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Sand, Gravel and Heavy-Mineral Resources Potential of Surficial Sediments Offshore of Cape Canaveral, Florida

by

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SAND, GRAVEL AND HEAVY-MINERAL RESOURCES POTENTIAL OF SURFICIAL SEDIMENTS OFFSHORE OF CAPE CANAVERAL, FLORIDA

Phase II and Final Report

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INTRODUCTION

The Florida Geological Survey, in cooperation with the United States Minerals Management Service, the University of Texas at Austin, the United States Geological Survey and the University of South Florida, has continued the investigation of continental shelf sediments offshore of Cape Canaveral, Florida, under cooperative agreement number 14-12-0001-30387. This study (Phase II) was funded from June, 1988 to December, 1989 and followed the Phase I project (cooperative agreement number 14-12-0001-30316) (Nocita et al., 1989a). Phase I plus Phase II complete the study of the Cape Canaveral area.

Much of the Inner Continental Shelf offshore of Cape Canaveral is mantled by an extensive set of sand shoals. These shoals (Figure 1) may be potential sources of sediment for beach nourishment and also for a variety of strategic and critical heavy-mineral species including ilmenite, rutile, zircon and monazite. Other heavy minerals of less economic importance such as garnet, staurolite, aluminosilicates (sillimanite/kyanite/andalusite), and phosphate are also present. This report summarizes the results of the Phase I and Phase II studies in the Cape Canaveral area.

PREVIOUS WORK

The inner continental shelf region offshore Cape Canaveral has been the subject of a variety of different types of studies. The work of Field and Duane (1974) examined the geomorphology and sediment characteristics in the area. Their data base consisted

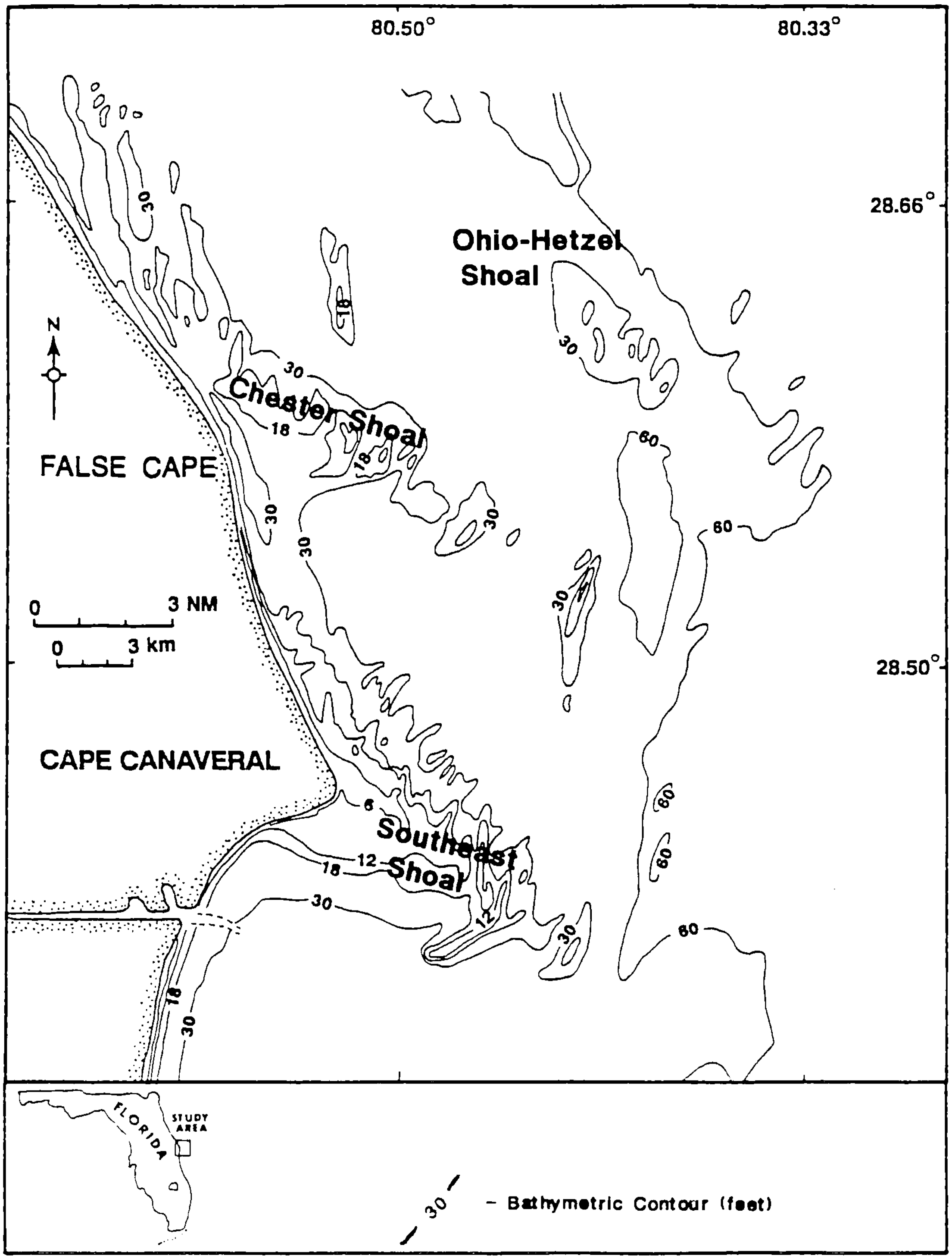

Fig. 1: Location map showing major shoal bodies and bathymetry.

of vibracore samples and high-resolution seismic lines. Sediment analysis was from plugs taken from the vibracore samples. The coverage of seismic profiles excluded most of the major sand-shoal body which is attached to the Cape. This was presumably due to the shallow water depths.

Evolution of the inner shelf sediments, including the shoal bodies has been discussed by Duane et al. (1972) and Field (1974). Field (1974) documented the occurrence and location of buried strandline deposits on the basis of accumulation of an intertidal clam, Donax variabilis. Duane et al. (1972) discussed shoreface-connected and isolated linear shoals associated with the Cape, and concluded that they formed by coastal-retreat processes.

Heavy-mineral studies in the Cape Canaveral area are those related to the current project. Preliminary results have been presented by Nocita et al. (1989a, 1989b) and Grosz et al. (1989a).

METHODS

The data base for Phase II is derived from two sets of sediment samples. One set is made up of vibracores and the other is surface grab samples. The vibracores were part of a larger repository of U.S. east coast samples that were initially collected by the U.S. Army Corps of Engineers Coastal Engineering Research Center (CERC) as part of a sand and gravel inventory program on the U.S. Atlantic Shelf (Field and Duane, 1974). Vibracores from offshore Florida's east coast originally were archived by The U.S. Geological Survey in Reston, Virginia, and now reside at the Florida Institute of Technology in Melbourne, Florida. Surface samples were collected and high-resolution seismic lines were run in July, 1989 as part of the Phase II study.

Phase II comprised a total of 79 samples derived from 44 vibracores. Added to the Phase I data base, this brings the total number of vibracores and samples for the Cape Canaveral area to 84 and 140 respectively (Figure 2). A total of 93 surface samples was collected, mostly in the shoal areas (Figure 3).

Vibracores

The methodology for initial preparation and sample analysis of the vibracores is the same for Phase II samples as for Phase I samples. Samples were processed for information on grain-size distribution, composition, heavy-mineral content, and mineralogy of the heavy-mineral assemblage. Cores were split lengthwise, described, photographed, and divided into approximately 1.5 m sections on the basis of lithology and/or section length if the lithology was consistent throughout. Repository samples of approximately 300-500 grams were collected from each section. Samples were weighed on a dry-weight basis; weights ranged from about 4 to 18 kilograms (kg), averaging approximately 9 kg. Samples were then sieved to separate the gravel fraction (>-1 phi) from which a weight-percent gravel was calculated.

