24. SEDIMENT C_1 TO C_7 HYDROCARBONS FROM DEEP SEA DRILLING PROJECT SITES 415 AND 416 (MOROCCAN BASIN)[1]

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ABSTRACT

Hydrocarbon yields from Lower Cretaceous (Hauterivian-Valanginian) cores from Hole 416A (1178 to 1532 m sub-bottom depths) were 0 to 38 ng $(C_4 + C_5)$/g dry weight of sediment and 2.1 to 28.2 ng $(C_6 + C_7)$/g dry weight of sediment. Two samples with low organic-carbon values showed moderate levels of C_4 to C_7 and high levels of $(C_4 + C_5)/C_{org}$ and $(C_6 + C_7)/C_{org}$. These values may indicate migrated hydrocarbons. One shallow, middle-Miocene sample from Site 415 (210 m) showed very low levels of C_1 to C_7 in spite of moderate organic-carbon content (0.9%).

INTRODUCTION

Sediments from DSDP Hole 416A represent some of the deepest (1119 to 1532 m sub-bottom) and oldest sediments (Lower Cretaceous: Hauterivian to Valanginian) we have examined for C_1 to C_7 hydrocarbons. Hole 416A sediments below 1200 meters were classified as mature, but lean with respect to petroleum generation, by gas-chromatography pyrolysis analysis aboard ship (Galimov et al., this volume). In spite of the small number of samples available (a total of seven), the Hole 416A sediment C_1 to C_7 levels provided a basis for comparison with the many other, younger, more immature sediments we have examined from other sites (Hunt, 1975; Whelan, in press; Whelan and Hunt, 1978, in press). One younger and shallower sample from Hole 415 also was examined.

DISCUSSION AND RESULTS

Levels of C_1 to C_7 hydrocarbons, per cent organic carbon, and total levels of $(C_4 + C_5)/C_{org}$ and $(C_6 + C_7)/C_{org}$ are shown in Table 1 (for experimental details see Whelan, in press).

The middle-Miocene sample from Hole 415 was typical of shallow (210 m sub-bottom), immature, siliceous nannofossil-chalk samples we have examined from other sites (Whelan and Hunt, in press). Only trace amounts of any light hydrocarbons were seen, in spite of a moderate organic-carbon level of 0.9 per cent. In addition, only one compound (toluene) made up the total amount of $C_6 + C_7$. This compound has been seen routinely as a dominant component in other immature sediments of this type we have examined. Toluene is not a contaminant, in that it does not show up in blanks or in many organic-matter-rich DSDP sediments we have examined, which show high levels of other C_4 to C_7 compounds.

In contrast, the much deeper and older sediments from Hole 416A show larger amounts and a much broader spectrum of compounds, even though the organic-carbon values are lower, i.e., 06 per cent or less. It can also be noted that, except for 2,2-dimethylbutane, the gem dimethylalkanes (2,2-dimethylpentane, 1,1-dimethylcyclopentane, and 3,3-dimethylpentane) are not substantial contributors to these sediments. These carbon skeletons would not be expected to survive a kinetically controlled process involving carbonium-ion intermediates such as that which probably occurs in petroleum generation.

All the sediments below 1200 meters in Hole 416A are classified as mature with respect to petroleum generation (Galimov et al., this volume). Thus, the samples from Sections 416A-23-3 and 416A-48-2 may contain migrated hydrocarbons. Both these samples have very low organic-carbon values (0.12 and 0.03%, respectively), yet they showed high yields of $(C_4 + C_5)/C_{org}$ and $(C_6 + C_7)/C_{org}$ in comparison to other samples we have examined (Hunt, 1975). Both these samples are lithologically described as consisting of calcareous mudstone interbedded with more-porous sandstone-siltstone layers. Thus, migration from fine-grained calcareous source sediments into more-porous sandstone-siltstone layers would be quite reasonable.

ACKNOWLEDGMENTS

We wish to thank Jenny Jasinska and Fred Connors for analyses, and Susan Palmer and Robert Gagosian for reviewing this manuscript. This work was supported by National Science Foundation Grant OCE73-06575.

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[1] Woods Hole Oceanographic Institution Contribution No. 4184.

