18. ORGANIC GEOCHEMISTRY, LEG 64: INTRODUCTION AND SUMMARY[1]

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INTRODUCTION

Organic geochemical studies were carried out on samples from all sites of Leg 64 off Cabo San Lucas and in the Central Gulf of California (Fig. 1). Short sections of core were cut on board, sealed with mylar under the core caps, taped with black vinyl type, and then kept frozen until the sub-sampling for the various investigations. Some samples that had extruded from the end of the core liner because of excessive gas pressure were sealed in Kapak bags. A listing of all frozen samples taken for organic geochemistry is found in Table 1, and their locations down-hole are indicated by the sequential numbers on the lithologic columns of each site (Figs. 2 and 3). Selected interstitial gas (in vacutainers) and small CHN samples were also analyzed in greater detail, and some interstitial-water samples (sealed in glass ampoules) were examined for organic matter.

The 22 papers that follow in Pt. 2 of Volume 64 present the results of the organic geochemical studies. These major aspects of organic geochemistry were addressed: (1) the effects of the various intrusives on the unconsolidated sediments in terms of gas and liquid products and of residual kerogen; (2) the maturity, diagenesis, and catagenesis of the organic matter; and (3) the various sources of that organic matter and environmental conditions of sedimentation.

In order to keep within the general arrangement of this volume, I have placed the papers in the following order: first, the background data are presented; followed by, second, papers presenting overall regional data; third, papers confined to the three regions—mouth of the Gulf, Guaymas Basin and Guaymas Continental Slope; and, fourth, miscellaneous papers, including a synthesis.

SUMMARY

The first four papers present general background material. The shipboard organic geochemical and safety monitoring data for gas, organic carbon and nitrogen, and bitumen fluorescence are summarized (Simoneit, this volume). Gas was present in all sites except 475 and 476, and the biogenic components become admixed with thermogenic products at depth. Petroliferous bitumen is present near sills. Detailed optical analyses of the palynological residues (humin, kerogen, and palynomorphs) are presented (Rueda-Gaxiola et al., this volume). These data are utilized to evaluate the biostratigraphic facies distributions, and the type and origin of sedimentary organic matter with its diagenesis and catagenesis. Samples from Sites 474, 476 to 479, and 481 were dated by the radiocarbon method to supplement the sedimentation rate based on the biostratigraphic record (Spiker and Simoneit, this volume). These data indicated higher rates; sedimentation is relatively greatest in Guaymas Basin > mouth of the Gulf of California > Guaymas slope. Methanogenic bacterial activity could be demonstrated to sediment depths of about 12 meters at some of the sites (Oremland et al., this volume).

The next nine papers discuss results on a regional scope and are presented in the order of gas, bitumen, and kerogen data. The C_2–C_8 hydrocarbons from Sites 474 and 476 are present at low concentrations and are typical of immature Recent sediments (Whelan and Hunt, this volume). In contrast, some of the samples from Sites 477 to 479 and 481 exhibited C_2–C_8 compositions characteristic of thermogenesis. Interstitial gas was analyzed in terms of the stable-isotope composi-

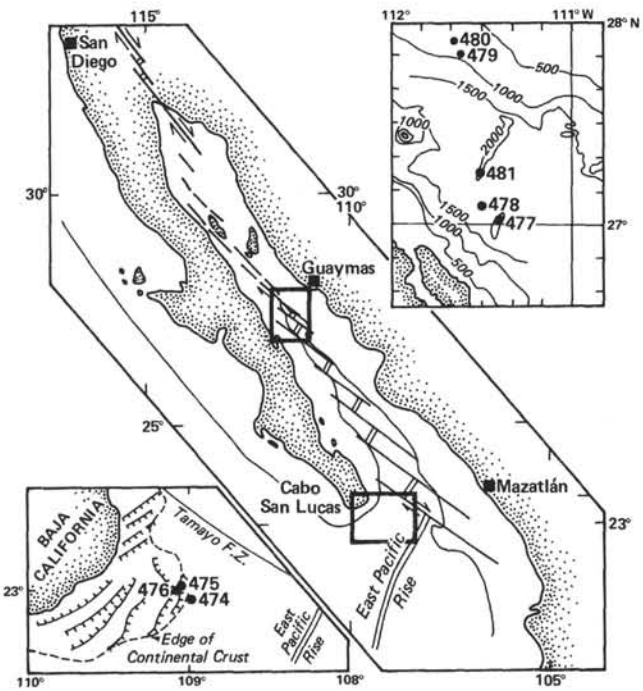

Figure 1. Location map for the Leg 64 drill sites at the mouth of and in the central Gulf of California.

