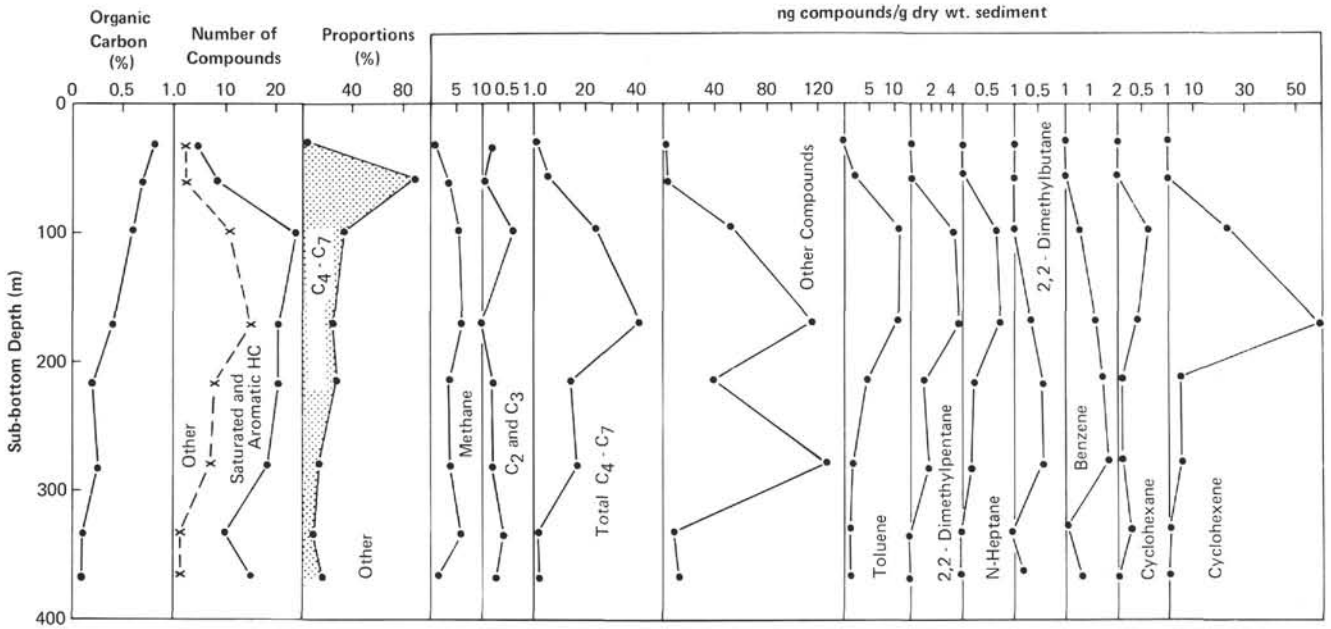

Figure 5. *C_1–C_7 volatile compounds from Site 436 sediments. Many specific occurrences of non-saturated or aromatic hydrocarbons are not shown because of the large diversity of compounds present (see Appendix 2).*

100 meters (Hunt, 1975). One of the dominant "other compounds" is cyclohexene, which reached very high levels—58 ng/g in 436-19-2 (172 m). This level is four times higher than the maximum at Site 438, the only other DSDP site where this compound has been detected in more than trace amounts. Some of the other compounds detected were low-molecular-weight alkenes, dimethylcyclopentenes, and methylfurans. The only sulfur compounds detected were thiophene in the shallowest sample and a small amount of dimethylsulfide in 436-7-4. Occurrences of many of these compounds were very specific. For example, 3-methylfuran was detected in 436-19-2. This compound has previously been detected in surface sediments (Whelan and Hunt, 1978) and is believed to be a terpene-degradation product since it is difficult to make by any chemical process (Miller, 1969). 1-C-3-dimethylcyclopentane was detected at fairly high concentration (17 ng/g) in the same sample. As mentioned earlier, this compound has been detected only rarely in other DSDP sediments. Several different dimethylcyclopentenes included the 3,5-; 1,3-; 1,4-; and 1,5-isomers. These compounds have not been detected previously in DSDP sediments, although they were found in a 1-meter gravity core of organic-matter-rich diatom ooze taken from Walvis Bay.

SUMMARY AND INTERPRETATION

As mentioned in the introduction, the most interesting result of this work was the appearance of compounds other than saturated and aromatic hydrocarbons (Appendix 2). We have looked for these olefinic and functionalized compounds in other DSDP samples; levels are generally much lower than found here. We have detected them as major volatile components in 1-meter gravity cores from such diverse areas as Walvis Bay (southwest Africa), the Persian Gulf and Arabian Sea (Whelan and Hunt, 1978), and Barnstable Marsh (Cape Cod, Massachusetts). In these very young sediments, it is probable that these molecules result from biological processes.

Similar arguments may apply to some of the Japan Trench sediments. The high degree of fracturing may have allowed flow of both water and organisms through these sediments. Since geothermal gradients suggest that these sediments remained cool (see Langseth, this volume), these compounds may have remained as indicators of past biological activity. Some specific features of the data which might be best explained as consequences of biological activity include:

1. The abrupt increase in many compounds at 600 meters in Hole 438A at the top of the section where rehealed fractures were noted (Figure 1; see Arthur and Carson, this volume).