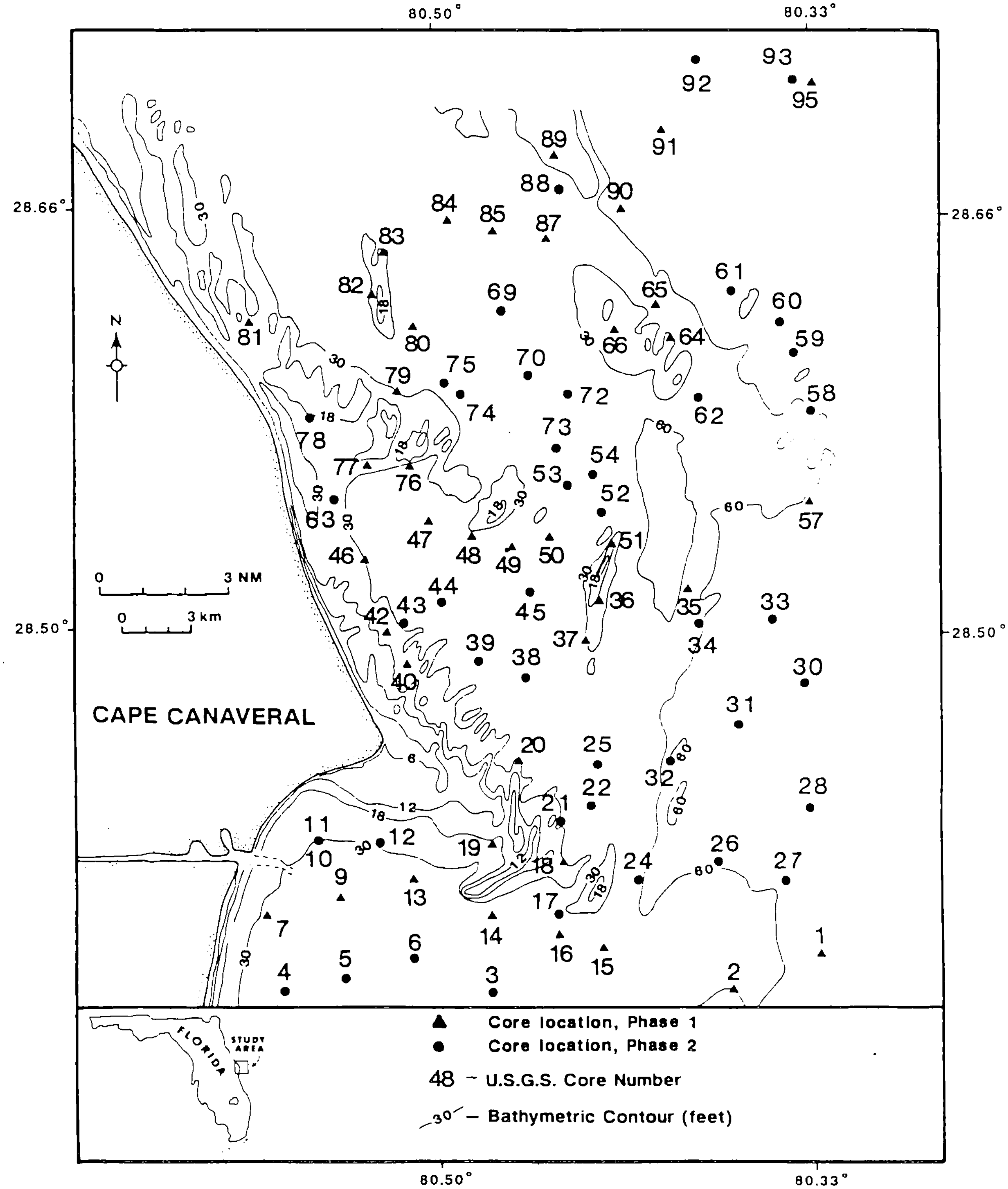

Fig. 2: Vibracore location map.

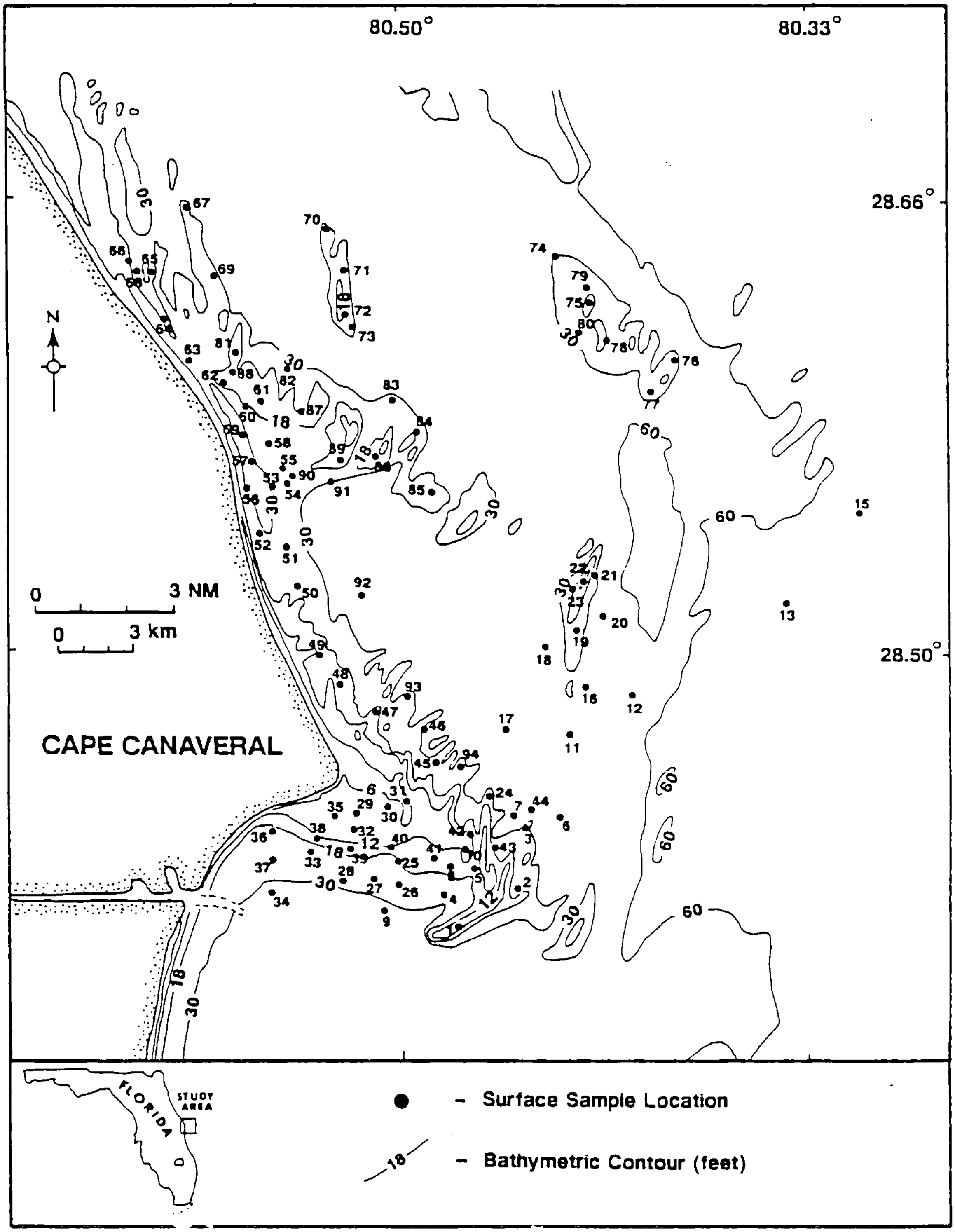

Fig. 3: Surface sample location map.

Heavy Minerals

Most previous studies of heavy minerals in recent marine sediments used initial samples of relatively small mass, typically in the range of 100 to 200 g, usually collected from the sea floor as grab samples. The heavy-mineral concentrate from these small samples commonly amounted to less than 1 g. Clifton et al. (1967) have shown that low concentrations of grains result in a "particle-sparsity-effect", which leads to inaccurate quantitative analysis of mineral species that occur in very small abundances. In order to compensate for this bias, large volumes of sediment, averaging approximately 9 kg, were processed for their heavy-mineral content.

Two different processes were used to produce a final heavy-mineral concentrate. Initially, the sediment was hydrodynamically separated, producing a 500 to 1,000 g sample enriched in heavy minerals. The second step utilized high-density liquids to remove the remaining "light" fraction. Magnetic fractionation produced subsamples that were then visually examined in order to estimate abundances.

Hydrodynamic Separation

The -10 mesh (<-1 phi) (sand, silt, clay) fraction was processed by use of a three-turn sampling spiral to produce a heavy-mineral concentrate (spiral heavies) averaging about 500 g in weight. After the initial processing on the spiral, the spiral-lights fraction (material rejected by the spiral) was processed in the spiral again, and the concentrate from these two runs was processed at least one more time. The spiral heavies (concentrate) and a split (200-300 g) of the spiral lights were dried and weighed.

Heavy-liquid Separation

A purified heavy-mineral concentrate was produced from both the spiral lights and spiral heavies by use of tetrabromoethane having a specific gravity of 2.96. Weight-percent heavy minerals was calculated on the basis of heavy minerals recovered (RHM) by the spiral concentrator. The total heavy-mineral concentration (THM) in a sample was calculated by summing the RHM with the calculated percentage of heavy minerals found in the spiral lights (calculated as a percent of heavy minerals in the spiral-light subsample multiplied by the weight of the total spiral-light material). This estimate of total heavy minerals is an underestimate because some heavy minerals contained in the mud fraction of the spiral lights were lost through elutriation. The RHM fractions for each sample were further split (utilizing a microsplitter) into repository (12.5 volume percent), chemical analysis (12.5 volume percent), and magnetic separation (75 volume percent) samples.