[1] Curray, J. R., Moore, D. G., et al., *Init. Repts. DSDP*, 64: Washington (U.S. Govt. Printing Office).

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Table 1. Listing of core samples taken on Leg 64 for shore-based organic geochemistry.

Sample Number (cf. Figs. 2 and 3)	DSDP Sample (interval in cm)	Sub-bottom Depth (m)[a]
1	474-2-3, 120–150	6.35
2	474-5-3, 120–150	34.85
3	474-6-5, 0–30	46.15
4	474-17-6, 100–125	153.13
5	474-17-6, 125–150	153.38
6	474A-7-2, 110–140	223.25
7	474A-21-6, 48–78	352.13
8	474A-28-2, 120–150	413.35
9	474A-31-2, 120–150	441.85
10	474A-32-2, 120–150	451.35
11	474A-40-3, 120–150	528.85
12	474A-41-3, 120–150	538.35
13	475-2-2, 120–150	8.85
14	475-6-5, 120–150	51.35
15	475-12-4, 120–150	106.85
16	475-16-2, 120–150	141.85
17	476-3-4, 120–150	24.35
18	476-7-6, 110–140	65.25
19	476-11-4, 110–140	100.25
20	476-15-2, 110–140	135.25
21	476-19-1, 120–150	171.85
22	477-5-1, 120–140	30.80
23	477-7-1, 132–142	49.87
24	477-16-5, 58–88	121.73
25	477-20-1, 115–135	154.25
26	477B-1-2, 84–98	2.41P
27	478-2-5, 120–150	10.85
28	478-4-3, 120–150	26.85
29	478-6-3, 120–150	45.85
30	478-7-5, 120–150	58.35
31	478-9-3, 110–140	74.25
32	478-11-4, 120–150	94.85
33	478-13-2, 120–150	110.85
34	478-14-4, 120–150	123.35
35	478-16-4, 120–150	142.35
36	478-17-4, 120–150	151.85
37	478-20-4, 108–138	170.73
38	478-28-4, 120–150	246.85
39	478-35-5, 110–140	305.25
40	481-2-2, 125–150	7.63P
41	481-8-2, 110–140	36.00P
42	481-11-1, 125–150	48.88P
43	481A-4-2, 110–140	73.25
44	481A-8-2, 110–150	111.30
45	481A-10-2, 110–150	130.30
46	481A-12-2, 120–150	149.35
47	481A-13-6, 0–14	153.57
48	481A-20-1, 140–145	223.93
49	481A-22-4, 120–150	247.35
50	481A-24-5, 110–140	267.75
51	481A-26-5, 120–150	286.85
52	481A-27,CC	298.98
53	481A-30-5, 110–140	324.75
54	480-20-3, 62–82	98.72P
55	479-3-2, 105–110	15.07B
56	479-3-2, 110–130	15.20
57	479-5-3, 120–125	35.73
58	479-5-3, 125–150	35.88
59	479-7-5, 110–140	57.75
60	479-9-2, 110–115	72.13B
61	479-9-2, 115–140	72.28
62	479-13-1, 110–140	108.75
63	479-15-5, 110–140	133.75
64	479-17-5, 120–150	152.85
65	479-19-5, 115–140	171.78
66	479-22-5, 110–140	200.10
67	479-27-4, 120–150	246.35
68	479-29-5, 120–150	266.85
69	479-34-5, 110–140	314.25
70	479-37-5, 130–150	342.90
71	479-39-4, 110–140	360.25
72	479-43-1, 120–140	393.80
73	479-47-4, 110–140	436.25

[a] Depths are given in the DSDP convention at the top of the core sample; P indicates piston core, and B indicates extruded sample sealed in Kapak bag.

tions of methane and carbon dioxide (Galimov and Simoneit, this volume; Schoell, this volume). The contribution of thermogenic components at depth could be confirmed by the enrichment of carbon-13 methane at Sites 477, 478, and 481. The CO_2 at depth was derived from thermal carbonate decomposition (Galimov and Simoneit, this volume), except at Site 479, where its source ranged from biogenic to decarbonylation reactions (Schoell, this volume). The ^{18}O and D concentrations of interstitial waters from Sites 479 and 481 were also determined and compared with lithology (Schoell, this volume).

