UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

DATA FROM SEDIMENT STUDIES OF THE RIO ORINOCO, VENEZUELA

AUGUST 15-25, 1982

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Open-File Report 83-679

Denver, Colorado
1983

UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

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ABSTRACT

Water and suspended-sediment discharges were measured and bed-material samples were collected during August, 1982, at 9 cross sections along a 800-kilometer reach of the Rio Orinoco. Flows varied from approximately 31,000 to 72,000 cubic meters per second, and sediment discharge varied from approximately 1,600 to 8,000 kilograms per second. The bed material is mostly fine to medium sand and almost one-third of the suspended sediment is sand.

INTRODUCTION

This report presents a summary of basic data on the flows and sediments of the Rio Orinoco, Venezuela, collected August 15-25, 1982. The study was part of a cooperative effort between the Water Resources Division, U.S. Geological Survey (USGS), and Planificacion y Ordenacion del Ambiente, Ministerio del Ambiente y de los Recursos Naturales Renovables (MARNR).

Work was done from the barge Duida. The Duida carried a crew of seven and a scientific party of nine.

During the cruise, water-discharge measurements were made, suspended-sediment, bed-material, and water-quality samples were collected, the bed was sounded with an ultrasonic echo-sounder at a number of locations. This report does not include any data on the water-quality samples or bed soundings.

The next section outlines the procedures. This is followed by a description and explanation of the tables of basic data.

Acknowledgments are due Ing. Guillermo Colmenares F., Director General, Planificacion y Ordenacion del Ambiente, and Ing. Abel Mejia B., Project Coordinator of Proyecto Orinoco for their assistance and support. Appreciation is extended to the ship's crew; Antonio Fernandez, Captain, Antonio Borges, Jose Flores, Jose Garcia, Dimas Morillo, Dario Perez, and Juan Torres. Members of the scientific crew were Carl F. Nordin, Jr., Robert H. Meade, and Clare C. Cranston of U.S. Geological Survey, Robert Stallard from Princeton University, Omar Alvarado, Luis Bravo, and Sarkis Farchack of MARNR, Roger Heny Parra of Instituto Nacional de Canalizaciones (INC) and Simon Munoz of Del Monte & Asociados, C.A.

PROCEDURES

Some new equipment and techniques were used in this study to measure water and sediment discharge of large rivers from a free-moving boat. The data-collection system consisted of:

1. A portable aluminum boom;
2. A reel with 100 meters of two-conductor cable;
3. A power unit and hydraulic system to drive the reel;
4. A large-volume collapsible-bag sampler and Ott-type current meter;
5. A sonic depth sounder;
6. Microwave positioning equipment
7. On-board sample processing;
8. A separate boom and reel for bed material sampling with a drag sampler for gravel and a grab sampler for sand.

The procedure is fairly simple. The cross section was sounded with cross-section markers and positioning equipment installed, and verticals (usually 25 to 30) were selected. At each vertical, the Duida was positioned approximately at preselected coordinates. The sampler and current meter were moved at constant transit rate from water surface to streambed and back to the water surface, and they collected: (1) A depth-integrated suspended-sediment sample, (2) two velocity profiles plotted on a battery-operated strip chart, and (3) two values of mean velocity in the vertical. Knowing the ship's position at any time during these measurements, velocities were corrected for ship's drift. Bed samples were collected after the velocity observations.

The suspended-sediment samples were partially processed at the sampling site by sieving out the sand, determining the total sample volume, and splitting a representative fraction of the water and the material finer than 0.062 millimeter that was filtered aboard ship. The filters and sand samples were transported to the laboratory for determination of concentration and particle-size distribution.

The microwave positioning equipment was provided by Oficina Tecnica Del Monte and Asociados, C.A., Puerto Ordaz, Venezuela. The procedure for positioning was to place one trisponder on the bank at the cross section to monitor the Duida's movement in the x-direction (cross channel) and to place the second trisponder a long distance upstream or downstream to monitor in the y-direction (the mean-flow direction). If the y-remote is greater than six channel widths from the cross section, the distances from the trisponder to the vessel can be used directly to approximate movements in the y-direction; corrections for the angle and arc distance are negligible. If the y-remote is close to the measuring cross section, the

angle between the cross section and the line from the remote to the vessel has to be accounted for, and the movement in the y-direction has to be computed graphically or by trigonometry. A complete description of equipment and procedures will be given in a later report.

We experienced some difficulties with the equipment. The battery-operated strip chart developed a short and was inoperative during most of the cruise. At Musinacio on August 20, 1982, a short developed in the Ott meter lead, and the recorded velocities were too low on a number of verticals. These velocities were corrected using the sampler nozzle velocities and known hydraulic efficiencies. At vertical no. 18, the current meter and sampling rig were caught on some obstruction at the bed, and the current meter shaft was bent. Because of these various difficulties, the measurement was repeated on August 21, 1982 using the Price meter. The difference between the two measurements is less than 2 percent, so we believe the corrections applied to the measurement of August 20 were adequate.