Magnetic Separation

Six magnetic fractions were derived from the 75 percentile split of each sample by use of a Frantz Laboratory Magnetic Barrier Separator. This procedure reduced the number of variables (mineral species) in each magnetic fraction thereby facilitating the mineral identification/quantification process. The Cape Canaveral samples contain essentially no magnetite; initial separation of ferromagnetic minerals, therefore, was not necessary and the Barrier Separator was used for the entire sample fractionation.

Mineral Identification

Each of the six magnetic fractions was examined by use of a binocular microscope in order to estimate mineral abundances. Comparison charts for visual estimation of percentage composition (Terry and Chilingar, 1955) were used for this purpose along with a modified point-counting method. Petrographic examination and X-ray diffraction analysis were used to aid and verify the identification of non-opaque minerals. The composition of the magnetic fractions was quantified using the following guidelines: <0.01% = Present (P); 0.0% = Not determined (N). An "others" category was also estimated, and included those grains which could not be identified or were present in minute quantities. The identification of zircon and monazite was aided by the use o long- and short-wave (respectively) ultraviolet illumination.

Sediment Analysis

Each of the 140 bulk samples had the gravel fraction removed by use of a 10 mesh (-1 phi) U.S. Standard stairless steel sieve by wet sieving. Gravel portions were dried, weighed and stored for later description. Repository samples were used for the calculation of sand and mud percentages and for grain-size analysis of the sand fraction.

Sand and Gravel

Samples were wet sieved to separate the gravel and mud fractions from the sand. Mud-weight percent was calculated from this separation and no further analyses were done on the mud fraction.

Grain-size analysis of the sand fraction (with carbonate) was done by either sieving (1/2 phi intervals) or by use of the Rapid Sediment Analyses (RSA; settling tube). Phase I samples were analyzed by the Florida Geological Survey and by the University of South Florida using sieve techniques (no RSA was available). Phase II samples were analyzed on the RSA at the Florida Institute of Technology. Raw data was run through grain-size analysis computer programs which calculated the first four moment measures (mean, standard deviation, skewness and kurtosis). This data is not intended for detailed, quantitative grain-size analysis.

Several authors have indicated that there are significant differences in the way grain size distributions are perceived by sieving and settling processes. Bergmann (1982), notes that the settling tube sees fine grain sizes coarser than they actually are and coarse grain sizes finer than they actually are, resulting in a "compression" of the distribution. Relative to sieving, settling mean grain sizes were not significantly different, standard deviation values in almost all cases were smaller. The settling process is very poor at detecting minor changes in sediment distribution that are reflected in skewness and kurtosis values (Bergmann, 1982).

A number of samples from Phase I do not have grain-size data. This is due to one of several reasons, including lack of enough sand-sized sediment because of the fine-grained nature of the sample; initial mass of repository too small for sieving; and operator error. Weight-percent carbonate of the sand fraction was calculated by acid digestion methods for a portion of the Phase I samples.

Surface Samples

A total of 93 surface samples were collected in July, 1989. Samples were collected by means of an "underway sampler". This device, consisting of a metal cylinder with a bag clamped to one end, is lowered to the sea floor while the ship is underway. Sediment is channeled down the tube and fills the sample bag. It was determined that little mud was lost during this procedure and that the sample is a good representative of sea-floor sediment.

All surface samples were analyzed for gravel, sand and mud content by wet-sieve techniques. Grain-size analysis was done on the sand fraction by use of sieves and computer programs.

Seismic Survey

High-resolution seismic data were collected using an EG&G UNIBOOM profiling system. This system emits a broad spectrum of high frequencies (400 HZ to 14 kHZ). Peak frequency is 600-800 Hz which renders a working vertical resolution of less than one meter. The UNIBOOM was fired 3 times per second using a spark-gap source box. This particular source produces a large post-cursor and pre-cursor pulse, resulting in a significant bubble pulse. The seismic signal was collected on an 8-element hydrophone, and recorded both graphically and on a stereo VCR (analog, magnetic tape as an archive).

The data are single-channel, analog data. No digital processing was performed. Instead, the raw seismic data were photocopied, studied and interpreted. Real reflecting horizons were discriminated from multiples and highlighted. Equipment failure about one third of the way through the cruise limited the seismic coverage mainly to the Southeast Shoal off Cape Canaveral.

RESULTS

Sand and Gravel

Percentages of gravel, sand and mud were plotted on maps of the offshore Cape Canaveral area in order to show the distribution of sediment, especially that which might be desirable for the purpose of beach nourishment. Maps were made for surface samples, upper core sections and lower core sections. Gravel, sand, and mud percentages, along with grain-size analysis data are listed in Tables 1 and 2 for vibracore samples and in Tables 3 and 4 for surface samples. Weight percent carbonate of the sand sized fraction for a portion of the Phase I samples is shown in Table 5.

Because of the distinct geologic differences between the

Table 1

Sand, shell-gravel and mud weight percent for vibracore samples

U.S.G.S. Sample No.	Shell-Gravel	Sand	Mud
1-1	23.31	68.36	8.33
1-2	12.21	-	-
2-1	13.78	-	-
2-2	23.79	-	-
3	10.39	76.62	12.99
4-1	1.73	76.19	22.08
4-2	18.55	5.75	94.25
5-1	6.94	83.82	9.25
5-2	20.53	73.18	6.29
6-1	22.60	66.56	10.84
6-2	6.36	86.40	7.24
7-1	8.32	-	-
7-2	18.30	81.27	0.43
9-1	1.32	45.70	52.98
9-2	4.82	28.17	67.01
10	2.59	-	-
11-1	4.61	68.42	26.97
11-2	4.76	58.93	36.31
12-1	1.89	75.38	22.73
12-2	.75	85.34	13.91
13-1	2.85	62.91	34.25
13-2	1.66	67.98	30.36
14	9.62	64.57	25.82
15	8.91	82.88	8.21
16-1	2.49	-	-
16-2	10.72	-	-
17-1	2.37	94.47	3.16
17-2	4.31	90.15	5.54
18-1	3.16	95.49	1.35
18-2	5.30	-	-
19-1	21.33	-	-
19-2	3.45	-	-
20-1	12.79	80.31	6.90
20-2	8.04	87.77	4.19
21-1	2.35	96.64	1.01
21-2	1.72	80.26	18.03
22-1	12.85	81.84	5.31
22-2	5.46	78.84	15.70
24	8.70	89.13	2.17
25-1	5.86	84.26	9.88
25-2	26.72	64.02	9.26
26-1	8.23	88.31	3.46
26-2	20.97	72.58	6.45
27-1	32.74	63.69	3.57
27-2	36.88	48.74	14.57

Table 1

U.S.G.S. Sample No.	Shell-Gravel	Sand	Mud
28-1	28.85	67.31	3.85
28-2	11.28	82.56	6.15
30-1	30.00	62.37	7.63
30-2	16.28	76.74	6.98
31-1	1.66	70.62	27.73
31-2	14.86	71.03	14.11
32	19.79	76.30	3.91
33	4.64	93.57	1.79
34-1	1.80	96.70	1.50
34-2	9.20	87.60	3.20
35-1	3.57	-	-
35-2	21.69	-	-
36-1	2.55	95.99	1.46
36-2	8.77	-	-
37-1	1.45	97.27	1.28
38-1	14.93	73.88	11.19
38-2	7.93	84.14	7.93
39-1	9.40	78.06	12.54
39-2	9.45	71.65	18.90
40	3.55	77.23	19.22
42-1	8.30	85.16	6.10
42-2	7.73	69.98	22.29
43	12.24	75.53	12.24
44-1	19.22	68.63	12.16
45-1	6.08	79.47	14.45
45-2	13.27	60.20	26.53
46-1	0.68	63.04	36.28
46-2	3.87	-	-
47-1	13.45	80.86	5.69
47-2	33.10	43.55	23.35
48-1	-	-	-
48-2	3.57	92.43	4.00
49-1	5.32	76.53	18.15
49-2	4.97	81.42	13.61
50	0.46	98.17	1.37
51-1	2.45	96.57	0.98
51-2	2.02	96.51	1.47
52	7.94	90.48	1.59
53	20.73	75.13	4.15
54-1	15.6	80.38	2.46
54-2	20.56	72.98	6.45
57-1	1.04	87.57	11.38
57-2	10.64	76.91	12.45
58-1	7.45	90.59	1.96
59-1	10.77	86.15	3.08
59-2	5.60	[illegible].80	3.60
60-1	7.00	89.21	3.79
61	29.11	65.19	5.70
62	15.85	81.13	3.02
63-1	1.77	82.07	16.16