Bitumen was analyzed for pigments and hydrocarbon compositions to evaluate sources, diagenesis, and catagenesis (Baker and Louda, this volume; Galimov et al., this volume; Rullkötter et al., this volume). Sediment samples from shallow depths contained primarily chlorophyll derivatives, formed under reductive diagenesis at Site 479 and in early oxidative conditions at Site 481, with traces of possible allochthonous porphyrins (Baker and Louda, this volume). Porphyrins were observed in sediments approaching sill intrusions, but not at close proximity (Galimov et al., this volume; Baker and Louda, this volume). Carotenoid concentrations decreased rapidly with sub-bottom depth, and perylene was ubiquitous (Baker and Louda, this volume). The hydrocarbon yield and distributions and the stable carbon isotope compositions reflect the effect of thermal stress and indicate a primarily marine origin at Sites 474 and 477, with a stronger terrestrial influence at Sites 478, 479, and 481 (Galimov et al., this volume). This is also confirmed by some of the data of Rullkötter et al. (this volume), based on the hydrocarbon distributions, molecular markers, and maceral analysis.

Kerogen was analyzed to evaluate its maturity, petroleum-generating potential, facies and sources (Rullkötter et al., this volume; Deroo et al., this volume; Gilbert and Summerhayes, this volume; Kendrick, this volume; Galimov et al., this volume). The kerogen was primarily of an autochthonous marine origin at all sites, except that at Sites 474, 478, and 481 a significant allochthonous component of terrigenous detritus was also detectable (Rullkötter et al., this volume; Deroo et al., this volume; Galimov et al., this volume). The kerogens are immature, except in the vicinity of sills, and have a fair to good petroleum-generating potential (Gilbert and Summerhayes, this volume; Kendrick, this volume; Deroo et al., this volume).

The sediments from the mouth of the Gulf that were analyzed contained organic matter derived from primarily marine autochthonous sources, and two lignite fragments were identified as driftwood (Simoneit, this volume). Carbohydrate residues were present in samples from Site 474 and 476 back into the Pliocene and indicated sources including bacteria, marine algae, and terrestrial plants (Swain and Bratt, this volume).

In Guaymas Basin, the sedimentary organic matter was analyzed to examine sources, depositional environment, and thermal stress from intrusions. The bitumen (lipids) and kerogen of a set of small samples (residues from the shipboard CHN analyses) from Sites 477, 478,