At El Almacen on August 22, the y-remote trisponder failed to operate, so a complete water-discharge measurement was not made. Instead, samples and velocities were collected at only 13 verticals. The discharge figure given for El Almacen (table 1) is a rough approximation only.

EXPLANATION OF TABLES

The results of our discharge measurements and the station numbers and locations where the measurements were made are shown in table 1. Station locations are shown in figure 1. A summary of how many suspended sediment and bed samples were collected at each of the major stations also is included in table 1. Station 209 is not listed; it was located in the Rio Caroni at Puerto Ordaz about 200 meters downstream of the bridge, near the center of the channel. A suspended sediment and chemistry sample were collected there (see table 15). The channel bed is rock at at this location.

The depth-integrated (DI) samples were individually analyzed to determine the cross-channel variation of suspended-sediment concentration and discharge. Cross-channel variations of depth and sediment concentrations are shown in figure 1. The equal-transit rate (ETR) samples were collected at equally spaced verticals across the section with the same vertical transit rate throughout the cross section. They were composited into a single sample for each cross section. Equal-transit rate samples (ETR) are sometimes called equal-width increment (EWI) samples.

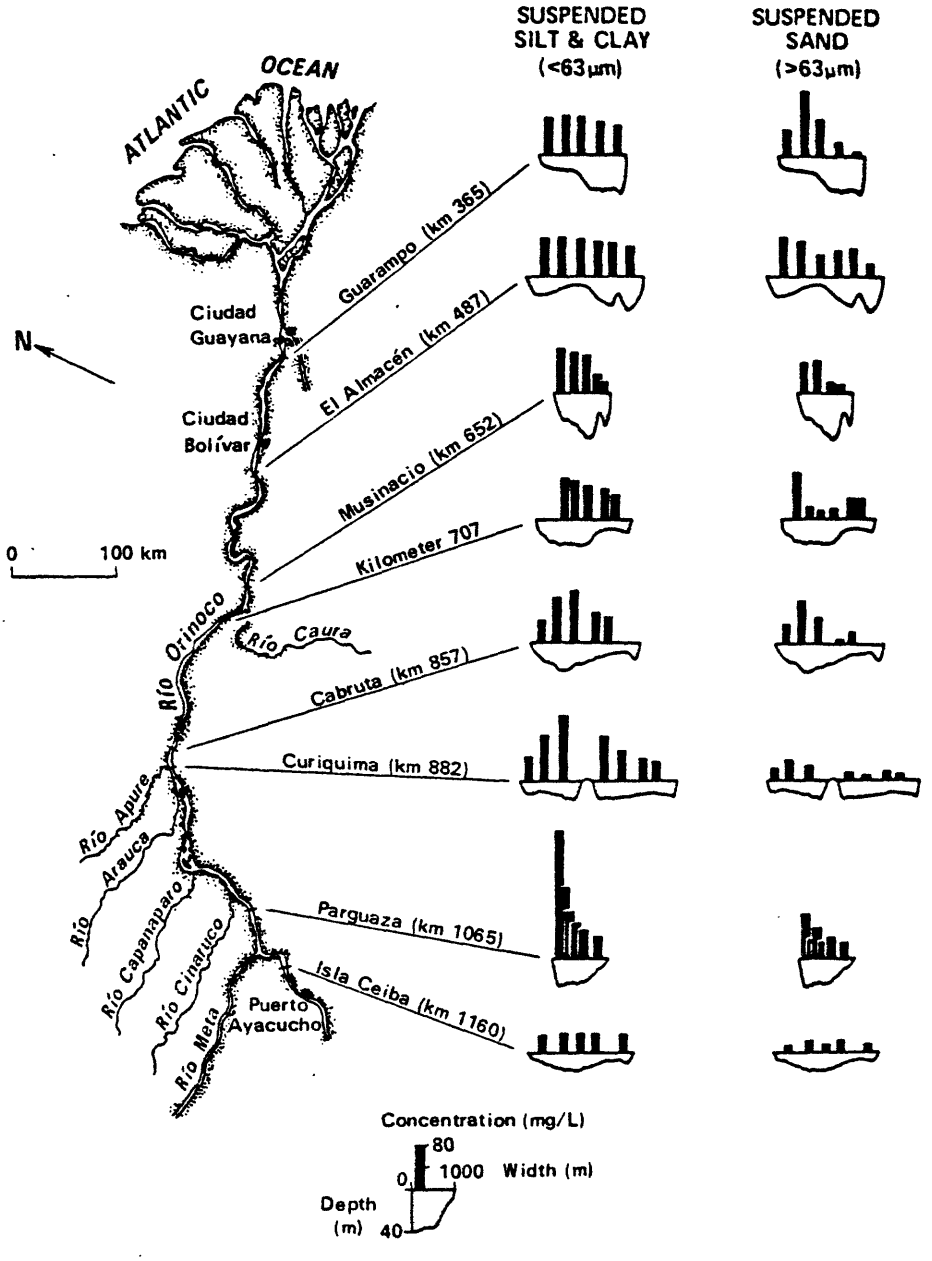

Figure 1.--Location map of stations and cross-channel variations in depths and sediment concentrations.

