41. GEOCHEMICAL ANALYSES OF SAMPLES FROM HOLE 515B, VEMA CHANNEL, AND HOLE 516F, RIO GRANDE RISE

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ABSTRACT

The petroleum-generating potential of five samples from Hole 515B, Vema Channel, and of 23 samples from Hole 516F, Rio Grande Rise, was analyzed. Organic carbon and pyrolysis data indicated that source rocks of good quality are not present. Microscopic examination showed predominance of woody organic matter, which is more favorable for the generation of gas in a mature stage; all samples, however, are still thermally immature.

INTRODUCTION

Samples from Holes 515B and 516F, Leg 72 (Fig. 1), were studied in detail in order to characterize and evaluate the petroleum-generating potential of the drilled section. In this investigation, routine geochemical parameters were measured and considered in conjunction with more detailed analyses (character of the C_{15}^{+} = saturated hydrocarbons and types of organic matter, qualitatively determined by microscopic examination). Lithologies and ages of the samples are summarized in Table 1.

ANALYTICAL METHODS

The organic carbon content was determined by combustion in a Leco carbon analyzer. Standard samples were analyzed frequently in order to check precision of the instrument. A pyrolysis apparatus developed in the PETROBRÁS Research Center was used to quickly determine source rock characteristics. Light hydrocarbon gases (C_1-C_4) were analyzed isothermally at 100°C from canned samples by gas chromatography, using a Perkin Elmer Model 990 equipped with a 1.2-m Porapak column.

Kerogen (insoluble organic matter) was separated according to the standard procedure used in palynology (Staplin, 1969), but an oxidation step was omitted. The separated kerogen was mounted on regular glass slides and studied under the microscope (400× magnification, plain transmitted light).

Bitumen was extracted in a Soxhlet apparatus by refluxing with pure choloroform at its boiling point. The extracts were fractionated via solid-liquid chromatography (after Cummings and Robinson, 1964). The total alkanes from rock extracts were analyzed in a Perkin Elmer Model 990 gas chromatograph equipped with hydrogen flame ionization detectors and two identical eutectic analytical columns.

RESULTS AND INTERPRETATION

Organic carbon. On the basis of our experience and published studies of organic carbon content of petroliferous and nonpetroliferous sedimentary basins, we have considered 1.0% organic carbon to be a minimum requirement for a potential source rock of petroleum. In general, the sediments contain very small amounts of organic matter (Table 2); the average is 0.22% (very poor source rock).

Light hydrocarbon gases. Methane was the dominant gaseous hydrocarbon in the air space of the cans, so that the "wetness" is very low; this indicates that the sediments are still immature (Table 2).

Pyrolysis. In all samples the hydrocarbon source potential was very low, less than 450 ppm (Table 2).

Organic extracts. The extracts (Table 3) range from 230–892 ppm. They are composed predominantly of heteroatomic compounds (NSO), indicating immature material.

Chromatography. The *n*-alkane distribution from rock extracts revealed a distribution with predominance in the C_{21}–C_{27} range (Fig. 2). The high proportion of naphthenic compounds indicates that the organic matter of all samples is immature.

Visual kerogen. The types of organic matter, as determined by microscopic examination of the kerogen slides, were reported as percentage of amorphous, herbaceous, and woody material (Table 2). *Amorphous* organic matter represents lipid-rich unstructured material, which can yield many petroleum hydrocarbons when subjected to appropriate diagenetic conditions. *Herbaceous* types include structured material, such as cuticles, spores, and pollens; they can yield oil and gas. *Woody* represents hydrogen-lean organic matter typically derived from land plants and includes coaly material; woody matter can yield only gas. Figure 3 shows the relationship of each of these organic matter types to petroleum generation and destruction zones.

CONCLUSIONS

Potential petroleum source rocks were not identified in Holes 515B and 516F, DSDP Leg 72, in the studied intervals. Analyses of light hydrocarbon gases, organic extracts, and *n*-alkane distribution suggests that the sediments are thermally immature.