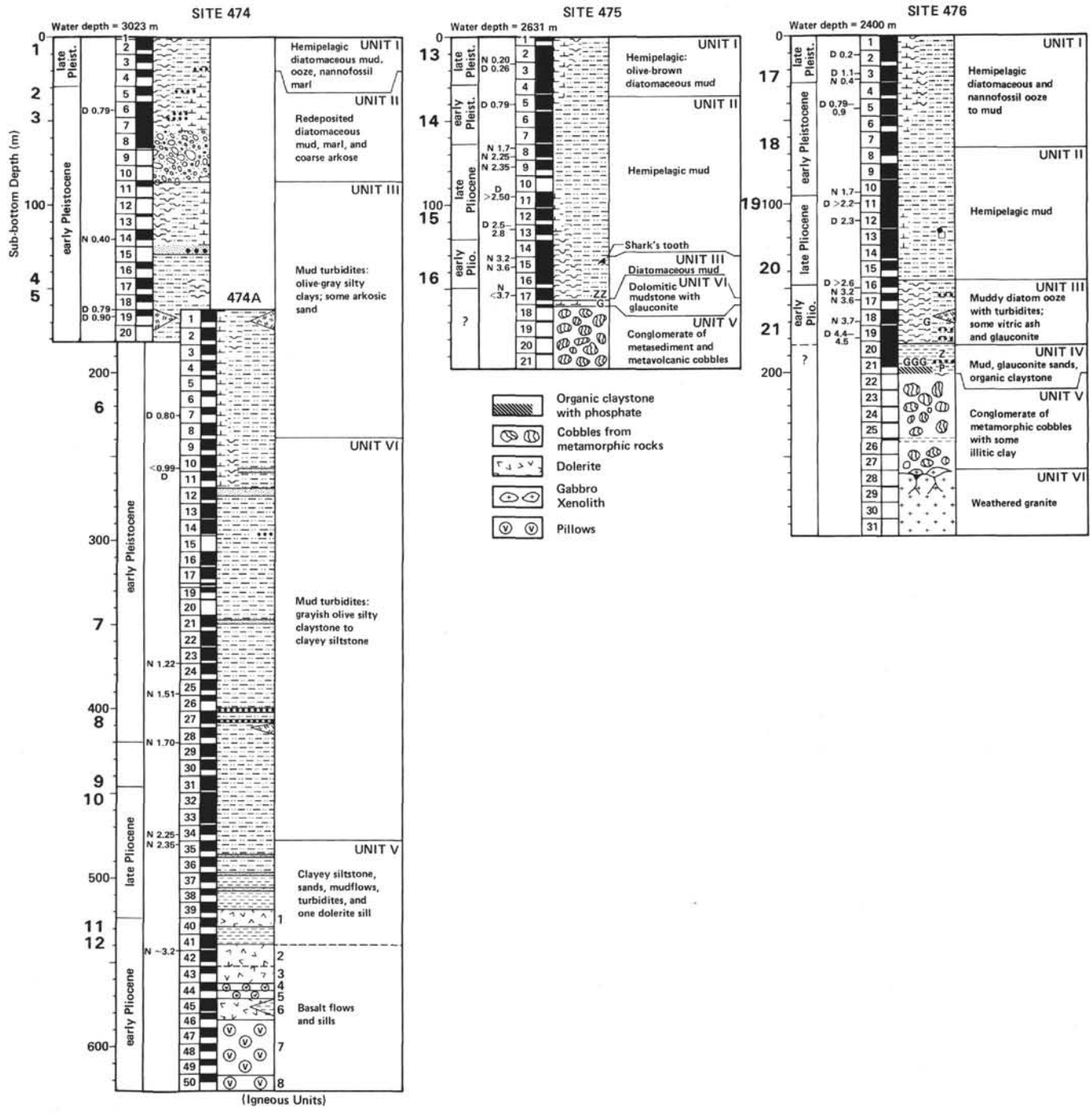

Figure 2. Lithologic columns for Sites 474 to 476 at the mouth of the Gulf of California. The organic geochemistry samples are indicated by the sequential numerals (on the left of each column), as listed in Table 1.

and 481 were characterized (Simoneit and Philp, this volume; Jenden et al., this volume). The bitumen of the unaltered samples was derived primarily from autochthonous marine sources, the allochthonous terrigenous influx being greatest at Site 481, and lowest at Site 477. The samples approaching sills contained bitumen pyrolysate, and those adjacent to contacts had essentially no bitumen. The pyrograms of the kerogens exhibited the inverse; unaltered material yielded complex bitumen pyrolysate, and the thermally stressed samples produced simpler mixtures of bitumen, if any, as the intrusive temperature increased. This is also confirmed by the N/C data and ESR spin density and line width. The $\delta^{13}C$ data, however, indicated differences in maturation behavior, possibly due to kerogen heterogeneity and dissimilar thermal stress (Jenden et al., this volume). A detailed lipid-with-molecular-marker analysis of Sample 481-2-2, 125–150 cm was carried out (Thomson et al., this volume). The major lipids were derived from algae, but lesser components from bacterial and terrestrial sources were also present, and all reflected a very early stage of diagenesis.