The cross-channel vertical stationing at each of the major cross sections, the distance from the trisponder, the depth, and the mean velocity for each vertical are shown in tables 2 through 11. The location of the trisponder (right or left bank) is given in the table headings.

Special velocity measurements were made at a proposed bridge crossing at Punta Cuchillo on August 25, 1982. The depths and the velocities at specified observation depths below the water surface are listed in table 12. The velocity coefficient shown in the fifth column was derived from the velocity-profile data of the station 791 meters from the right bank. The near-surface velocity (at 2.7 meters depth) is multiplied by the coefficient to estimate the mean velocity in the vertical. Where velocities were recored at 0.2, 0.5, and 0.8 of the depth, the average of the readings at 0.2 and 0.8 depth is taken as the mean velocity in the vertical.

At three selected verticals, velocity readings were taken at 10 points distributed approximately in equal increments of depth. These point-velocity readings are given in table 13.

The particle-size distributions of bed material samples are listed in table 14. The size distributions were determined by sieving. The concentrations of suspended sediment in individual depth-integrated samples, are given in table 15 and concentrations and discharges of suspended sediments from the ETR samples are listed in table 16. The particle-size distributions of the ETR samples for the material coarser than 0.062 millimeter, determined by wet-sieving the sand fractions of the samples are listed in table 17.

The information in tables 1, 14, 16, and 17 give all the information needed for calculations of total sediment discharge by the Modified Einstein method (Colby and Hembree, 1955). For these calculations, the increment of depth not sampled is 46 centimeters, which was the distance from sample nozzle to the bottom of the sounding weight.

REFERENCES

Colby, B. R., and Hembree, C. H., 1955, Computations of total sediment discharge, Niobrara River near Cody, Nebraska: U.S. Geological Survey Water-Supply Paper 1357, 187 p.

Table 1.--Summary of station locations, discharge measurements, water temperature, and sediment samples collected.

Date Aug. 1982	River kilometers	Station number	Station Rio Orinoco	Water discharge cubic meters per second	Area, square meters	Width, meters	Mean depth, meters	Mean velocity, meters per second	Gage height, meters	Gage	Average water temp., degrees Celcius	No. of bed samples	No. of DI samples	No. of verticals in ETR samples
15	1,269	201	Below Isla Ceiba	30,820	28,620	2,505	11.4	1.08	51.14	Puerto Ayacucho	26.8	5	5	8
16	1,131	202	Near Parguaza	43,650	23,750	1,333	17.8	1.84	10.39	Parguaza	26.6	5	6	9
17	882	203	At Curiquima	47,100	41,980	3,338	12.6	1.12	13.10	Capuchinos	27.5	8	7	9
18	857	204	At Cabruta	59,900	42,200	2,560	16.5	1.42	33.95	Caicara	28.6	8	5	8
19	707	205	At Mile 382	57,300	38,100	2,195	17.4	1.50	-	-	28.2	6	6	7
20	652	206	At Musinacio	70,700	36,700	1,310	28.0	1.93	26.77[1]	Musinacio	29.6	5	6	8
21	652	206	At Musinacio	72,000	37,000	1,290	28.7	1.95	26.78[1]	Musinacio	-	-	-	-
22	487	207	At El Almacen	65,000	46,000	2,680	17.2	1.41	-	-	29.4	6	6	7
23	365	208	At Guarampo	67,140	43,750	2,040	21.4	1.53	11.70	Punta Cuchillo	30.0	5	5	10
25	355	210	At Punta Cuchillo	70,900	39,700	1,518	26.2	1.79	-	-	-	-	-	-

	Location	
Station	Latitude	Longitude
201	05° 53.9'N	67° 32.8'W
202	06° 26.3'N	67° 10.6'W
203	07° 35.4'N	66° 25.7'W
204	07° 37.9'N	66° 15.3'W
205	07° 48.0'N	65° 07.3'W
206	07° 42.8'N	64° 43.4'W
207	08° 04.4'N	63° 51.7'W
208	08° 17.0'N	62° 52.2'W

[1]There is some uncertainty in these gage readings.