Table 1

U.S.G.S. Sample No.	Shell-Gravel	Sand	Mud
63-2	18.39	52.91	28.70
64-1	13.77	75.30	10.93
64-2	19.62	-	-
65	10.48	87.83	1.69
66-1	3.4	-	-
66-2	11.15	-	-
69-1	8.41	88.32	3.27
69-2	18.24	78.12	3.65
70	11.17	83.78	5.05
72-1	32.19	65.24	2.58
72-2	21.89	71.30	6.80
73	10.50	82.65	6.85
74-1	19.16	72.08	8.77
74-2	27.32	68.85	3.83
75-1	19.48	76.62	3.90
76-1	3.96	95.12	0.92
76-2	3.61	94.54	1.85
77-1	3.62	95.65	0.73
77-2	4.40	93.20	2.40
78-1	30.04	66.52	3.43
78-2	37.93	57.47	4.60
79-1	10.03	85.07	4.9
79-2	16.68	-	-
80-1	3.84	84.51	11.65
80-2	2.90	-	-
81-1	3.47	93.30	3.22
81-2	34.63	58.10	7.27
82-1	11.28	86.01	2.71
82-2	4.24	-	-
83-1	6.30	91.45	2.25
83-2	28.42	66.51	5.07
84-1	48.28	-	-
84-2	29.51	-	-
85	13.06	85.04	1.9
87-1	33.75	-	-
87-2	31.06	-	-
88-1	34.68	60.36	4.95
88-2	11.27	85.45	3.29
89-1	33.69	-	-
89-2	18.54	77.57	3.89
90	24.14	70.13	5.73
91-1	-	-	-
91-2	5.08	89.77	5.15
92-1	38.37	56.59	5.04
92-2	79.86	16.25	3.89
93	13.22	84.3	2.48
95	0.85	-	-

Table 2

Granulometric data for vibracore samples (carbonate included).
Phase 1 samples indicated by asterisk.

U.S.G.S. Sample No.	Mean grain size (phi)	Standard Deviation	Skewness	Kurtosis
1-1 *	-	-	-	-
1-2 *	1.55	1.10	-0.02	2.99
2-1 *	-	-	-	-
2-2 *	-	-	-	-
3	2.54	2.55	0.49	14.17
4-1	2.55	2.13	0.12	14.06
4-2	2.98	2.02	2.30	16.14
5-1	2.64	2.87	2.27	24.55
5-2	2.24	3.47	4.93	47.92
6-1	2.10	2.49	0.11	9.93
6-2	2.19	2.32	2.85	30.40
7-1 *	-	-	-	-
7-2 *	-	-	-	-
9-1 *	-	-	-	-
9-2 *	-	-	-	-
10	-	-	-	-
11-1	3.19	1.82	3.08	24.02
11-2	2.09	3.17	0.48	14.07
12-1	3.09	1.58	1.27	11.77
12-2	3.05	1.76	1.40	10.3
13-1 *	-	-	-	-
13-2 *	-	-	-	-
14 *	2.77	1.31	-1.16	3.43
15 *	-	-	-	-
16-1 *	3.61	0.70	-1.73	6.07
16-2 *	1.60	1.34	0.46	2.23
17-1	2.16	2.21	2.05	26.69
17-2	1.98	1.89	0.84	15.30
18-1 *	1.57	0.66	-0.89	4.62
18-2 *	1.48	0.76	-0.50	4.03
19-1 *	1.45	0.95	-0.52	3.38
19-2 *	1.76	0.76	-0.74	4.77
20-1 *	1.43	1.02	0.02	3.00
20-2 *	1.15	0.94	0.51	3.62
21-1	2.03	1.20	-2.52	22.13
21-2	2.88	1.69	0.60	13.08
22-1	1.62	2.32	-0.09	13.34
22-2	2.83	1.59	0.94	16.00
24	1.[illegible]9	1.75	-0.35	14.11
25-1	1.69	1.53	-1.30	10.40
25-2	1.73	1.90	-0.75	10.93
26-1	1.73	1.46	-0.48	11.65
26-2	1.45	1.61	-0.15	11.02
27-1	1.23	1.69	-0.25	14.43
27-2	1.28	2.13	-0.63	7.93
28-1	1.29	1.88	-1.03	15.76
28-2	1.30	1.75	-0.50	8.45
30-1	0.70	1.74	-1.78	14.27

Table 2

U.S.G.S. Sample No.	Mean grain size (phi)	Standard Deviation	Skewness	Kurtosis
30-2	1.37	1.52	-1.05	9.28
31-1	1.54	2.33	-0.25	9.95
31-2	2.87	4.13	6.60	62.43
32	1.94	2.65	2.93	30.45
33	1.68	1.49	-0.48	12.45
34-1	1.71	1.10	0.34	17.78
34-2	1.84	1.07	0.44	14.30
35-1 *	1.94	0.85	-0.61	4.37
35-2 *	-	-	-	-
36-1 *	1.35	0.81	-0.50	3.76
36-2 *	1.06	0.85	-0.06	3.19
37-1 *	1.34	0.67	-0.22	5.07
38-1	1.66	1.97	-0.84	9.44
38-2	0.98	1.82	-1.53	12.19
39-1	2.75	1.96	0.93	11.68
39-2	2.94	1.53	1.37	12.28
40 *	3.09	0.96	-2.24	8.08
42-1 *	3.19	1.03	-1.73	5.31
42-2 *	-	-	-	-
43	2.66	2.39	0.07	13.12
44-1	2.51	2.55	0.58	8.91
45-1	1.66	2.68	-0.06	9.32
45-2	2.02	2.93	-0.20	8.72
46-1 *	-	-	-	-
46-2 *	-	-	-	-
47-1 *	2.96	0.99	-0.85	3.27
47-2 *	-	-	-	-
48-1 *	1.45	0.76	-0.28	3.44
48-2 *	1.80	0.85	-0.08	4.02
49-1 *	2.42	1.18	-0.64	2.58
49-2 *	2.36	1.26	-0.61	2.40
50 *	2.04	0.59	-0.78	7.63
51-1 *	1.25	0.74	-0.33	3.67
51-2 *	2.01	0.56	1.02	6.80
52	0.71	1.66	1.06	11.47
53	1.66	1.63	-0.30	9.06
54-1	0.81	1.56	-1.81	13.30
54-2	1.93	2.49	0.44	9.23
57-1 *	2.77	0.75	-1.21	6.14
57-2 *	-	-	-	-
58-1	1.80	1.23	-0.90	17.78
59-1	1.45	1.64	-0.65	17.70
59-2	2.15	2.00	3.19	29.86
60-1	1.94	1.40	-0.12	8.14
61	1.40	1.80	-0.71	9.16
62	1.70	1.45	0.71	10.41
63-1	2.18	2.18	-1.82	14.22
63-2	2.49	1.95	0.72	11.67
64-1 *	-	-	-	-

Table 2

U.S.G.S. Sample No.	Mean grain size (phi)	Standard Deviation	Skewness	Kurtosis
64-2 *	2.09	1.31	-0.34	2.24
65 *	1.95	0.78	0.19	4.23
66-1 *	1.14	0.66	-0.11	4.68
66-2 *	1.13	0.75	-0.11	3.90
69-1	1.42	1.47	0.90	15.20
69-2	1.27	1.93	-0.02	11.89
70	1.47	1.84	-0.12	11.12
72-1	0.45	1.48	-2.80	16.96
72-2	1.47	1.59	-0.30	11.92
73	-	-	-	-
74-1	1.48	1.86	-0.63	11.76
74-2	1.43	1.50	0.17	10.57
75-1	1.79	1.80	-0.58	8.41
76-1 *	1.70	0.70	0.01	6.88
76-2 *	2.48	0.86	0.10	2.40
77-1 *	1.48	0.71	-0.38	5.19
77-2 *	1.49	0.78	0.21	4.70
78-1	0.40	1.48	-3.27	17.15
78-2	0.56	1.43	-1.97	13.92
79-1 *	2.34	0.89	0.14	3.20
79-2 *	2.35	0.82	0.56	3.18
80-1 *	2.66	0.93	-1.22	4.94
80-2 *	2.71	1.40	-0.29	1.49
81-1 *	2.29	0.91	0.62	2.14
81-2 *	-	-	-	-
82-1 *	1.39	0.96	-0.06	3.22
82-2 *	2.00	0.90	-0.05	4.15
83-1 *	1.85	0.74	-1.28	5.48
83-2 *	1.62	1.43	0.74	2.23
84-1 *	0.87	1.33	0.72	2.80
84-2 *	-	-	-	-
85 *	-	-	-	-
87-1 *	0.68	1.06	0.75	3.60
87-2 *	1.04	1.14	0.87	3.51
88-1	0.90	2.17	-1.52	13.00
88-2	1.56	1.44	0.08	12.41
89-1 *	0.87	1.10	0.27	2.49
89-2 *	1.44	1.09	0.15	3.00
90 *	2.03	1.30	0.27	1.97
91-1 *	1.68	0.92	0.87	4.08
91-2 *	1.57	1.09	0.29	2.66
92-1	1.24	1.75	-0.88	8.70
92-2	1.34	2.00	-1.16	10.25
93	2.13	1.76	2.11	21.59
95 *	-	-	-	-