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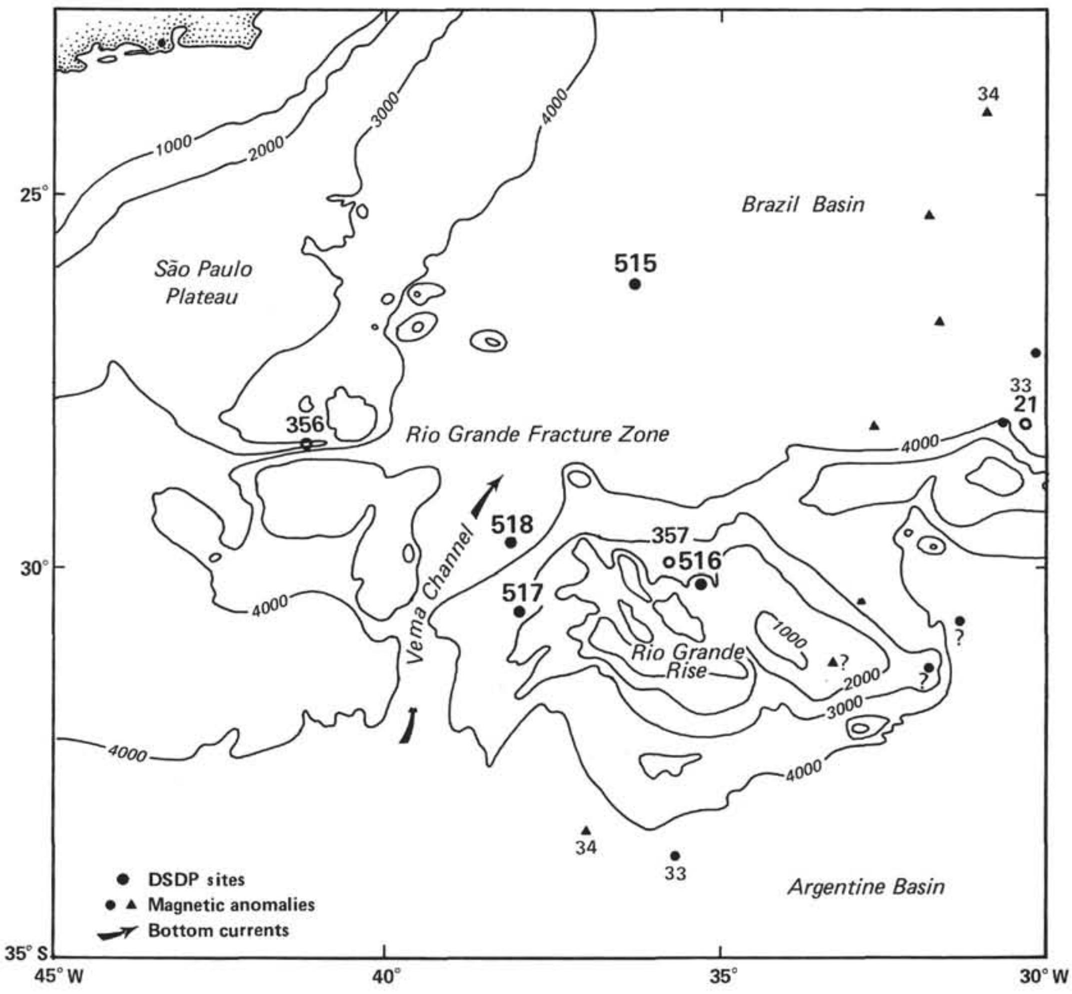

Figure 1. Location map showing positions of Leg 72 sites, marine magnetic anomalies, and generalized bathymetry.

Table 1. Summary lithology for samples analyzed for hydrocarbons.