TABLE 1
C_1 to C_7 Sediment Hydrocarbons, Sites 415 and 416

Section	415-4-2	416A-9-2	416A-14-4	416A-18-3	416A-23-3	416A-28-4	416A-42-2	416A-48-2
Lithology	Nannofossil Chalk-Siliceous Debris	Calc. Mudstone, Siltstone, Sandstone (Turbidite)	Calc. Mudstone, Silt and Sand Layers (Pyrite = 2%)	Calc. Mudstone to Marl with Silt Layers	Dark Mudstone, Sandstone and Siltstone Layers (~ 1% Pyrite)	Calc. Claystone, Mudstone, Sandstone and Siltstone Layers	Turbidite, Red Mudstone, Calcareous Sand Layers	Red Mudstone, Calc. Silt Layers (Pyrite 0 to 3%)
Sub-Bottom Depth (m)	209.5	1119.5	1227.5	1266.2	1313	1361.5	1474.8	1532.4
Age	Middle Miocene	Hauterivian	Valanginian	Valanginian	Valanginian	Valanginian	Valanginian	Valanginian
Hydrocarbon	ng/g dry weight sediment[a]							
Methane	1.15	11.4	0	0	14.9	0	2.48	1.20
Ethane	0.11	1.74	0	0	2.68	0	0.44	0.24
Propane	0	1.37	0.33	3.32	6.28	0	0.25	0.41
i-Butane	0	0.14	0	2.37	7.10	2.80	0	0.22
n-Butane	0	0.81	0	3.38	7.64	5.71	0.12	0.48
Neopentane	0	0	0	0.24	0	0	0	0
i-Pentane	0	0.58	0	5.21	8.87	13.8	0	0.32
n-Pentane	0	0.51	0	13.54	8.50	15.3	0.48	1.07
Cyclopentane	0	0	0	1.86	0.73	0.37	0	0
2, 2-Dimethylbutane	0	0.13	0.22	0.31	0.42	0.34	0.65	0.64
2, 3-Dimethylbutane	0	0.03	0.02	0.14	0	0.40	0.02	0.09
2-Methylbutane	0	0.15	0.07	1.10	1.77	2.44	0.09	0.67
3-Methylpentane	0	0.12	0.05	0.23	0.81	0.59	0.06	0.23
n-Hexane	0	0.17	0.13	1.11	1.74	2.61	0.18	0.01
Methylcyclopentane	0	0.07	0.07	0.62	2.75	1.35	0.02	0.08
2, 2-Dimethylpentane	0	0.04	0	0.08	0.10	0.07	0.20	0.16
Benzene	0	0.76	0.50	0.76	1.48	0.61	0.11	0.38
2, 4-Dimethylpentane	0	0	0	0	0	0	0	0
2, 2, 3-Trimethylbutane	0	0	0	0	0	0.04	0	0.02
Cyclohexane	0	0	0.02	0.12	0.59	0	0.02	0.08
3, 3-Dimethylpentane	0	0	0	0	0	0.02	0	0.02
1, 1-Dimethylcyclopentane	0	0	0	0	0.03	0.04	0	0.01
2-Methylhexane	0	0.05	0.02	0.15	0	0.29	0.04	0.22
2, 3-Dimethylpentane	0	0.23	0.07	0.77	2.04	0.70	0.08	0.36
3-Methylhexane	0	0.09	0.03	1.37	1.72	0.79	0.04	0.20
1-t-3-Dimethylcyclopentane	0	0.07	0.02	0.58	1.41	0.62	0.04	0.02
1-t-2-Dimethylcyclopentane	0	0.12	0.05	0.53	1.04	0.26	0.02	0.05
3-Ethylpentane	0	0.005	0	0.02	0.02	0.03	0.01	0.02
n-Heptane	0	0.07	0.07	0.73	2.04	1.52	0.23	2.07
1-c-2-Dimethylcyclopentane	0	0	0	0.10	0.24	0.08	0	0
Methylcyclohexane	0	0.06	0	0.50	2.24	0.79	0.06	0.25
Ethylcyclopentane	0	0.04	0.02	0.14	0.28	0	0.007	0
Toluene	0.72	1.10	0.76	3.30	7.49	2.55	0.50	0.66
$C_2 + C_3$	0.11	3.11	0.33	3.3	8.96	0	0.69	0.65
$C_4 + C_5$	0	2.04	0	26.6	32.8	38.0	0.60	2.09
$C_6 + C_7$	0.72	3.30	2.12	12.7	28.2	16.1	2.38	6.24
Organic Carbon (C_{org})	0.9	0.50	0.49	0.61	0.12	0.44	0.21	0.03
$[ng(C_4 + C_5)/ng\ C_{org}] \times 10^7$	0	4.1	0	43.6	273.3	86.3	2.8	69.7
$[ng(C_6 + C_7)/ng\ C_{org}] \times 10^7$	0.80	6.6	4.3	20.8	235.0	36.6	11.3	208

[a]Organic carbon in %.

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