Table 2.--Summary of depth and mean velocity from water-discharge measurement, Rio Orinoco below Isla Ceiba, August 15, 1982. Trisponder is on right bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
201 - 0	2505	0	0
1	2425	7.4	.79
2	2319	7.6	.78
3	2185	9.2	.90
4	2108	11.4	.88
5	2012	12.4	.94
6	1918	13.9	1.05
7	1798	15.8	1.07
8	1712	15.8	1.14
9	1644	18.4	1.18
10	1578	15.5	1.35
11	1486	18.0	1.19
12	1412	17.0	1.19
13	1364	17.5	1.27
14	1287	18.0	1.06
15	1230	16.4	1.27
16	1094	15.4	1.16
17	1070	14.3	1.10
18	959	12.0	.97
19	903	11.5	1.04
20	763	9.5	1.03
21	724	9.1	.89
22	600	9.0	.81
23	474	8.2	.87
24	422	7.6	.92
25	290	9.2	.96
26	202	11.0	.94
27	96	10.3	.90
28	10	0	0

Table 3.—Summary of depth and mean velocity from water-discharge measurement, Rio Orinoco near Rio Parguaza, August 16, 1982. Trisponder is on left bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
202 - 0	1335	0	0
1	1208	8.0	1.18
2	1095	9.8	1.06
3	1050	10.7	1.13
4	948	15.2	1.49
5	888	17.5	1.69
6	864	18.5	1.58
7	804	21.0	1.81
8	750	22.6	1.85
9	700	22.2	1.94
10	660	22.4	2.03
11	605	25.5	2.05
12	538	23.8	1.95
13	510	23.8	2.03
14	459	22.8	2.05
15	424	23.6	1.94
16	395	23.2	1.94
17	346	21.2	2.02
18	320	22.8	1.79
19	265	24.8	1.95
20	228	24.6	2.20
21	179	25.5	2.51
22	154	26.2	2.12
23	132	27.6	2.00
24	89	21.5	1.59
25	40	12.0	1.23
26	2	0	0

Table 4.--Summary of depth and mean velocity from water-discharge measurements, Rio Orinoco at Curiquima, August 17, 1982. Trisponder is on right bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
203 - 0	200	0	0
1	280	15.5	1.23
2	392	12.4	1.16
3	467	12.5	1.49
4	606	12.5	1.47
5	690	11.4	1.30
6	795	10.0	1.08
7	902	10.5	1.11
8	1004	11.3	1.21
9	1105	12.3	1.14
10	1234	12.8	.90
11	1284	13.0	1.04
12	1428	14.5	1.08
13	1511	15.0	1.15
14	1607	16.2	1.16
15	1710	15.8	1.14
16	1800	15.4	1.33
17	1909	14.7	1.17
18	1996	17.1	1.01
19	2100	14.0	.99
--	2140	0	0
--	2380	0	0
20	2580	18.0	.95
21	2688	15.9	.95
22	2802	15.2	1.03
23	2919	12.8	1.13
24	2978	13.9	.99
25	3088	12.1	1.11
26	3225	10.6	1.12
27	3296	10.2	1.22
28	3408	9.4	1.15
29	3501	9.4	1.15
30	3600	10.2	1.13
31	3710	11.2	1.01
32	3778	8.8	.37

Table 5.--Summary of depth and mean velocity from water-discharge measurement, Rio Orinoco at Cabruta, August 18, 1982. Trisponder is on left bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
204 - 0	2560	0	0
1	2418	17.5	.97
2	2264	8.8	1.02
3	2004	11.1	.96
4	1788	11.4	1.20
5	1702	12.7	1.06
6	1542	15.6	1.06
7	1507	15.5	1.20
8	1436	16.9	1.21
9	1348	19.6	1.23
10	1308	18.2	1.22
11	1206	21.3	1.12
12	1151	20.8	1.48
13	1046	22.9	1.51
14	995	22.6	1.61
15	898	24.8	1.75
16	842	26.3	2.00
17	760	27.2	1.86
18	694	28.3	1.82
19	594	25.3	1.72
20	544	21.3	1.92
21	446	19.0	1.73
22	408	19.3	1.41
23	308	18.4	1.43
24	229	16.3	1.42
25	150	13.2	1.45
26	102	10.8	1.41
27	44	7.5	.96
28	3	0	0

Table 6.--Summary of depth and mean velocity from water-discharge measurement, Rio Orinoco at mile 382, August 19, 1982. Trisponder is on left bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
	5	0	0
205 - 0	54	14.0	1.34
1	150	16.0	1.50
2	196	16.8	1.74
3	304	21.8	1.54
4	340	22.2	1.49
5	452	22.5	1.87
6	488	23.3	1.56
7	596	23.6	1.72
8	646	22.5	1.76
9	740	23.5	1.64
10	806	22.6	1.63
11	855	24.5	1.60
12	894	24.3	1.54
13	1014	24.8	1.39
14	1068	25.0	1.50
15	1131	24.5	1.48
16	1192	22.5	1.42
17	1265	21.5	1.46
18	1395	12.0	1.24
19	1581	10.0	1.18
20	1698	9.6	1.31
21	1801	10.4	1.21
22	1872	10.8	1.24
23	1976	12.7	1.31
24	2151	13.4	1.24
25	2200	0	0