2. The sporadic appearance of specific compounds—for example, 1-C-3-dimethylcyclopentane and cyclohexene—as the major components in 436-19-2. This type of specificity is more typical of the surface sediments we have examined than of deeper DSDP samples. Such specificity is more typical of biological than of chemical or thermal processes.

3. The relatively high levels of C_4–C_7-saturated and aromatic compounds and alkenes at Site 436, in spite of low organic-carbon levels. There is evidence of slower deposition rates for these sediments, as well as black staining of minerals from activities of sulfate-reducing micro-organisms through most of the hole.

4. The high levels of alkenes, particularly at Sites 436 and 438. These compounds previously were found to be

the major volatile components in 1-meter gravity cores taken from the Persian Gulf (Whelan and Hunt, 1978). In many of the Persian Gulf cores, concentrations of olefins were highest at the sediment/water interface, where the micro-organisms are most active.

5. High levels of toluene in the surface at Sites 438, 434, and 435, followed by a sharp drop. Toluene then increases again at 600 meters at Site 438 where rehealed fractures begin. This compound can be produced in many ways. However, we have consistently observed it as a major component in organic-matter-rich reducing sediments, such as at Walvis Bay, the Peru Basin, the Cariaco Trench, and the Black Sea. Studies in this laboratory have shown that anaerobic bacteria from a marine innoculum can produce toluene from carotene within a week. (Miller, Hunt, and Whelan, unpublished data). Thus, toluene also may have a bacterial source in some surface sediments.

There is no question that gradual diagenetic changes (chemical changes occurring at less than 50°C) are responsible for many changes in sediment organic matter. However, in these colder sediments, a microbial imprint seems probable—especially considering evidence for artesian water flow and sediment fracturing in westwall sediments, and the more aerobic depositional conditions in the case of Site 436. Aerobic microbial degradation of hydrocarbons has been documented widely in places where oxygenated surface water comes in contact with petroleum accumulations (Tissot and Welte, 1978, pp. 413–419, and references cited therein). Degradation of organic matter by the anaerobic sulfate-reducing microorganisms is also well known (Tissot and Welte, 1978, pp. 415–416).

We may be observing an intermediate stage of this degradation process in many of these sediments. Thus, as the bacterial population decreases as essential nutrients are used by the organisms, fracture healing or burial may lock in remaining compounds as indicators of past biological processes.

ACKNOWLEDGMENTS

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APPENDIX 1
SATURATED AND AROMATIC C_1-C_7 SEDIMENT HYDROCARBONS, DSDP LEGS 56 and 57, JAPAN TRENCH

Section	434-1-3	434-15-3	434-23-3	434B-15-1	435-5-4	435-13-2	435-15-2	436-4-3
Sub-Bottom Depth (m)	4	133	207	419	43.5	115	133.8	32.8
Lithology	Diatom. Ooze	Diatom Mudstone	Diatom Mudstone	Vitric Diatom Mudstone	Diatom Ooze	Diatom Mud	Diatom Mud	Diatom Mud and Vitric Ash
Age	L. Pleist.	E. Plio.	E. Plio.	E. Plio.	Pleist.	Plio.	Plio.	Quat.
Compound	(ng compound/g dry wt. sediment)							
Methane	17	300	515	900	4.2	446	89	3.9
Ethane	0	1.6	7.9	2.8	0.1	1.46	0.15	0.17
Propane	0	2.8	0.49	0.39	0	0.87	0.12	0
i-Butane	0	0.66	0	0.22	0	0	0	0
n-Butane	0	0.71	0	0.14	0	0.37	0.18	0
i-Pentane	0	0.01	0	0.12	0	0	0	0
n-Pentane	0	0.01	0.01	5.4	0	0	0	0.01
Cyclopentane	0	0.17	0.01	0	0	0.05	0	0.01
2,2-Dimethylbutane	0	0.45	0.21	0.22	0.22	0	0.57	0
2,3-Dimethylbutane	0.34	0.40	0.17	2.42	0.01	0.05	0.01	0
2-Methylpentane	0	0.33	0.16		0.03	0.10	0.01	0
3-Methylpentane	0.01	0.32	0	0.05	0.05	0.09	0.08	0
n-Hexane	0	0.17	0.13	0.05	0.11	0.10	0.4	0
Methylcyclopentane	0	0.19	0.1	0	0	0.5	0.1	0
2,2-Dimethylpentane	0	0.20	0	0	0	0	0	0
2,4-Dimethylpentane	0	0.14	0	0.30	0	0	0	0
Benzene	0	0.16	2.4	0	0.25	0	0.16	0
2,2,3-Trimethylbutane	0.01	0.09	0.01	0.01	0	0	0	0
Cyclohexane	0.01	0.23	0.1	0.01	0.70	0	0.01	0
3,3-Dimethylpentane	0	0.46	0.08	0	0	0	0	0
1,1-Dimethylcyclopentane	0	0.19	0.08	0.01	0	0	0	0
2-Methylhexane	0	1.16	0.13	0.01	0	0	0.01	0
2,3-Dimethylpentane	0	1.63	0.19	0.01	0	0	0	0
1-C-3-Dimethylcyclopentane	0	0	0	0	3.48	0	0	0
3-Methylhexane	0	3.1	0.22	0	0	0.21	0.01	0
1-t-3-Dimethylcyclopentane	0.01	0.27	0.10	0.01	0	0	0.01	0
1-t-2-Dimethylcyclopentane	0.01	0.65	0.17	0.01	0	0	0.01	0
3-Ethylpentane	0.01	0.47	0.15	0.01	0.04	0	0.05	0
n-Heptane	0.01	1.34	0.18	0.08	0.08	0.05	0.11	0
1-C-2-Dimethylcyclopentane	0	0.26	0	0	0	0	0	0
Methylcyclohexane	0.66	4.3	0.07	0	0.04	0	0	0
Ethylcyclopentane	0	0.19	0	0	0	0	0	0
Toluene	11.7	0.53	0	0	7	0	0	0