Hole	Core-section (interval in cm)	Sub-bottom depth (m)	Age	Lithology
515B	25-1, 113-123	324	late Miocene	Siliceous mudstone, olive gray, radiolarian
	41-4, 32-38	480	late Oligocene	Siliceous biogenic mudstone, bioturbated, dark greenish gray
	55-5, 118-126	615	early Eocene	Mudstone, dark greenish gray, mottled
	56-4, 120-125	622	early Eocene	Bioturbated, quartz-rich zeolitic mudstone
	56-4, 70-78	626	early Eocene	with darker laminations
516F	8-7, 5-12	245	early Miocene	Nannofossil chalk, light gray
	28-3, 0-5	429	late Oligocene	Nannofossil chalk, light gray, with gray mottled
	33-4, 8-15	478	early Oligocene	Foraminiferal-nannofossil chalk, light gray
	44-1, 77-82	578	late Eocene	Nannofossil chalk, white with dark gray laminations
	51-1, 90-96	645		Nannofossil limestone, greenish gray
	53-4, 102-112	669		Nannofossil limestone, dark greenish
	53-5, 51-56	670		gray, with dark gray laminations
	60-3, 141-142	724		Marly nannofossil limestone, olive gray
	61-1, 141-149	731		Marly nannofossil limestone, olive gray
	64-1, 1-3	756	middle Eocene	Recrystallized limestone, light olive gray, with darker ash laminations
	64-6, 25-30	764		Darker ash laminations
	74-4, 120-121	829		Limestone micritic, greenish, with black spots
	80-3, 97-99	882		Nannofossil-foraminiferal limestone, light olive gray, with ash laminations
	83-2, 121-124	903		Nannofossil-foraminiferal limestone,
	83-3, 25-28	904	late Paleocene	greenish olive gray with black layers
	84-5, 119-123	917		Nannofossil limestone, light gray, with olive gray laminations
	102-1, 92-97	1057	Campanian/Maestrichtian	Marly limestone, dark greenish gray
	114-6, 1-8	1162	late Santonian	Nannofossil limestone, gray with darker
	114-6, 32-38	1162	late Santonian	layers, *Inoceramus*
	116-2, 5-16	1174		Micritic limestone, light to dark gray
	120-1, 113-120	1205	Coniacian/Santonian	Calcarenite medium to light gray, glauconitic, *Inoceramus*
	122-1, 140-143	1223		Calcarenite and calcareous black claystone
	122-2, 23-27	1223		with *Inoceramus*