Table 7.--Summary of depth and mean velocity from water-discharge measurement, Rio Orinoco at Musinacio, August 20, 1982. Trisponder is on left bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
206 - 0	90	0	0
1	168	14.2	.95
2	258	22.5	1.54
3	299	24.5	1.70
4	349	25.3	2.10
5	395	25.0	2.06
6	435	25.7	2.05
7	494	27.9	1.88
8	547	31.0	2.04
9	590	31.4	2.08
10	642	33.1	2.10
11	696	37.0	1.95
12	756	39.4	2.00
13	790	38.5	2.16
14	853	42.0	2.02
15	892	43.6	1.94
16	952	43.9	2.00
17	986	43.5	1.88
18	1058	38.5	1.76
19	1095	25.5	2.23
20	1160	18.0	2.05
21	1216	18.5	2.00
22	1245	30.0	2.36
23	1292	33.0	1.58
24	1343	21.0	1.05
25	1400	0	0

Table 8.--Summary of depth and mean velocity from water-discharge measurement, Rio Orinoco at Musinacio (Repeat) August 21, 1982. Trisponder is on left bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
206 - 0	90	0	0
1	158	14.6	.58
-	162	14.8	1.37
2	248	22.5	1.48
-	272	22.5	1.73
-	304	22.5	1.83
3	316	22.5	1.74
4	345	24.0	1.78
-	354	24.5	1.86
-	416	24.8	2.09
5	422	25.0	2.10
-	444	28.0	2.03
6	455	30.0	2.20
-	488	27.0	2.17
7	497	27.0	1.96
8	561	31.0	2.02
9	584	32.0	1.70
10	654	33.6	2.18
11	694	35.0	2.13
12	742	36.6	2.13
13	798	36.5	2.33
14	839	37.5	2.12
15	893	36.5	2.30
16	935	35.8	2.02
17	1008	33.5	2.25
18	1032	35.5	2.14
19	1098	31.8	1.90
20	1143	33.5	1.77
21	1212	40.4	1.68
22	1235	24.0	1.82
23	1270	20.5	1.98
24	1336	18.0	.80
25	1380	0	0

Table 9.—Summary of depth and mean velocity from water-discharge measurement, Rio Orinoco at El Almacen, August 22, 1982. Trisponder is on right bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
207 - 0	100	0	0
1	250	25.7	1.13
2	402	33.4	1.36
3	572	20.2	.54
4	784	28.0	1.62
5	1022	22.8	1.51
6	1174	20.0	1.34
7	1368	12.0	1.18
8	1556	8.1	1.15
9	1795	9.5	1.76
10	1980	12.4	1.77
11	2213	15.8	1.77
12	2400	19.0	1.71
13	2600	19.0	1.62
14	2780	0	0

Table 10.--Summary of depth and mean velocity from water-discharge measurement, Rio Orinoco at Guarampo, August 23, 1982. Trisponder is on right bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
208 - 0	-10	0	0
1	93	34.0	.94
2	148	37.5	.94
3	217	32.5	1.04
4	258	32.0	1.36
5	304	31.7	1.41
6	380	33.5	1.55
7	410	32.4	1.58
8	457	32.0	1.81
9	492	32.3	1.69
10	556	35.6	1.78
11	611	32.0	1.79
12	650	32.5	1.82
13	709	32.3	1.76
14	738	32.8	1.79
15	805	32.8	1.58
16	850	31.6	1.84
17	882	30.6	1.54
18	940	26.0	1.48
19	1050	21.8	1.66
20	1108	18.4	1.52
21	1208	16.0	1.72
22	1318	16.0	1.68
23	1410	15.0	1.76
24	1520	14.5	1.68
25	1600	14.0	1.58
26	1712	13.5	1.30
27	1793	12.3	1.34
28	1900	11.8	1.21
29	1960	10.8	1.12
30	2030	0	0

Table 11.--Summary of depth and mean velocity from water-discharge measurement, Rio Orinoco at Punta Cuchillo, August 25, 1982. Trisponder is on right bank

Station and vertical number	Distance from trisponder, meters	Depth, meters	Mean velocity, meters per second
210 - 1	-5	0	0
2	50	19.5	.44
3	106	28.2	.78
4	157	31.0	1.21
5	204	32.7	1.47
6	248	34.6	1.72
7	299	34.3	1.74
8	352	32.7	1.98
9	398	32.4	2.11
10	442	33.0	1.96
11	503	32.2	2.14
12	543	32.0	2.22
13	603	31.9	1.94
14	648	31.1	2.17
15	692	33.2	2.14
16	748	31.6	2.25
17	791	32.5	2.13
18	840	31.0	2.18
19	894	30.0	2.23
20	956	28.0	2.14
21	1002	27.0	2.01
22	1050	27.0	2.22
23	1100	26.0	1.85
24	1160	26.0	1.76
25	1196	24.5	1.69
26	1252	23.2	1.60
27	1295	20.0	1.52
28	1350	19.0	1.39
29	1397	18.2	1.17
30	1453	15.0	1.07
31	1495	12.5	.80
32	1552	9.5	.49
33	1600	0	0