APPENDIX 1 – *Continued*

436-7-4	436-11-4	436-19-2	436-24-1	436-31-1	436-36-3	436-39-5	438-5-3	438-10-4
61	99	172.1	218.2	284.5	335 m	366.7	37.5	86.5
Diatom–Vitric Mud (Disturbed)	Diatom–Vitric Mud (Mottled)	Diatom-Vitric Mud (Brecciated)	Diatom-Vitric Mud (Brecciated)	Vitric Diatom Mudstone	Radiolarian Diatom Mudstone	Pelagic Clay and Mn Nodules	Mud, Silt, Sand, Wood Frag.	Silty Diatom Clay and Ash
Quat.	Plio.	Plio.	Plio.	E. Mio.	M. Mio.	Mio.–Cret.	Pleis.	Plio.
(ng compound/g dry wt. sediment)								
3.0	5.0	5.8	3.2	4.36	5.7	1.9	442	1493
0	0.34	0	0.11	0.16	0.41	0.22	5.0	4.36
0	0.24	0	0.07	0	0	0.04	5.94	3.06
0	0	0	0.58	0	0	0	1.75	0.35
0	0	0	0	0	0	0	8.76	2.63
0	0	0	0	0	0	0	0.77	0.01
0	0	0	0	0	0	0	1.93	Tr
0	0	0	0	0	0	0.01	0	0
0	0	0.37	0.61	0.64	0	0.14	3.1	0
0.2	0.62	0.62	0.51	0.35	0	0	0.67	0.08
0	0.32	0.49	0.17	0.22	0	0	1.25	0.53
0.1	0.32	0.58	0.33	0.23	0	0.01	3.7	0.9
0	0.56	0.46	0.48	0.41	0	0.01	2.56	0.8
0.01	0.01	0.10	0	1.71	0	0	0.22	1.23
0	4.2	4.84	1.39	1.65	0	0	0.63	0.49
0	0	0.17	0.50	5.40	0	0	0	n.d.[a]
0	0.50	1.05	1.40	1.63	0	0.60	1.24	1.10
0	1.1	1.11	1.38	0.96	0	0	0.14	n.d.[a]
0	0.56	0.37	0.10	0.08	0.27	0	0.16	7.41
0.22	0.1	0.13	0	0	0	0.01	0	0
0	0.1	0	0	0	0	0	0	1.38
0	0.60	0.36	0.18	0.23	0.01	0.01	1.20	0.26
0	0.81	0.81	0.28	0.37	0.01	0.01	0.08	0
0	0	16.9	0.86	0	0	0	0	0
0.24	0.7	0	0.4	0.39	0.01	0.01	1.14	0.39
0	0.13	0	0	0	0.01	0	0.83	0.27
0	0.18	0	0	0	0.01	0	0.35	0.10
0	0.08	0.12	0	0	0	0	1.40	0.49
0	0.69	0.72	0.21	0.20	0.01	0.01	2.9	1.05
0	0.01	0	0	0	0	0	0	0
0.44	1.07	0.13	0	0	0.21	0.11	0.21	0
0	0	0	0	0	0	0	0	0
1.6	10.8	10.2	4.61	1.94	0	0.77	33	1.5