Table 3

Sand, shell-gravel and mud weight percent for surface samples

Sample no.		Shell-Gravel	Sand	Mud
S-1		0.00	99.84	0.16
S-2		0.12	99.75	0.13
S-3		1.42	98.53	0.05
S-4		0.01	96.31	3.68
S-5		3.27	96.63	0.10
S-6		0.18	99.37	0.45
S-7		4.68	95.03	0.29
S-8		15.19	83.01	1.80
S-9		1.11	87.66	11.23
S-10		6.36	93.59	0.05
S-11		20.77	78.06	1.17
S-12		2.77	96.94	0.29
S-13		0.08	73.83	26.09
S-14	No Sample	----	-----	----
S-15		0.08	65.42	34.50
S-16		13.88	85.75	0.37
S-17		0.48	99.05	0.47
S-18		0.88	90.00	9.12
S-19		1.67	97.94	0.39
S-20		1.67	98.16	0.17
S-21		0.61	99.25	0.14
S-22		1.08	98.72	0.12
S-23		23.60	75.26	1.14
S-24		0.31	99.17	0.52
S-25		0.11	95.92	3.97
S-26		0.06	93.11	6.83
S-27		0.24	91.52	8.24
S-28		3.42	73.54	23.04
S-29		0.00	96.17	3.83
S-30		5.66	94.07	0.27
S-31		3.58	96.34	0.08
S-32		0.26	99.45	0.29
S-33		9.15	76.33	14.52
S-34		3.78	58.26	37.96
S-35		1.39	98.37	0.24
S-36		1.95	61.29	36.76
S-37		2.55	65.60	31.85
S-38		5.64	85.76	8.60
S-39		0.31	97.68	2.01
S-40		0.00	99.23	0.77
S-41		0.05	99.37	0.58
S-42		4.38	95.50	0.12

Table 3

Sample No.	Shell-Gravel	Sand	Mud
S-43	0.08	99.59	0.33
S-44	0.15	99.44	0.41
S-45	13.82	85.38	0.80
S-46	0.18	96.55	3.27
S-47	0.04	97.62	2.34
S-48	5.85	93.78	0.37
S-49	33.96	65.80	0.24
S-50	67.41	31.60	0.99
S-51	14.80	83.82	1.38
S-52	24.87	73.73	1.40
S-53	1.97	96.29	1.74
S-54	3.54	95.97	0.49
S-55	1.46	97.59	0.95
S-56	0.00	98.82	1.18
S-57	38.77	60.69	0.54
S-58	39.38	60.16	0.46
S-59	31.21	68.50	0.29
S-60	61.55	38.35	0.10
S-61	67.17	32.76	0.07
S-62	8.89	90.85	0.26
S-63	25.15	73.90	0.95
S-64	0.07	98.66	1.27
S-65	55.61	44.10	0.29
S-66	7.05	92.65	0.30
S-67	15.02	84.56	0.42
S-68	0.01	98.45	1.54
S-69	0.37	99.24	0.39
S-70	5.87	93.45	0.68
S-71	1.35	98.43	0.22
S-72	8.56	91.36	0.08
S-73	3.11	96.67	0.22
S-74	21.62	78.27	0.11
S-75	11.63	88.25	0.12
S-76	9.27	90.58	0.15
S-77	0.71	99.11	0.18
S-78	0.18	99.82	0.00
S-79	0.33	99.52	0.15
S-80	62.49	37.40	0.11
S-81	45.25	54.66	0.09
S-82	1.30	98.56	0.14
S-83	0.37	99.28	0.35
S-84	0.35	99.48	0.17
S-85	.47	99.31	0.22
S-86	10.46	89.42	0.12
S-87	50.00	49.67	0.33
S-88	48.41	51.39	0.20
S-89	3.56	96.05	0.39
S-90	1.76	63.75	34.49
S-91	57.38	40.89	1.73
S-92	0.07	98.07	1.86
S-93	5.37	94.51	0.12
S-94	2.9	96.59	0.51

Table 4

Granulometric data for sand fraction of surface samples

Sample No.	Mean grain size (phi)	Standard Deviation	Skewness	Kurtosis
S- 1	1.71	0.34	-0.96	6.35
S- 2	1.25	0.55	-0.32	4.01
S- 3	1.46	0.50	-1.02	5.05
S- 4	3.32	0.58	-1.19	5.15
S- 5	1.65	0.61	-0.78	4.13
S- 6	1.85	0.54	-0.88	6.33
S- 7	1.45	0.56	-0.94	4.82
S- 8	1.60	0.77	-0.12	3.97
S- 9	3.69	0.38	-3.99	34.54
S-10	1.39	0.61	-1.09	4.32
S-11	1.31	0.84	0.09	3.42
S-12	1.26	0.76	-0.38	3.16
S-13	3.38	0.54	-1.83	10.29
S-15	3.16	0.63	-1.57	7.41
S-16	0.89	0.75	0.01	3.18
S-17	1.53	0.67	-0.33	4.08
S-18	3.12	0.77	-1.42	5.88
S-19	1.58	0.63	-0.72	3.92
S-20	1.16	0.64	-0.56	3.10
S-21	1.48	0.56	-0.99	4.64
S-22	1.33	0.55	-0.86	4.37
S-23	0.85	0.83	0.16	2.72
S-24	1.93	0.55	-0.80	5.85
S-25	3.42	0.50	-1.31	5.75
S-26	3.59	0.46	-3.21	20.52
S-27	3.66	0.38	-3.12	22.46
S-28	3.62	0.52	-4.19	28.36
S-29	3.52	0.37	-2.26	17.27
S-30	1.05	0.83	0.05	2.78
S-31	1.78	0.62	-0.98	5.43
S-32	2.13	0.73	-0.38	4.12
S-33	3.17	0.95	-1.87	6.49
S-34	3.52	0.79	-3.37	15.17
S-35	1.78	0.69	-0.28	4.22
S-36	3.20	1.21	-2.12	6.36
S-37	3.49	0.82	-2.99	12.78
S-38	3.49	0.50	-3.95	27.23
S-39	3.52	0.41	-2.69	20.17
S-40	3.25	0.59	-1.04	4.33
S-41	2.38	0.41	-0.11	8.81
S-42	1.33	0.82	-0.36	2.55
S-43	1.29	0.48	-0.48	5.22
S-44	1.61	0.53	-0.69	4.86
S-45	1.24	1.10	0.57	3.25
S-46	3.51	0.46	-2.55	15.12
S-47	3.46	0.40	-2.74	19.59

Table 4

Sample No.	Mean grain size (phi)	Standard Deviation	Skewness	Kurtosis
S-48	0.89	0.54	0.14	6.22
S-49	0.80	0.69	-0.62	2.94
S-50	1.34	1.53	0.34	1.77
S-51	0.85	0.96	1.08	4.93
S-52	1.50	1.26	0.43	2.22
S-53	1.77	1.21	0.60	2.12
S-54	1.23	0.70	0.60	5.79
S-55	1.10	0.81	1.31	6.27
S-56	3.26	0.38	-2.83	20.32
S-57	0.96	0.70	0.97	6.63
S-58	0.61	0.83	1.03	5.20
S-59	1.05	0.95	1.09	4.01
S-60	-0.09	0.50	1.67	11.51
S-61	-0.06	0.53	1.22	7.01
S-62	0.37	0.55	3.41	20.57
S-63	1.84	1.43	0.39	1.64
S-64	2.84	0.73	-0.98	3.77
S-65	0.59	0.73	0.40	4.11
S-66	1.06	0.76	-0.23	2.54
S-67	0.96	0.76	-0.33	2.50
S-68	3.47	0.51	-3.95	25.15
S-69	2.02	0.46	-1.42	7.53
S-70	1.72	0.79	-1.09	4.03
S-71	1.71	0.59	-1.38	5.75
S-72	1.14	0.75	-0.43	2.71
S-73	1.36	0.68	-0.82	3.48
S-74	0.82	0.75	-0.23	2.28
S-75	0.99	0.85	-0.16	2.04
S-76	0.97	0.82	-0.11	2.29
S-77	1.64	0.59	-1.05	4.63
S-78	1.38	0.48	-0.79	4.59
S-79	1.33	0.51	-0.78	4.44
S-80	0.22	0.64	0.49	3.33
S-81	0.21	0.68	0.98	5.24
S-82	1.51	0.57	-0.70	4.77
S-83	1.56	0.68	-0.40	3.61
S-84	1.75	0.50	-1.31	6.05
S-85	1.89	0.54	-1.00	5.53
S-86	1.21	0.76	-0.67	2.74
S-87	0.63	0.76	0.23	3.58
S-88	0.15	0.55	0.48	3.90
S-89	1.36	0.55	-0.89	5.08
S-90	1.25	0.75	0.47	5.40
S-91	1.01	1.35	0.93	2.95
S-92	3.26	0.57	-1.72	8.53
S-93	1.45	0.79	-0.36	2.76
S-94	1.58	0.65	-0.87	4.19

Table 5

Weight percent carbonate of the sand-sized fraction for selected (whole core) repository samples from Phase I.