Table 12.--Summary of depth and velocity observations, Rio Orinoco at Punta Cuchillo, August 25, 1982. This cross section is at an angle of 18° 55' 12" from a line perpendicular to the mean flow direction

Station from right bank, meters	Depth, meters	Observation depth, meters	Velocity, meters per second	Velocity coefficient for observation depth	Mean velocity in vertical, meters per second
-5	0				
50	19.5	2.7	0.50	.88	0.44
106	28.2	6.4	.93		.78
		16.2	1.04		
		23.2	.62		
157	31.0	2.7	1.36	.89	1.21
204	32.7	7.2	1.56		1.47
		17.3	1.41		
		28.0	1.38		
248	34.6	2.7	1.93	.89	1.72
299	34.3	7.6	1.99		1.74
		17.8	1.86		
		28.0	1.68		
352	32.7	2.7	2.22	.89	1.98
398	32.4	7.2	2.56		2.11
		16.8	2.22		
		26.4	1.66		
442	33.0	2.7	2.20	.89	1.96
503	32.2	7.4	2.58		2.14
		17.3	2.19		
		27.2	1.71		
543	32.0	2.7	2.50	.89	2.22
603	31.9	7.2	2.00		1.94
		16.8	2.34		
		26.4	1.89		
648	31.1	2.7	2.44	.89	2.17
692	33.2	7.0	2.58		2.14
		16.8	2.32		
		27.2	1.71		
748	31.6	2.7	2.53	.89	2.25

Table 12.--Summary of depth and velocity observations, Rio Orinoco at Punta Cuchillo, August 25, 1982.--Continued

Station from right bank, meters	Depth, meters	Observation depth, meters	Velocity, meters per second	Velocity coefficient for observation depth	Mean velocity in vertical, meters per second
791	32.5	4.0	2.49		
		7.9	2.67		2.13
		10.4	2.41		
		13.6	2.52		
		16.8	2.26		
		20.5	2.03		
		23.2	1.76		
		26.4	1.59		
		29.6	1.63		
		31.7	1.73		
840	31.0	2.7	2.45	.89	2.18
894	30.0	6.8	2.19		2.23
		15.8	2.22		
		24.8	2.27		
956	28.0	2.7	2.41	.89	2.14
1002	27.0	6.4	1.91		2.01
		14.8	2.40		
		23.2	2.11		
1050	27.0	2.7	2.49	.89	2.22
1100	26.0	6.0	2.51		1.85
		13.3	1.94		
		20.8	1.19		
1160	26.0	2.7	1.98	.89	1.76
1196	24.5	5.6	1.93		1.69
		13.3	1.88		
		20.8	1.45		
1252	23.2	2.7	1.82	.89	1.60
1295	20.0	4.8	1.74		1.52
		10.8	1.93		
		16.8	1.29		
1350	19.0	2.7	1.56	.89	1.39
1397	18.2	4.4	1.28		1.17
		7.8	1.36		
		15.2	1.06		
1453	15.0	2.7	1.19	.90	1.07
1495	12.5	8.3	.82	.98	.80
1552	9.5	2.7	.54	.90	.49
1600	0				

Table 13.--Point-velocity readings at three selected verticals from the Rio Orinoco

Station and vertical number depth = 14.3 meters	Observation depth, meters	Velocity, meters per second	Station and vertical number depth = 25.8 meters	Observation depth, meters	Velocity, meters per second
201.- 17	1.37	1.19	202 - 21	2.44	2.31
	2.74	1.23		4.88	2.56
	4.11	1.23		7.32	2.44
	5.49	1.25		9.75	2.60
	6.86	1.29		12.2	2.34
	8.23	1.29		14.6	2.40
	9.60	1.17		17.1	2.42
	10.97	1.14		19.5	2.40
	12.34	1.00		21.9	2.10
	13.72	.96		24.4	2.08

Table 13.--Point-velocity readings at three selected verticals from the Rio Orinoco--Continued

Station and vertical number depth = 32.5 meters	Observation depth, meters	Velocity, meters per second
210 - 17	4.0	2.49
	7.9	2.67
	10.4	2.41
	13.6	2.52
	16.8	2.26
	20.5	2.03
	23.2	1.76
	26.4	1.59
	29.6	1.63
	31.7	1.73

Table 14. Particle size distribution from sieve analyses of bed material samples, Rio Orinoco, August 1982.