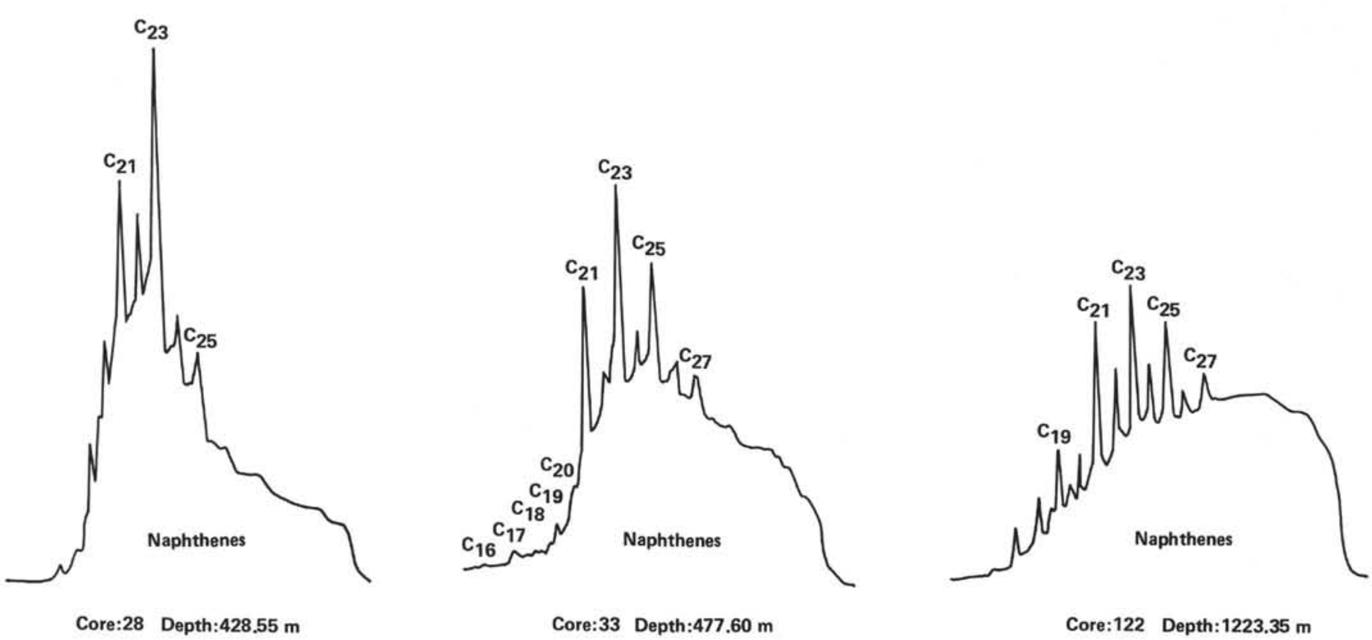

Figure 2. The *n*-alkanes distribution in three samples from Hole 516F.

Table 2. Organic carbon content, relative concentrations of C_1–C_4 gases, hydrogen potential, and kerogen analysis results for samples from Holes 515B and 516F.

Core-section (interval in cm)	Organic carbon (wt.%)	Relative concentration (%)					Hydrocarbon source potential (ppm)	Description from kerogen analysis
		C_1	C_2	C_3	$i = C_4$	$n = C_4$		
Hole 515B								
25-1, 113–123	0.16	69.2	18.9	11.9	—	—	174	Virtually devoid of organic debris
41-4, 32–38	0.13	60.3	22.4	17.3	—	—	101	No palynomorphs observed; wood fragments, rare
55-5, 118–126	0.02	77.5	17.1	5.4	—	—		
56-4, 120–125	0.02	73.7	17.2	9.1	—	—		Virtually devoid of organic debris; no palynomorphs observed
56-6, 70–78	0.05	81.9	13.9	4.2	—	—	62	Wood fragments, structured, brown, 50%; Sapropel, dispersed, yellow brown, 50%; palynomorphs (pollen, spores, foraminifers)
Hole 516F								
8-7, 5–12	0.12	40.7	21.2	26.3	9.3	2.5	133	Cuticle and wood fragments, rare
28-3, 0–5	0.42	66.7	20.3	13.0	—	—	208	Wood fragments, structured and unstructured, black and dark brown, 50%; cuticle, well preserved, pale yellow brown, 50%; palynomorphs (pollen, spores)
33-4, 8–15	0.71	58.1	26.9	15.0	—	—	258	
44-1, 77–82	0.08	79.3	—	20.7	—	—	219	Sapropel, granular, aggregated, pale yellow brown; palynomorphs (dinoflagellate cysts, scolecondont).
51-1, 90–96	0.14	65.1	22.3	12.6	—	—	208	Sapropel, granular, dispersed, pale yellow, 100%
53-4, 102–112	0.16	72.5	17.6	9.9	—	—	109	Wood fragments, unstructured, black and dark brown; sapropel, granular, aggregated, yellow brown in some cases showing intermediate stages in the morphologic fragments of plant tissue, 77%
53-5, 51–56	0.32	71.4	18.2	10.4	—	—	271	Wood fragments, unstructured, black and dark brown, 10%; herbaceous fragments, yellow brown, 10%; sapropel, granular, aggregated, yellow brown, 80%
60-3, 141–142	0.27	—	—	—	—	—		
61-1, 141–149	—	60.5	23.7	15.8	—	—	222	Wood fragments, unstructured and structured, dark brown, 25%; herbaceous fragments, yellow brown; sapropel, granular, aggregated, yellow brown; palynomorphs (*Phycopeltis microthyrioides*)
64-1, 1–3	0.20	63.3	21.7	15.0	—	—	124	Wood fragments, unstructured, black and dark brown; herbaceous fragments, yellow brown; palynomorphs (dinoflagellate cyst, fungi)
64-6, 25–30	0.28	70.6	17.6	11.8	—	—	0.75	Wood fragments, structured and unstructured black and dark brown, 90%; herbaceous fragments, brown and yellow brown, 10%
74-4, 120–121	0.30	52.4	23.8	23.8	—	—	424	Wood fragments, structured, dark brown; herbaceous fragments, yellow brown; sapropel, granular, aggregated, yellow brown in some cases showing intermediate stages in the breakdown of morphologic fragments of plant tissue
80-3, 97–99	0.24	—	—	—	—	—	124	Rare organic material (80-3 to 83-3)
83-2, 121–124	0.08	64.6	23.3	12.1	—	—	190	
83-3, 25–28	0.13	64.5	22.6	12.9	—	—	83	
84-5, 119–123	0.10	42.9	32.1	25.0	—	—	248	Virtually devoid of organic debris; no palynomorphs observed
102-1, 92–97	0.07	64.3	21.4	14.3	—	—	65	Virtually devoid of organic debris
114-6, 1–8	0.09	58.6	20.7	20.7	—	—	44	Wood fragments, unstructured and structured, dark brown, 100% palynomorphs (Hystrichosphaeridae)
114-6, 32–38	0.17	95.4	19.2	15.4	—	—	143	
116-2, 5–16	0.09	70.6	18.5	10.9	—	—		Wood fragments, structured and unstructured, black and dark brown, 90%; sapropel, aggregated, yellow brown, 10%; palynomorphs (Hystrichosphaeridae)
120-1, 113–120	0.38	60.7	24.7	14.6	—	—	157	Wood fragments, structured, yellow brown, 100%; palynomorphs (foraminifers)
122-1, 140–143	0.31	56.9	25.3	17.8	—	—	246	Wood fragments, structured and unstructured, dark brown, 50%; sapropel, aggregated, granular, dark brown and yellow brown, 50%; palynomorphs (Hystrichosphaeridae)
122-2, 23–27	0.95	53.4	22.3	15.9	3.6	4.8	338	Wood fragments, structured and unstructured, dark brown and yellow brown, 50%; herbaceous fragments, yellow brown, 50%