APPENDIX 1 – *Continued*

Section	438A-4-4	438A-18-2	438A-29-5	438A-40-5	438A-50-4	438A-55-5	438A-65-5	438A-79-3
Sub-Bottom Depth (m)	47.6	223	332	436.7	531.6	581.1	676	806
Lithology	Complex Diatom Silty Clay	Homogeneous Diatom Clay	Mottled Diatom Ooze	Mottled Diatom Claystone	Mottled Diatom Claystone	Mottled Diatom Claystone	Diatom Claystone (Disturbed)	Diatom Claystone (Burrowed)
Age	L. Plio.	Plio.	Plio.	L. Mio.	L. Mio.	L. Mio.	M. Mio.	M. Mio.
Compound	(ng compound/g dry wt. sediment)							
Methane	4.43	606	511	690	1689	427	167	675
Ethane	0.48	1.34	1.14	1.63	4.02	1.51	2.6	1.22
Propane	0.33	0.47	0.53	0.86	0.77	1.02	0.57	0.79
i-Butane	0	0	0	0	0	0	0	0.38
n-Butane	0.71	0	0	0.13	0.49	0.82	0.37	0.63
Neopentane	0	0	0	0	0	0	0	0
i-Pentane	0	0	0	0	0	0	0	0.28
n-Pentane	0	0	0	0.08	0	0.70	0.05	0.54
Cyclopentane	0	0	0	0	0	0	0	0.01
2,2-Dimethylbutane	0.88	0.88	0.40	0.53	0	0.75	0.08	0.50
2,3-Dimethylbutane	0.29	0.77	0.11	0.16	0.27	0.37	0	0.3
2-Methylpentane	0.26	2.24	0.73	0.87	0.19	1.6	0	0.7
3-Methylpentane	0.48	2.44	0.38	0.59	0	0	0	0.6
n-Hexane	0.22	1.45	0.5	1.27	0.16	2.3	0	0.54
Methylcyclopentane	0	1.02	0	0	0.71	0.38	0	0.44
2,2-Dimethylpentane	0.23	1.68	1.45	1.24	1.19	0.9	0	0.50
2,4-Dimethylpentane	0	0.2	0	0	0.80	0.19	0	0
Benzene	0.96	1.13	4.15	0.85	2	8	0	1
2,2,3-Trimethylbutane	0	0.23	0.46	0.13	0.06	0.30	0	0.10
Cyclohexane	0	0.66	0.18	0.7	0.50	1.2	0	0.08
3,3-Dimethylpentane	0	0	0.1	0	0	0.3	0.01	0.55
1,1-Dimethylcyclopentane	0	0	0.1	0	0.26	0.16	0	0.01
2-Methylhexane	0.24	0	0.31	0.51	0.04	2.4	0	0.10
2,3-Dimethylpentane	0	0.64	0.68	0.1	0.17	1.3	0	0.24
1-C-3-Dimethylcyclopentane	0	0	0	0	0.14	0	0	0
3-Methylhexane	0.22	0.05	0.34	0.3	0.14	3.6	0	0.15
1-t-3-Dimethylcyclopentane	0	0	0.13	0	0	0.16	0	0.02
1-t-2-Dimethylcyclopentane	0	0	0.30	0.1	0	0.78	0	0.02
3-Ethylpentane	0.1	0	0.24	0.35	0	1.4	0	0.12
n-Heptane	1.08	0.76	1.27	2.18	0.19	4.0	0.04	0.31
1-C-2-Dimethylcyclopentane	0	0	0	0	0	0.21	0	0
Methylcyclohexane	0	0.41	0.76	0.34	0	3.80	0.03	0.18
Ethylcyclopentane	0	0	0	0	0	0.39	0	0
Toluene	8.5	12	12	38	1.5	60	2	14

APPENDIX 1 – *Continued*

438A-84-1	438B-4-6	438B-12-5	438B-19-2	439-9-4	439-21-2	439-25-4	439-31-5	440-5-6	440A-7-6
850.5	858.7	935.7	997.2	893	994.5	1035.6	1093	42.5	138.6
Diatom Claystone-Sand Fractures	Intensely Mottled Diatom Claystone	Diatom Vitric, Silty, Sandy Claystone	Clayey Siltstone	Burrowed Claystone–Dewatering Veins	Clayey Siltstone	Clayey Siltstone, Shells, Wood, Pyrite	Calcite-Cemented Sandstone	Diatom Claystone, Silt and Sand	Diatom Claystone, Silt and Sand
M. Mio.	M. Mio.	Olig.	Olig.	M. Mio.	Olig.	L. Cret.	L. Cret.	Pleis.	Pleis.
(ng compound/g dry wt. sediment)									
383	135	134	22	26	87	23	21	115	842
1.52	0.34	0.54	2.72	1.6	2.2	16.6	17.6	0.13	1.55
1.02	0.30	0.32	0.34	0.49	0.67	4.0	2.9	0.01	0.32
0	0	0	0.04	0	0.23	0.71	0.37	0.19	0.37
0	0	0	0.10	0	0.83	1.37	0.44	0	0.20
0	0	0	0.32	0	0	0	0		
0	0	0	0.13	0	0	0.75	0.13	0.01	0
2.30	1.09	0	0.39	2.32	0.01	3.96	0.78	0.16	0
0	0.05	0	0	0	0	0	0.01	0	0
0.27	0.04	0.01	0.95	0.77	1.34	0.08	0.42	0	0.05
0.04	0.1	0	0.05	0.01	0.15	0.14	0.01	0	0.19
0.09	0.2	0	0.03	0.03	0.3	0.11	0.02	0.31	0.1
0.05	0.15	0	0.03	0.03	0.55	0.13	0	0	0.08
0.25	0.19	0	0.02	0.05	0.44	0.08	0.06	0.08	0.05
0.23	0.05	0	0.02	0	0	0.11	0.06	0	0
0.3	0.04	0	0	0	0.06	0.01	0.02	0.54	0
0	0	0	0	0	0	0.01	0	0	0
1.5	3.3	0.14	0.46	0.54	0.12	0.5	0.13	0	0.01
0	0	0	0.02	0	0	0.02	0.02	0	0.01
0	0.01	0	0	0	0.07	0.09	0.05	0.17	0.01
0.51	0.09	0	0.18	0.07	0	0.01	0.01	0.17	0.01
0	0	0	0	0	0	0.02	0.02	0	0.01
0.19	0.08	0.01	0	0.07	0.04	0.03	0.08	0	0.01
0.05	0.03	0	0.02	0	0	0.07	0.02	0	0.01
0	0	0	0	0	0	0	0	0	0.01
0.02	0.03	0.005	0.02	0.06	0.05	0.06	0.02	0	0.01
0	0	0	0.02	0	0.05	0.04	0.01	0	0.01
0	0	0	0.01	0	0.03	0.01	0.02	0	0.01
0.01	0.04	0	0.02	0.05	0.08	0.04	0.01	0	0.01
0.17	0.06	0.005	0.02	0.07	0.08	0.04	0.02	0	0
0	0	0	0	0	0	0	0	0	0
0.08	0.15	0.03	0.02	0.07	0	0.03	0.09	0.01	0.01
0	0	0	0	0	0	0	0	0	0
32	9	1.7	2.3	4.9	1.7	3.0	2.1	0	0.37