Date 1982	Station and vertical number	Percent finer than indicated size, in millimeters															
		0.062	.088	.125	.177	.250	.354	.500	.707	1.00	1.41	2.00	2.82	4.00	5.66	8.00	11.3	16.0
15 August	201 - 3	0	.2	.5	1.8	12.9	32.9	56.8	75.8	89.8	97.0	99.3	99.8	100				
	9	0	0	.1	.4	3.8	19.3	50.1	74.5	88.1	95.8	98.4	99.1	99.7	99.9	100		
	14	0	0	.2	.9	4.4	24.2	51.0	67.9	79.6	87.6	93.1	96.0	97.1	99.2	100		
	19	.2	.2	.6	1.3	17.6	51.9	67.5	76.1	82.1	86.6	90.6	94.0	95.5	97.4	100		
	25	1.1	1.7	4.4	17.8	62.5	90.4	96.9	98.7	99.0	99.4	99.4	99.8	100				
16 August	202 - 3	0	.2	.2	.6	6.4	39.6	93.2	99.6	100								
	8	0	0	0	0	1.0	8.7	55.4	95.7	100								
	12	0	0	.1	.4	2.3	10.0	35.1	67.8	85.4	93.1	97.5	99.4	99.6	100			
	15	0	0	0	0	1.1	8.3	30.5	57.2	77.1	87.5	94.3	97.2	99.1	99.3	99.7	100	
	22	.6	.9	1.5	6.5	38.5	91.1	98.8	99.4	100								
17 August	203 - 1	.2	.2	.6	4.8	40.4	87.2	98.2	100									
	5	0	0	.5	.9	10.1	52.2	82.1	92.2	96.3	98.4	99.1	99.8	100				
	9	0	0	.2	.2	2.0	17.7	48.8	69.7	82.8	90.8	95.6	98.2	99.1	99.7	100		
	13	0	0	0	0	2.2	11.0	41.9	64.9	80.0	90.4	96.4	98.4	99.0	99.5	99.6	100	
	17	0	0	0	.3	4.0	24.2	61.6	81.4	90.6	95.8	98.4	99.5	99.9	100			
	20	.7	.9	6.0	41.9	75.9	91.2	97.8	99.1	99.6	99.8	100						
	24	0	0	1.4	10.0	25.0	33.0	43.2	52.1	59.7	68.0	79.5	90.3	96.2	99.1	100		
	28	0	0	.5	1.8	13.3	80.9	96.9	98.9	99.5	99.8	100						
18 August	204 - 1	.7	1.3	3.6	7.2	20.7	62.8	92.8	97.7	99.0	99.3	100						
	3	.3	.8	2.4	14.9	60.4	92.8	98.7	99.7	100								
	5	.7	.7	.7	2.3	10.7	45.7	72.0	83.6	89.8	94.8	97.2	99.1	99.6	100			
	9	0	0	0	.7	5.2	27.3	51.4	67.3	78.9	88.2	94.5	98.2	99.2	99.9	100		
	13	.2	.2	.8	4.4	19.1	39.7	61.8	76.9	87.2	93.9	97.7	99.4	96.6	100			
	17	0	0	.2	1.7	13.4	58.3	95.2	99.3	99.8	99.8	99.8	100					
	21	0	0	.2	.4	3.6	20.8	53.8	76.2	87.4	93.6	97.2	98.8	99.8	100			
	25	0	0	0	0	1.4	19.6	80.6	98.6	100								

Teble 14. Particle size distribution from sieve analyses of bed material samples, Rio Orinoco, August 1982.--Continued.