Note: Dashes indicate none found; blanks indicate that the analysis was not performed. See Table 1 for the sub-bottom depths of these samples.

Table 3. Organic extracts, Hole 516F.

Core-section (interval in cm)	Total extract (ppm)	Liquid chromatography: Hydrocarbon compounds: Aromatics (%)	Saturates (%)	Heteroatomic compounds (NSO) (%)
28-3, 0-5	892	2	24	74
33-4, 8-15	232	20	3	77
122-2, 23-37	368	17	14	69

Note: See Table 1 for sub-bottom depths of samples.

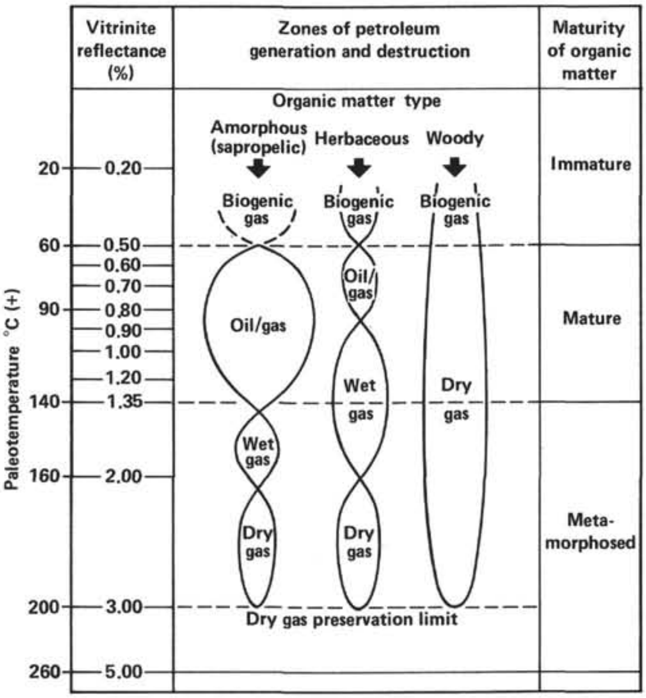

Figure 3. Petroleum generation zones (modified from Dow, 1977).