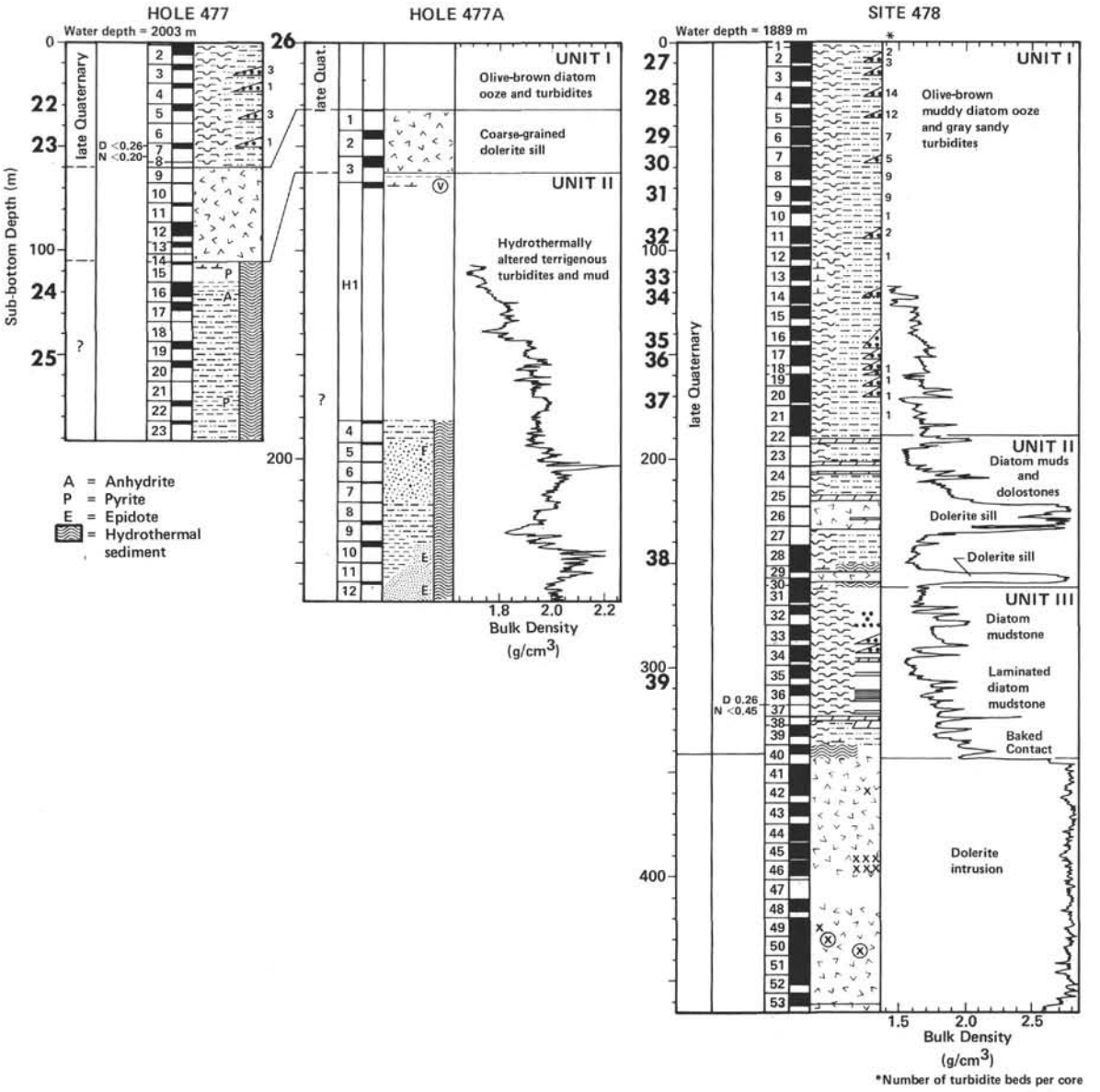

Figure 3. Lithologic columns for Sites 477 to 481 in the central Gulf of California. The organic geochemistry samples are indicated by the sequential numerals, as listed in Table 1.

The organic matter in samples from Sites 479 and 480 on the Guaymas Slope has been analyzed to examine possible differences between laminated and nonlaminated facies (Simoneit, this volume; Peters and Simoneit, this volume). The lipid composition of both facies is very similar and is of an autochthonous microbial origin, with traces of terrestrial influx. The non-laminated sections contain relatively more terrigenous detritus and a much greater amount of perylene. The kerogen analyses also indicate a primarily marine source and immature nature, and the laminated, anoxic facies contain more hydrogen-rich, oxygen-poor organic matter than the oxic, homogeneous facies.

The organic geochemistry of interstitial waters from Sites 474 and 479 was examined (Michaelis et al., this volume). Dissolved organic carbon, amino acids, and carbohydrates were determined, and significant compositional changes were observed versus sub-bottom depth.