U.S.G.S. Sample No.	Weight % $CaCO_3$
1-2	46.27
9-1	7.87
14	14.40
18-1	36.32
19-1	32.45
20-1	39.55
20-2	39.36
35-1	32.90
36-1	38.89
37-1	39.96
40	5.39
46-1	10.38
48-1	27.64
48-2	29.40
49-1	22.38
49-2	31.85
50	27.15
51-1	41.38
57-1	28.87
66-1	50.54
76-1	27.03
77-1	26.94
77-2	32.32
80-1	24.42
82-1	36.91
82-2	33.23
83-1	36.24
89-2	39.70
91-2	46.60
95	42.02

surface and vibracore samples, each is treated separately in discussing sediment characteristics. The surface samples represent only the upper few centimeters of sediment and therefore are in equilibrium with modern shelf processes. The vibracore samples, on the other hand, are up to 1.5 m in length and thus represent a range of geologic time and depositional environments.

Surface Samples

The 93 surface samples collected are predominantly sand and gravel rich. Twenty samples have greater than 15% shell gravel, 12 of which are greater than 30%. Thirteen samples have greater than 5% mud.

Sand

Sand-rich areas (Figure 4) correspond roughly to the shoal areas. Virtually all of Southeast Shoal, with water depths less than 30 feet, is >90% sand. Most samples from this shoal have greater than 95% sand. Chester Shoal, the shore-attached shoal to the north of the cape, as well as several isolated, offshore shoals are also sand-rich. Figure 4 emphasizes the wide distribution of sediment with >90% sand. Virtually the entire sample area has >70% sand.

Gravel

The most extensive shell-gravel rich zones of surface samples are found close to shore, generally north of the cape (Figure 5). Minor concentrations of shell material are

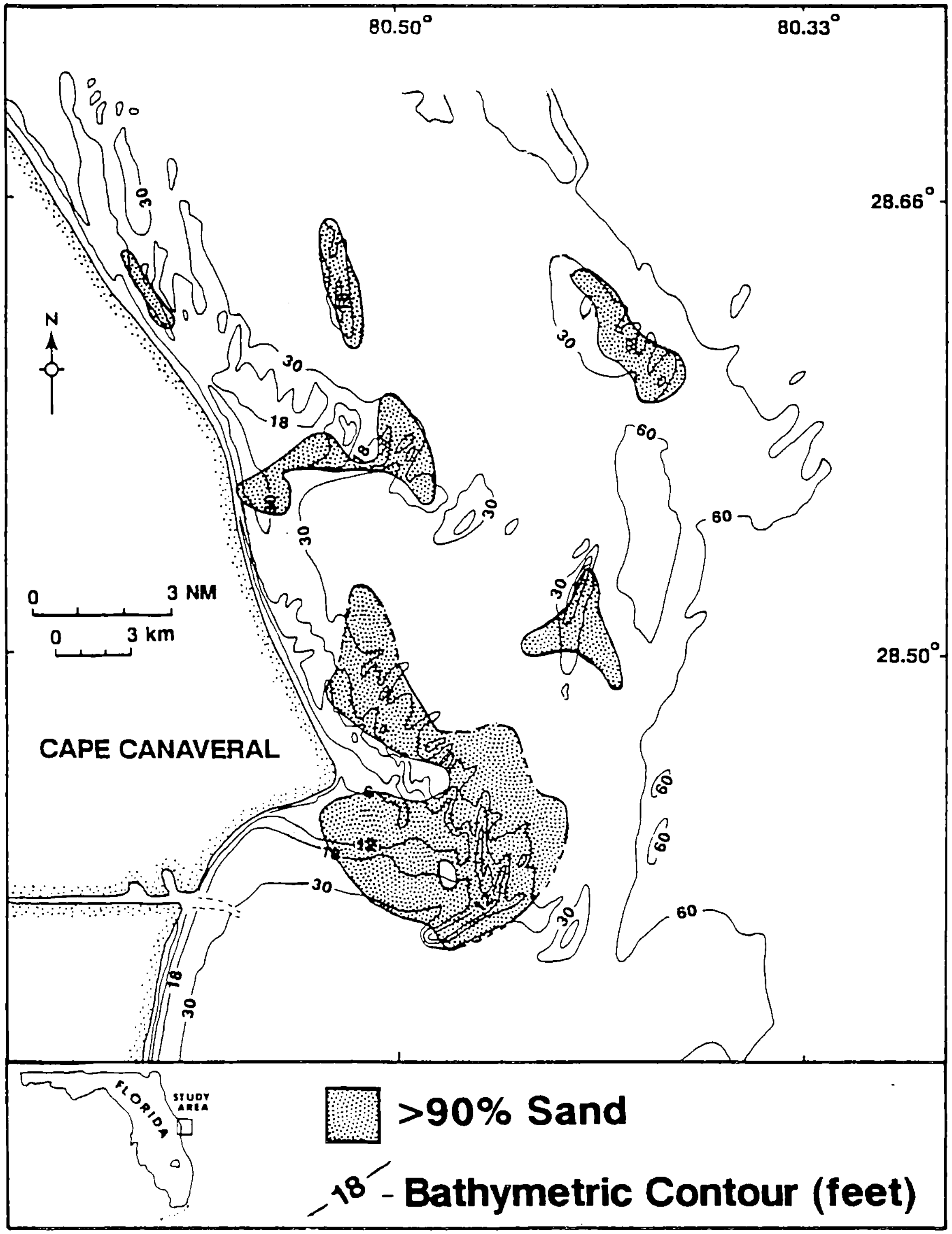

Fig. 4: General distribution of sand-rich surficial sediment.

associated with some of the offshore shoals.

Mud

On the whole, the surface samples have small percentages of mud. The only area of significant size that has >5% mud is located along the southern flank of Southeast Shoal (Figure 6). Regions with less than 5% mud correspond roughly to the two main shore-attached shoal bodies where sand percentages are high.

Vibracore Sections

Sediment distribution for the core samples has been analyzed for the upper vs. the lower 1.5 m core sections. In this manner, a regional picture of sediment distribution with depth can be developed.

Sand - Upper Core Section

Sand distribution for the upper core-section samples is divided into two categories; >90% sand, and 70- 90% sand (Figure 7). Much of the top meter and a half of sediment in the study area is characterized by sandy sediment, with significant areas on several shoals having >90% sand. The grain size distribution for the upper core sections is shown in Figure 8.

Gravel - Upper Core Section

The highest percentages (>30%) of shell-gravel in the upper core sections are found parallelling the shore off of False Cape to the north of the true cape (Figure 9). Surface samples in this same area are also gravel rich.