APPENDIX 1 – *Continued*

Section	440B-3-5	440B-8-4	440B-12-4	440B-17-5	440B-23-4	440B-29-3
Sub-Bottom Depth (m)	165.1	211.6	249.5	298.6	354.1	409.5
Lithology	Diatom Clay	Diatom Clay, Sand and Silt	Silty Claystone, Tuffs	Burrowed Silty Claystone	Mottled Diatom Claystone	Mottled Diatom Claystone
Age	Pleis.	Pleis.	Pleis.	Plio.-Pleis.	L. Plio.	Plio.
Compound	(ng compound/g dry wt. sediment)					
Methane	803	1596	127.2	788	151	821
Ethane	16	4.0	0.17	2.0	0.13	2.39
Propane	2.3	0.81	0	0.23	0.12	0.76
i-Butane	0.90	0	0	0	0	0.01
n-Butane	2.1	0	0	0	0	0.01
i-Pentane	1.18	0	0	0	0	0
n-Pentane	0.85	0	0	0	0	0
Cyclopentane	0.07	0	0	0	0	0
2,2-Dimethylbutane	0	0.01	0	0	0	0
2,3-Dimethylbutane	2.0	0.09	0	0	0	0.1
2-Methylpentane	0.35	0.09	0	0	0.01	0
3-Methylpentane	0.08	0	0.05	0	0	0.1
n-Hexane	0	0	0	0	0	0
Methylcyclopentane	0	0	0	0	0.01	0
2,2-Dimethylpentane	0	0	0	0	0	0
2,4-Dimethylpentane	0	0	0	0	0	0
Benzene	0	0	0	0	0	0
2,2,3-Trimethylbutane	0	0	0	0.01	0.01	0.05
Cyclohexane	0.71	0.01	0.01	0	0	0.02
3,3-Dimethylpentane	0.47	0	0	0	0.33	0.32
1,1-Dimethylcyclopentane	0.69	0.01	0	0	0	0
2-Methylhexane	1.5	0.01	0.01	0	0	0
2,3-Dimethylpentane	0.56	0.01	0.01	0	0.01	0
1-C-3-Dimethylcyclopentane	0	0	0	0	0	0
3-Methylhexane	2.9	0.01	0.01	0	0.01	0.01
1-t-3-Dimethylcyclopentane	0.19	0	0	0	0	0
1-t-2-Dimethylcyclopentane	0.23	0	0	0	0.01	0.01
3-Ethylpentane	0	0	0	0	0.01	0.01
n Heptane	0.54	0	0	0	0.1	0.46
1-C-2-Dimethylcyclopentane	0.15	0	0	0	0	0
Methylcyclohexane	2.7	0.01	0.01	0	0.1	0.01
Ethylcyclopentane	0.08	0	0	0	0	0
Toluene	18[b]	0	1.6	3.0	3.0	18[b]
Total C_8	0	0	0	0	0	0

APPENDIX 1 – *Continued*

440B-34-3	440B-39-3	440B-46-3	440B-51-3	440B-56-3	440B-63-3	440B-68-2
457	504.5	571.1	618.6	666.0	732	778.7
Diatom Claystone, Dewatering Veins	Mottled Diatom Claystone	Mottled and Fractured Diatom Claystone	Mottled and Fractured Diatom Claystone	Highly Fractured Diatom Clay	Highly Fractured Diatom Clay and Tuff	Silty Claystone (Bioturbated and Brecciated)
Plio.	Plio.	Plio.	E. Plio.	L. Mio.		
(ng compound/g dry wt. sediment)						
180	215	514	1124	132	108	289
0.36	0.78	1.25	3.61	0.20	0.18	1.54
0.32	0.44	0.86	0.81	0.15	0.30	0.20
0	0	0	0	0	0	0
0	0	0.17	0.16	0	0	0
0	0	0	0.17	0	0	0
0	0	0	0.22	0	0	0.80
0	0.01	0.3	0	0	0.01	0
0	0	1.1	0.72	0	0	0
0	0.01	0	0.05	0	0.01	0
0	0.39	0.3	0.2	0	0.01	0.01
0	0.24	0.88	0.12	0	0.01	0.01
0	0.50	0.36	0.60	0	0	0.01
0	0	0.06	0.01	0	0	0.13
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0.16	0	0	0.22
0	0.01	0.01	0.14	0	0	0
0	0	0.01	0.05	0	0	0
0.01	0	0	0	0	0	0.01
0	0.01	0	0	0	0	0
0	0.01	0.01	0.34	0.01	0.01	0.01
0	0.01	0.01	0.1	0	0	0
0	0	0	0	0	0	0
0	0.01	0.01	0.16	0	0	0.01
0	0	0	0.01	0	0	0
0	0.01	0.01	0.01	0	0	0
0	0.01	0.01	0.18	0	0	0.01
0	0.2	0.3	0.24	0	0	0.01
0	0	0	0	0	0	0
0	0.01	0.16	0.18	0	0	0.01
0	0	0	0	0	0	0
0.4	2.5	1.0	9.1	0	1.8	5.9
0	0	0	2.8	0	0	1.5

[a]Not determined.
[b]Includes 3-methylthiophene.