Results of the organic carbon and nitrogen and the carbonate analyses carried out both on board and ashore are given in Appendix II (Simoneit and Bode, this volume).

These organic geochemical studies have been discussed in the perspective of an overall synthesis which follows at the end of this section (Simoneit et al., this volume).

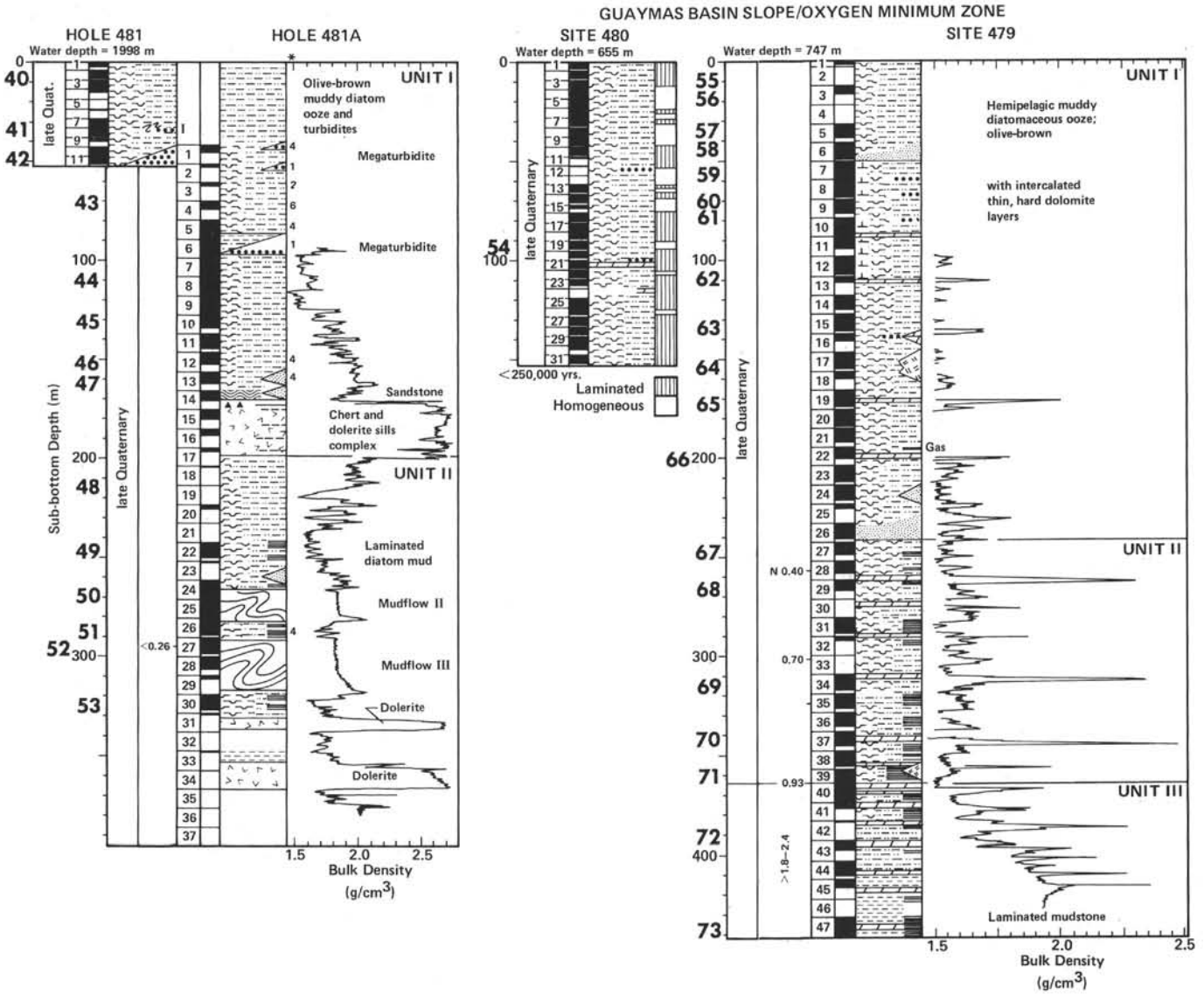

Figure 3. (Continued).