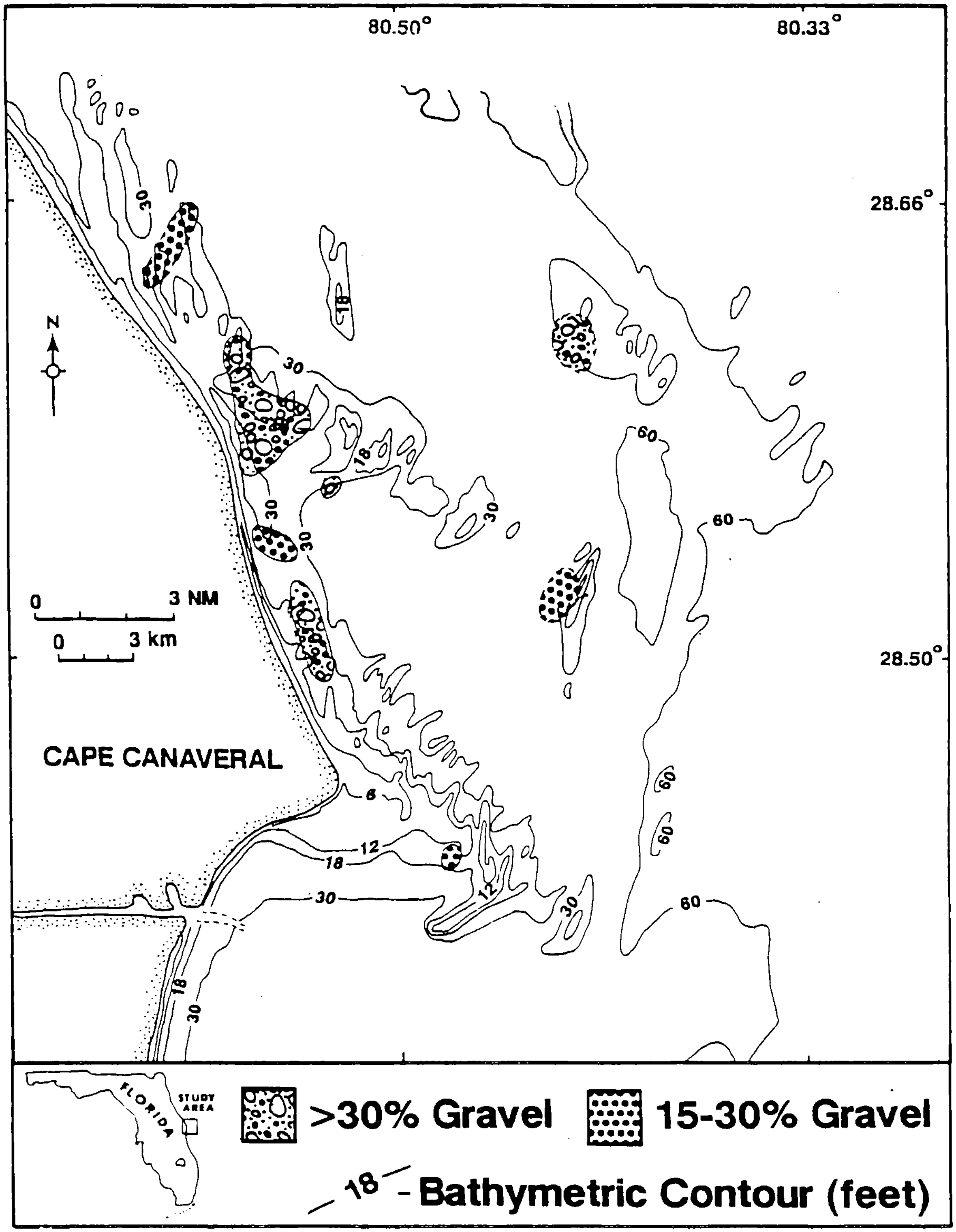

Fig. 5: General distribution of shell-gravel-rich surficial sediment.

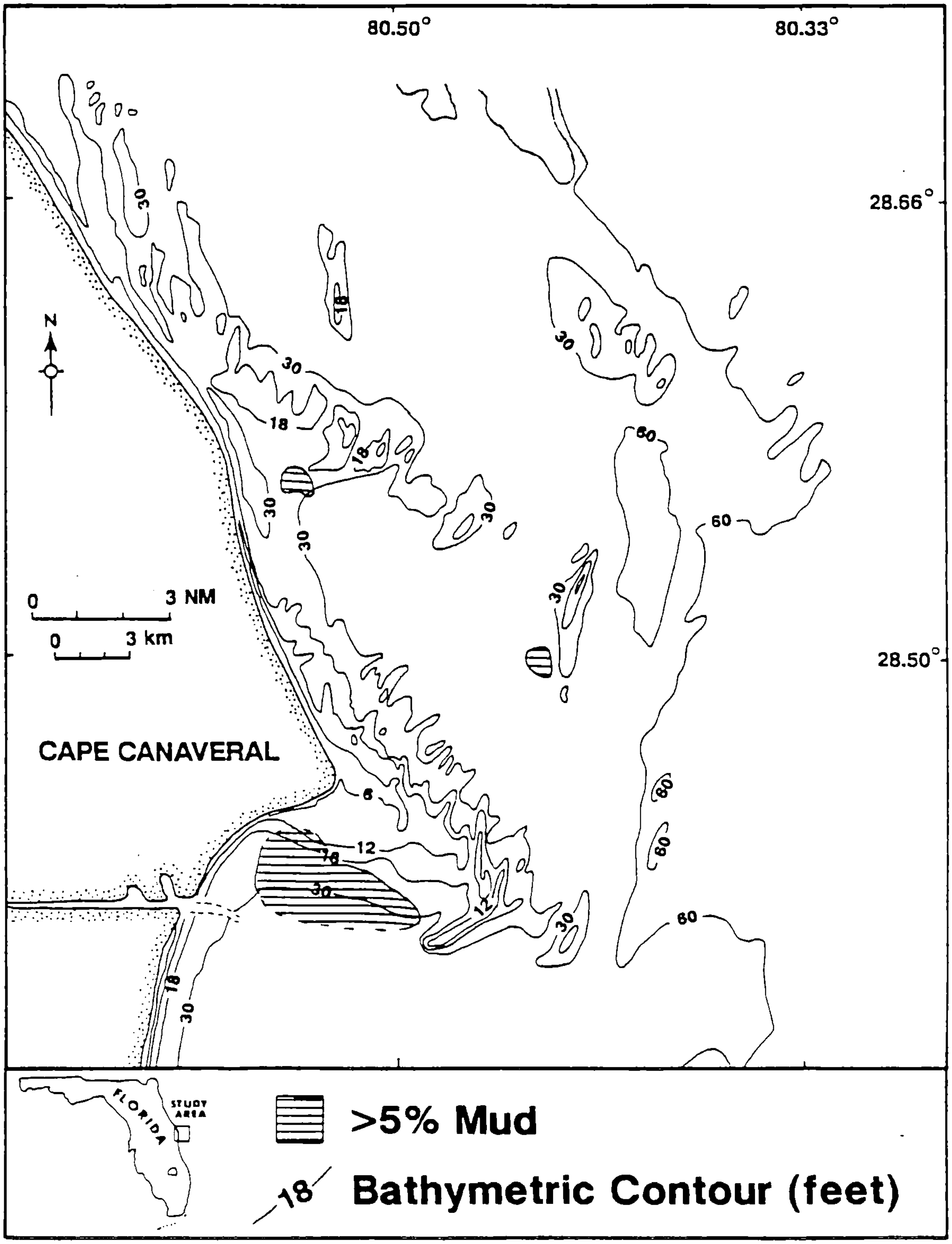

Fig. 6: General distribution of mud-rich surficial sediment.

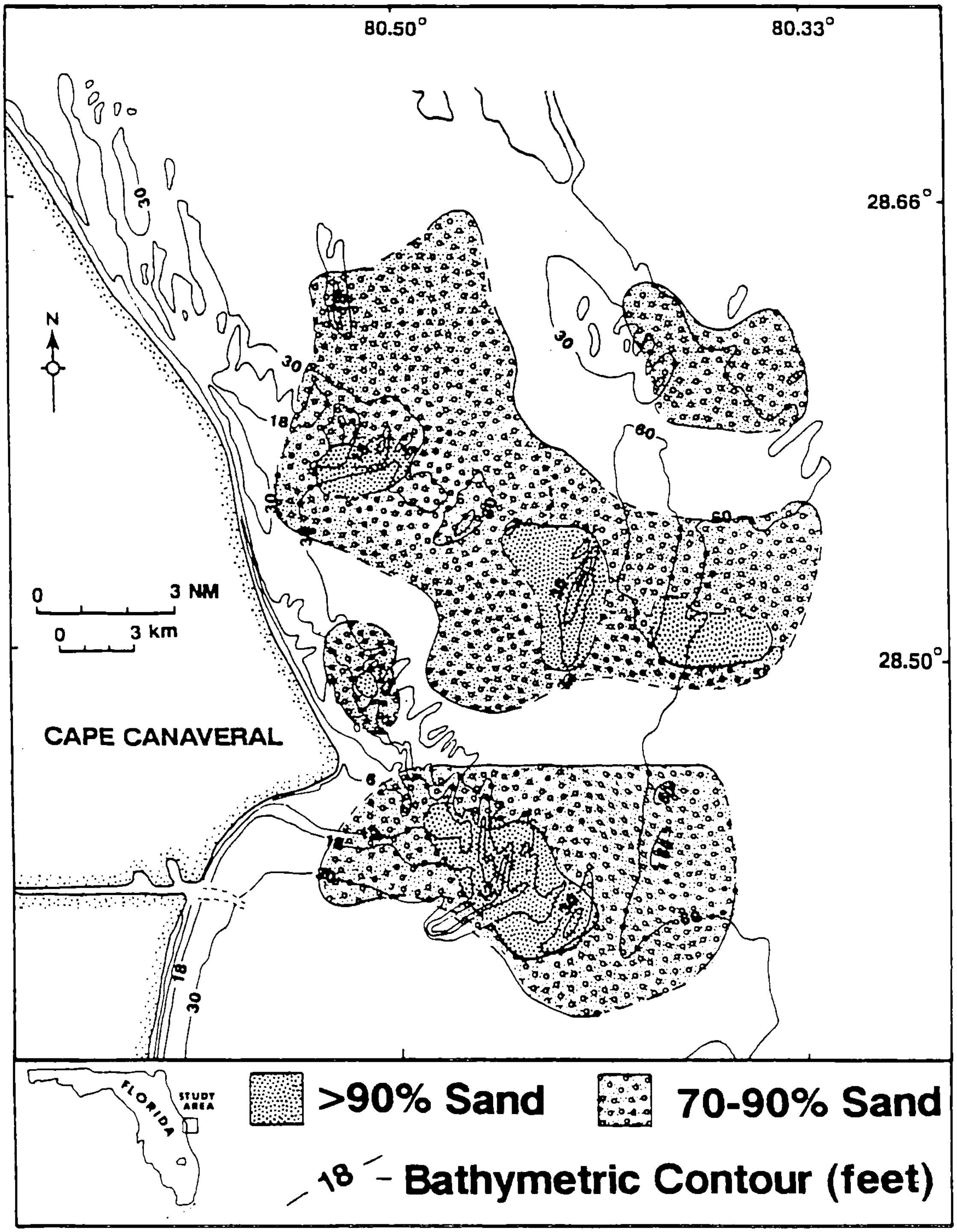

Fig. 7: General distribution of sand-rich sediment in upper section of vibracores.