APPENDIX 2
COMPOUNDS OTHER THAN SATURATED AND AROMATIC HYDROCARBONS AND TOTAL AMOUNTS IN VARIOUS VOLATILE COMPOUNDS, DSDP LEGS 56 AND 57, JAPAN TRENCH

Section	434-1-3	434-15-3	434-23-3	434B-15-1	435-5-4	435-13-2	435-15-2	436-4-3	436-7-4
Sub-Bottom Depth (m)	4	133	207	419	43.5	115	133.8	32.8	61
Lithology	Diatom Ooze	Diatom Mudstone	Diatom Mudstone	Vitric Diatom Mudstone	Diatom Ooze	Diatom Mud	Diatom Mud	Diatom Mud, Vitric Ash	Diatom-Vitric Mud (disturbed)
Age	L. Pleis.	E. Plio.	E. Plio.	E. Plio.	Pleis.	Plio.	Plio.	Quat.	Quat.
Compound	(ng compound/g dry wt. sediment)								
Ethylene	0	0	0	0	0	0	0	0	0
Propylene	0	0	0	0.18	0	0	0	0	0
Cyclohexene	0.49	0.05	0	0	0	0.1	0	0	0
1-Methylcyclopentene	0	0	0	0	0.06	0	0	0	0
Methylmethylenecyclopentane	0	0	0	0	0	0	0	0	0
3,5-Dimethylcyclopentene(A)[a]	0	0	0	0	0	0	0	0	0
3,5-Dimethylcyclopentene(B)[a]	0	0	0	0	0	0	0	0	0
1,3-Dimethylcyclopentene	0	0	0	0	0	0	0	0	0
1,4-Dimethylcyclopentene	0	0	0	0	0	0	0	0	0
1,5-Dimethylcyclopentene	0	0	0	0	0	0	0	0	0
1,2-Dimethylcyclopentene	0	0	0	0	0	0	0	0	0
Miscellaneous C_4–C_6 Alkenes	15.4	0.85	3.5	3.5	7.0	2.4	26.3	0.01	1.7
2-Methylfuran	0	0	0	0	0	0	0	0	0
3-Methylfuran	0	0	0	0	0.01	0.06	0.08	0	0
2,5-Dimethylfuran	0	0	0	0	0	0	0	0	0
3-Methylbutanal	0	0	0	0	0	0.1	0	0	0
3-Pentanone	0	0	0	0	0	0	0	0	0
Thiophene	0	0	0	0	0	0	0	1.6	0
Dimethylsulfide	0	0	0	0	0	0	0	0	0.6
2-Methylthiophene	0	0	0	0	0	0	0	0	0
3-Methylthiophene	0	0	0	0	0	0	0	0	0
Totals									
Organic Carbon (%)	1.2	0.5	0.7	0.9	0.97	0.44	0.87	0.8	0.7
ng C_1/g dry wt. sediment	17	300	515	900	4.2	446	88.7	3.9	3
ng (C_2+C_3)/g dry wt. sediment	0	4.4	8.4	3.2	0.11	2.3	0.27	0.2	0
ng $\Sigma(C_4–C_7)$/g dry wt. sediment	12.7	18.6	4.6	9.0	12.0	1.5	1.7	Tr	2.8
ng ΣC_8/g dry wt. sediment	0	0.64	0	0	0	0	0	0	0
ng Σ other/g dry wt. sediment	15.9	0.9	3.5	3.7	7.1	2.7	26.4	1.6	2.3
Number saturated alkanes	11	32	23	22	14	12	18	4	8
Number other compounds	3	5	1	7	6	4	4	2	2