Date 1982	Station and vertical number	Percent finer than indicated size, in millimeters															
		0.062	.088	.125	.177	.250	.354	.500	.707	1.00	1.41	2.00	2.82	4.00	5.66	8.00	11.3	16.0
19 August	205 - 2	.3	.3	.9	3.3	6.2	18.4	54.4	80.6	90.4	93.7	95.4	96.4	96.9	97.6	98.1	100	
	6	0	0	0	0	.9	4.6	13.4	25.5	42.1	60.0	78.2	89.8	94.1	97.1	97.9	97.9	100
	15	.2	.2	.2	5.0	5.4	20.7	53.6	79.6	90.7	95.5	98.4	99.6	99.8	100			
	18	.2	.2	.8	10.7	25.0	82.1	97.4	99.2	99.8	100							
	20	0	.2	.8	3.7	30.9	84.5	96.6	98.5	99.1	99.3	100						
	23	0	0	.2	2.1	30.8	93.6	99.0	99.4	99.8	100							
20 August	206 - 2	0	0	0	1.7	15.1	47.2	93.8	99.8	100								
	5	0	0	0	0	0	.9	7.7	36.1	72.1	90.5	97.1	98.9	99.3	99.6	100		
	8	.2	.2	.2	.3	2.4	22.1	65.2	85.8	94.0	97.1	98.8	99.1	99.2	99.4	100		
	14	0	0	0	0	1.9	26.9	65.7	83.4	93.1	97.3	99.2	99.6	100				
	19	0	0	0	0	1.0	7.0	19.0	36.8	56.2	72.2	85.8	93.2	96.2	98.6	100		
22 August	207 - 3	.2	.2	.7	.7	2.3	20.0	66.2	94.1	98.9	99.5	100						
	5	0	0	.6	2.8	8.9	20.7	41.1	57.2	72.5	84.5	93.1	96.9	97.9	98.8	99.8	100	
	7	0	0	.2	.8	11.2	57.6	88.6	95.1	98.0	98.8	99.2	99.8	100				
	8	0	0	.5	1.6	9.6	54.4	87.7	96.0	98.9	100							
	11	0	0	0	.5	4.2	24.5	61.9	84.0	92.0	96.4	98.4	98.9	99.7	100			
	13	0	0	.7	4.9	12.1	20.9	44.9	69.4	83.3	91.0	96.0	98.2	99.2	99.6	100		
23 August	208 - 3	0	0	1.4	6.3	17.3	24.8	30.8	37.1	43.6	50.1	57.8	66.7	76.6	87.7	96.8	100	
	11	0	0	0	.2	.2	1.4	16.7	48.6	71.4	84.9	92.9	97.9	98.6	99.8	100		
	19	0	.4	.5	2.0	9.2	43.7	88.8	97.5	98.9	99.3	99.6	99.6	99.9	100			
	23	0	0	0	1.3	10.6	73.3	98.9	100									
	27	0	0	.8	4.8	19.5	53.9	86.5	98.2	100								

Table 15.—Concentrations of suspended sediment in individual depth-integrated samples, Rio Orinoco, August 1982. Silt and clay are finer than 0.062 millimeters. Sand is coarser than 0.062 millimeters.

Station number	Sample distance from left bank, meters	Depth meters	Concentration, in milligrams per liter		
			Silt and clay	Sand	Total
201	320	9	32	13	45
	860	18	37	22	59
	1220	18	35	14	49
	1600	11	36	21	57
	2220	9	33	14	47
202	150	27	237	86	323
	320	23	131	37	168
	420	24	88	59	147
	540	24	66	32	98
	750	23	54	42	96
	1060	11	42	31	73
203	180	10	46	22	68
	550	11	85	36	121
	980	15	124	28	152
	1930	16	83	14	97
	2350	13	56	10	66
	2740	10	43	17	60
	3170	12	36	13	49
204	230	16	41	36	77
	590	25	84	79	163
	990	23	98	49	147
	1500	15	56	10	66
	1780	11	49	22	71
205	340	22	—	85	—
	640	23	76	23	99
	890	25	70	16	86
	1190	22	62	20	82
	1580	10	57	39	96
	1870	11	46	35	81
206	150	23	83	57	140
	320	25	76	57	133
	460	31	77	61	138
	760	43	71	21	92
	1000	27	35	17	52
	1160	18	22	2	24
207	380	19	72	73	145
	800	12	73	66	139
	1220	8	69	41	110
	1610	20	66	48	114
	2000	28	63	53	116
	2380	33	57	25	82
208	240	12	67	48	115
	620	15	72	121	193
	980	21	71	68	139
	1420	32	62	25	87
	1810	32	53	9	62
209	mid-river	16	6	2	8

Table 16.--Concentrations and discharges of suspended sediment as measured in equal-width-increment samples, Rio Orinoco, August 1982. Silt and clay are finer then 0.062 millimeters. Sand is coarser than 0.062 millimeters.

Station number	Number of verticals used for sediment sample	Concentration, in milligrams per liter			Sediment Discharge	
		Silt and clay	Sand	Total	Kilograms per second	Megagrams per day
201	8	36	15	51	1,570	136,000
202	9	115	61	176	7,680	664,000
203	9	69	20	89	4,190	362,000
204	8	76	35	111	6,650	574,000
205	7	72	36	108	6,190	535,000
206	8	65	34	99	7,130	616,000
207	7	67	53	120	7,800	674,000
208	10	68	51	119	7,990	690,000

Table 17.--Particle size distributions of suspended sediment in equal-width-increment samples, Rio Orinoco, August 1982.

Station number	Concentration, milligrams per liter	Percent finer than indicated size, in millimeters				
		0.062	0.125	0.250	0.500	1.00
201	51	70.6	82.6	95.5	98.5	100
202	176	65.3	75.4	94.7	99.4	100
203	89	77.5	86.8	97.7	99.7	100
204	111	68.5	79.5	93.3	99.6	100
205	108	66.7	82.1	96.9	99.7	100
206	99	65.7	80.1	91.7	99.5	100
207	120	55.8	71.9	90.1	99.3	100
208	119	57.1	75.3	93.5	99.7	100