APPENDIX 2 – *Continued*

Section	438A-18-2	438A-29-5	438A-40-5	438A-50-4	438A-55-5	438A-65-5	438A-79-3
Sub-bottom Depth (m)	223	332	436.4	531.6	581.1	676	806
Lithology	Diatom Clay	Mottled Diatom Ooze	Mottled Diatom Ooze	Mottled Diatom Claystone	Mottled Diatom Claystone	Diatom Claystone (disturbed)	Burrowed Diatom Claystone
Age	Plio.	Plio.	L. Mio.	L. Mio.	L. Mio.	M. Mio.	M. Mio.
Compound	(ng compound/g dry wt. sediment)						
Ethylene	0	0	0	0	0	0	0
Propylene	0	0	0	0	0	0	0
Cyclohexene	11.9	14.0	4.8	3.3	3.9	0.61	3.2
1-Methylcyclopentene	0	0.1	0.09	0	0.35	0	0.2
Methylmethylcyclopentane	0	0	0	0	0	0	0
3,5-Dimethylcyclopentene(A)[a]	0	0	0	0	0.3	0	0
3,5-Dimethylcyclopentene(B)[a]	0	0	0	0	0	0	0
1,3-Dimethylcyclopentene	0	0	0	0	0	0	0
1,4-Dimethylcyclopentene	0	0	0	0	0	0	0
1,5-Dimethylcyclopentene	0	0	0	0	0.2	0	0
1,2-Dimethylcyclopentene	0	0	0	0	0	0	0
Miscellaneous C_4–C_6 Alkenes	48.7	37.0	30.4	0.75	52	14.2	69.8
2-Methylfuran	0	0	0	0	0.19	0	0
3-Methylfuran	0	0	0.11	0	0.9	0	0
2,5-Dimethylfuran	0.51	0.3	0.3	0	0	0	0.15
3-Methylbutanal	0	0	0	0	0	0	0
3-Pentanone	0	0	0	0	0	0	0
Thiophene	0	0	0	0	0	0	0
Dimethylsulfide	0	0	0	0	0	0	0
2-Methylthiophene	0	0	0	0	0	0	0
3-Methylthiophene	0	0	0	0	0	0	9
Totals							
Organic Carbon (%)	1	0.8	n.d.[b]	0.9	0.6	0.9	0.4
ng C_1/g dry wt. sediment	606	511	690	1689	427	167	675
ng (C_2+C_3)/g dry wt. sediment	1.8	1.7	2.5	4.8	2.5	3.2	2
ng $\Sigma(C_4–C_7)$/g dry wt. sediment	26.6	25.6	48.5	8.8	95.6	2.6	22.0
ng ΣC_8/g dry wt. sediment	0	0	18	0	17.6	2	0
ng Σ other/g dry wt. sediment	61	51	36	4.0	58	14.8	82
Number saturated alkanes	19	23	22	20	28	10	29
Number other compounds	10	10	13	4	21	3	12

APPENDIX 2 – *Continued*

436-11-4	436-19-2	436-24-1	436-31-1	436-36-3	436-39-5	438-5-3	438-10-4	438A-4-4
99	172.1	218.2	284.5	335	366.7	37.5	86.5	47.6
Diatom-Vitric Mud (mottled)	Diatom-Vitric Mud (brecciated)	Diatom-Vitric Mud (brecciated)	Vitric Diatom Mudstone	Radiolarian Diatom Mudstone	Pelagic Clay, Mn Nodules	Mud/Silt/Sand, Wood Fragments	Silty Diatom Clay, Ash	Complex Diatom Silty Clay
Plio.	Plio.	Plio.	E. Mio.	M. Mio.	Mio–Cret.	Pleis.	Plio.	L. Plio.
(ng compound/g dry wt. sediment)								
0	0	0	0	0	0	4.0	0	0.01
0	0	0	0	0	0	0	0	0
22.6	58.4	4.6	5.4	0	0	0.19	7.4	0.68
0	0	0	0	0	0	0	0	0
0.25	0	0.15	0.19	0	0	0.13	0	0
0.2	0	0	0	0	0	7.1	0	0
0.1	0	0	0	0	0	0	0	0
0	0.03	0	0	0	0	0.07	0	0
0	0.03	0	0	0	0	0.15	0	0
0	0	0	0	0	0	0.09	0	0
0	0	0	0	0	0	0	0	0
28.5	66.7	34.3	122.8	7.0	9.2	46.6	5.7	48.2
0	0	0	0	0	0	0	0.15	0
0	0.12	0	0	0	0	0.47	0.3	0
0.3	0.35	0.2	0.2	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	18	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	33	0	0
0	0	0	0	0	0	0	0	0
0.6	0.4	0.2	0.25	0.1	0.1	0.5	1.0	0.5
5	5.8	3.2	4.4	5.7	1.9	442	1493	4.4
0.6	0	0.2	0.2	0.4	0.3	10.9	7.4	0.82
24.3	40.5	14.0	16.4	0.48	1.6	68.0	21.0	14.2
3.5	0.09	0	0	1.7	0	15.9	0	0
52.6	126	39.2	128.6	7.0	9.2	92	31.6	49
24	20	20	18	10	15	26	23	16
11	15	8	7	1	1	22	15	12

APPENDIX 2 – *Continued*

438A-84-1	438B-4-6	438B-12-5	438B-19-2	439-9-4	439-21-2	439-25-4	439-31-5
850.5	858.7	935.7	997.2	893	994.5	1035.6	1093
Diatom Claystone, Sand Fractures	Mottled Diatom Claystone	Diatom Vitric Silty, Sandy Claystone	Clayey Siltstone	Burrowed Claystone Dewatering Veins	Clayey Siltstone	Clayey Siltstone, Wood, Shells, Pyrite	Calcite-Cemented Sandstone
M. Mio.	M. Mio.	Olig.	Olig.	M. Mio.	Olig.	L. Cret.	L. Cret.
(ng compound/g dry wt. sediment)							
0	0	0	0	0	0.01	0	0
0	0	0	0	0	0	0	0
3.0	0.06	0	0	0	0.02	0.03	0
0	0	0	0	0	0	0.03	0.02
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
41.5	16.5	6.0	10.6	17.0	81.0	9.7	13.1
0	0	0	0	0	0	0	0
0	0	0	0	0	0.35	0	0
0.20	0	0	0	0	0.32	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0.8	n.d.[b]	n.d.[b]	n.d.[b]	0.8	0.5	0.5	0.4
383	135	134	22	26	87	23	21
2.5	0.64	0.86	3.1	2.1	2.8	20.6	20.5
37.8	15.0	1.9	5.1	9.0	6.1	11.3	5.0
0	0	0	0	0	0.03	0	0
44.8	17.1	6.0	10.6	17.0	81.7	9.8	13.1
20	22	10	25	17	21	29	28
6	8	1	3	2	11	9	5

APPENDIX 2 – *Continued*

Section	440-5-6	440A-7-6	440B-3-5	440B-8-4	440B-12-4	440B-17-5	440B-23-4
Sub-bottom Depth (m)	42.5	138.6	165.1	211.6	249.5	298.6	354.1
Lithology	Diatom Claystone, Silt and Sand	Diatom Claystone, Silt and Sand	Diatom Clay	Diatom Clay, Sand, Silt	Silty Claystone, Tuffs	Silty Burrowed Claystone	Mottled Diatom Claystone
Age	Pleis.	Pleis.	Pleis.	Pleis.	Pleis	Pleis./Plio.	L. Plio.
Compound	(ng compound/g dry wt. sediment)						
Ethylene	0	0	1.9	0	0	0	0
Propylene	0	0	0	0	0	0	0
Cyclohexene	0	0	0	0	0	0	0
1-Methylcyclopentene	0	0	0	0	0	0	0
Methylmethylenecyclopentane	0	0	0	0	0	0	0
3,5-Dimethylcyclopentene(A)[a]	0	0	0	0	0	0	0
3,5-Dimethylcyclopentene(B)[a]	0	0	0	0	0	0	0
1,3-Dimethylcyclopentene	0	0	0	0	0	0	0
1,4-Dimethylcyclopentene	0	0	0	0	0	0	0
1,5-Dimethylcyclopentene	0	0	0	0	0	0	0
1,2-Dimethylcyclopentene	0	0	0	0	0	0	0
Miscellaneous C_4-C_6 Alkenes	123	1.1	85	2.7	5	0.56	0.3
2-Methylfuran	0	0	0	0	0	0	0
3-Methylfuran	0	0	0.49	0	0	0	0
2,5-Dimethylfuran	0	0	0	0	0	0	0
3-Methylbutanal	0	0	0	0	0	0	0
3-Pentanone	0	0	0	0	0	0	0
Thiophene	0	0	0	0	0	0	0
Dimethylsulfide	0	0	0	0	8	0	0.6
2-Methylthiophene	0	0	0	0	0	0	0
3-Methylthiophene	0	0[c]	0	0	0	0	0
Totals							
Organic Carbon (%)	1.5	0.9	1.4	0.9	0.7	0.6	0.55
ng C_1/g dry wt. sediment	115	842	803	1596	127	788	151
ng (C_2+C_3)/g dry wt. sediment	0.13	1.9	18	4.8	0.17	2.2	0.25
ng $\Sigma(C_4$-$C_7)$/g dry wt. sediment	1.6	n.d.[c]	n.d.[c]	0.23	1.7	3	3.53
ng ΣC_8/g dry wt. sediment	0	0	0.32	0	16	0	0
ng Σ other/g dry wt. sediment	123	n.d.[c]	n.d.[c]	2.7	13	0.56	0.9
Number saturated alkanes	12	24	24	12	9	5	14
Number other compounds	3	4	5	1	1	2	2

APPENDIX 2 – *Continued*

440B-29-3	440B-34-3	440B-39-3	440B-46-3	440B-51-3	440B-56-3	440B-63-3	440B-68-2
409.5	457	504.5	571.1	618.6	666.0	732	778.7
Mottled Diatom Claystone	Diatom Claystone Dewatering Veins	Diatom Claystone	Mottled and Fractured Diatom Claystone	Mottled and Fractured Diatom Claystone	Highly Fractured Diatom Clay	Highly Fractured Diatom Clay, Tuff	Bioturbated and Brecciated Silty Claystone
Plio.	Plio.	Plio.	Plio.	E. Plio.	L. Mio.	?	?
(ng compound/g dry wt. sediment)							
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0.23	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0						
0	0	0	0	0	0	0	0
4.3	0.02	9.2	5.6	32	4.5	11.2	5.6
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0.12	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0.8	0.8	1.3	1.0	0.7	0.8	0.7	0.5
821	180	215	514	1124	132	108	289
3.2	0.68	1.2	2.1	4.4	0.35	0.48	1.7
n.d.[c]	0.4	3.9	4.6	12.9	0.01	1.8	7.1
0	0	0	0	2.8	0	0	1.5
n.d.[c]	0.14	9.2	5.6	32.2	4.5	11.2	5.6
16	5	18	20	25	4	9	17
3	2	2	3	4	1	1	2

[a] Cis + trans isomers.
[b] Not determined.
[c] Toluene + 3MT equals 18 (see Appendix 1).