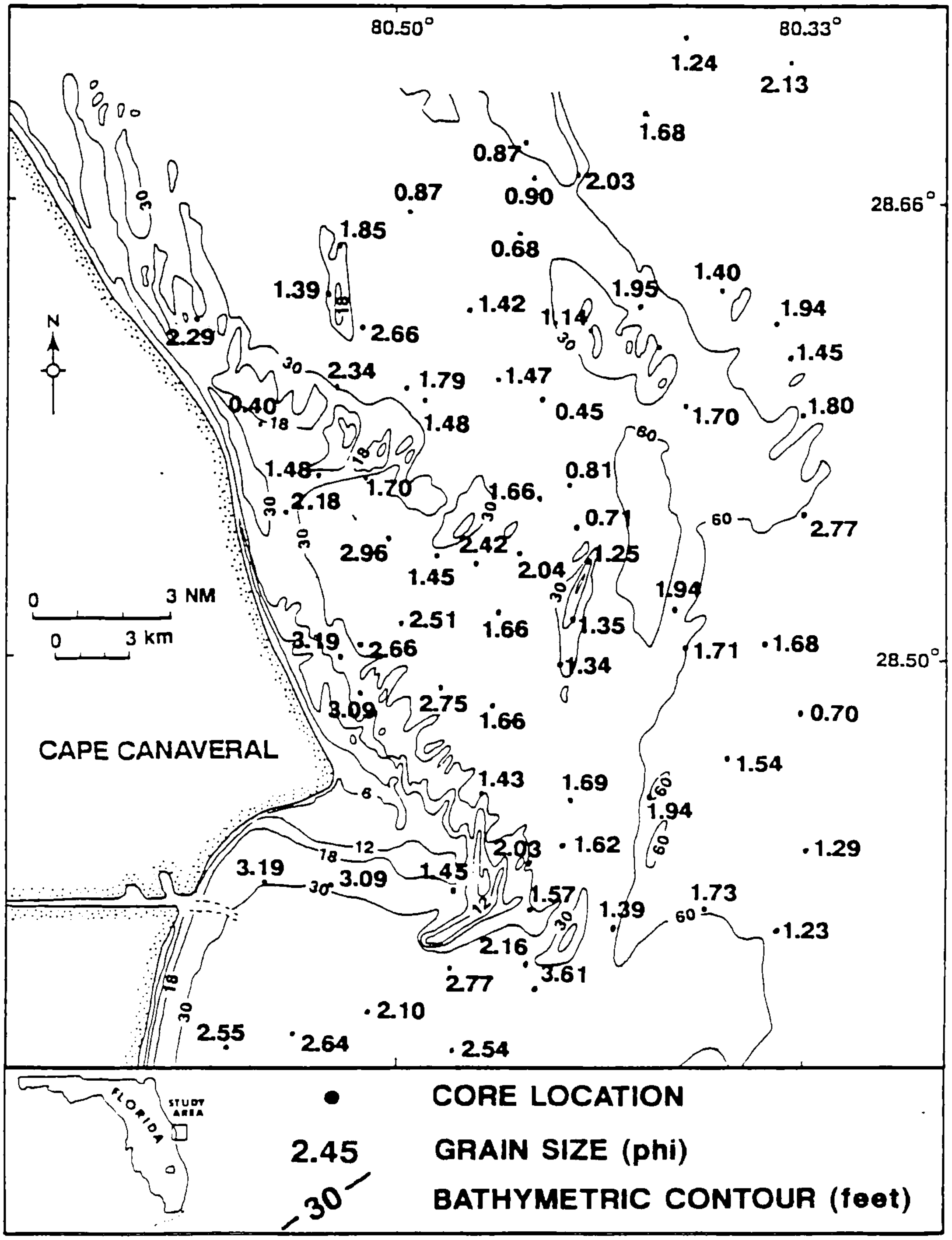

Fig. 8: Distribution of mean grain size (phi) for the upper section of vibracores.

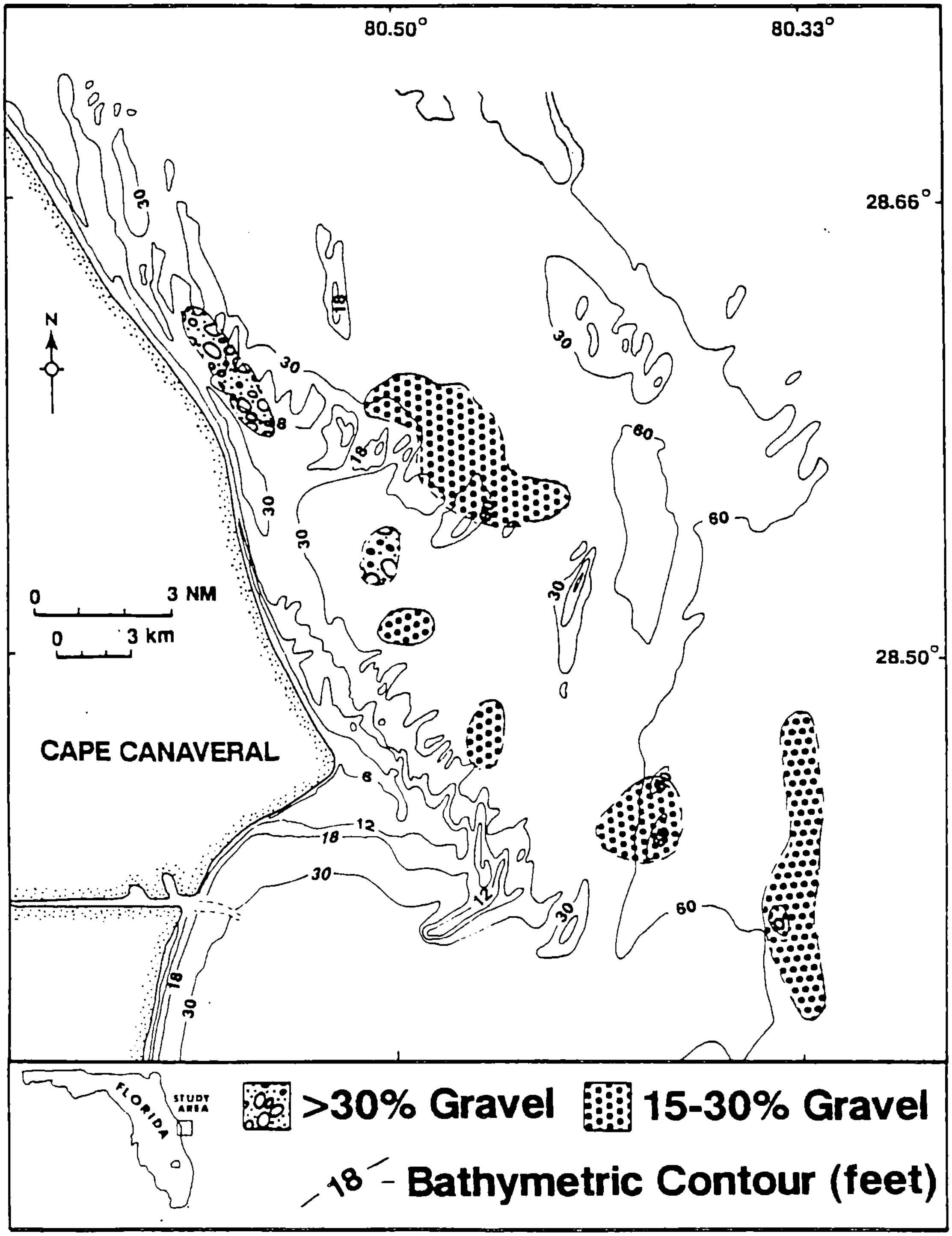

Fig. 9: General distribution of shell-gravel-rich sediment for the upper section of vibracores.

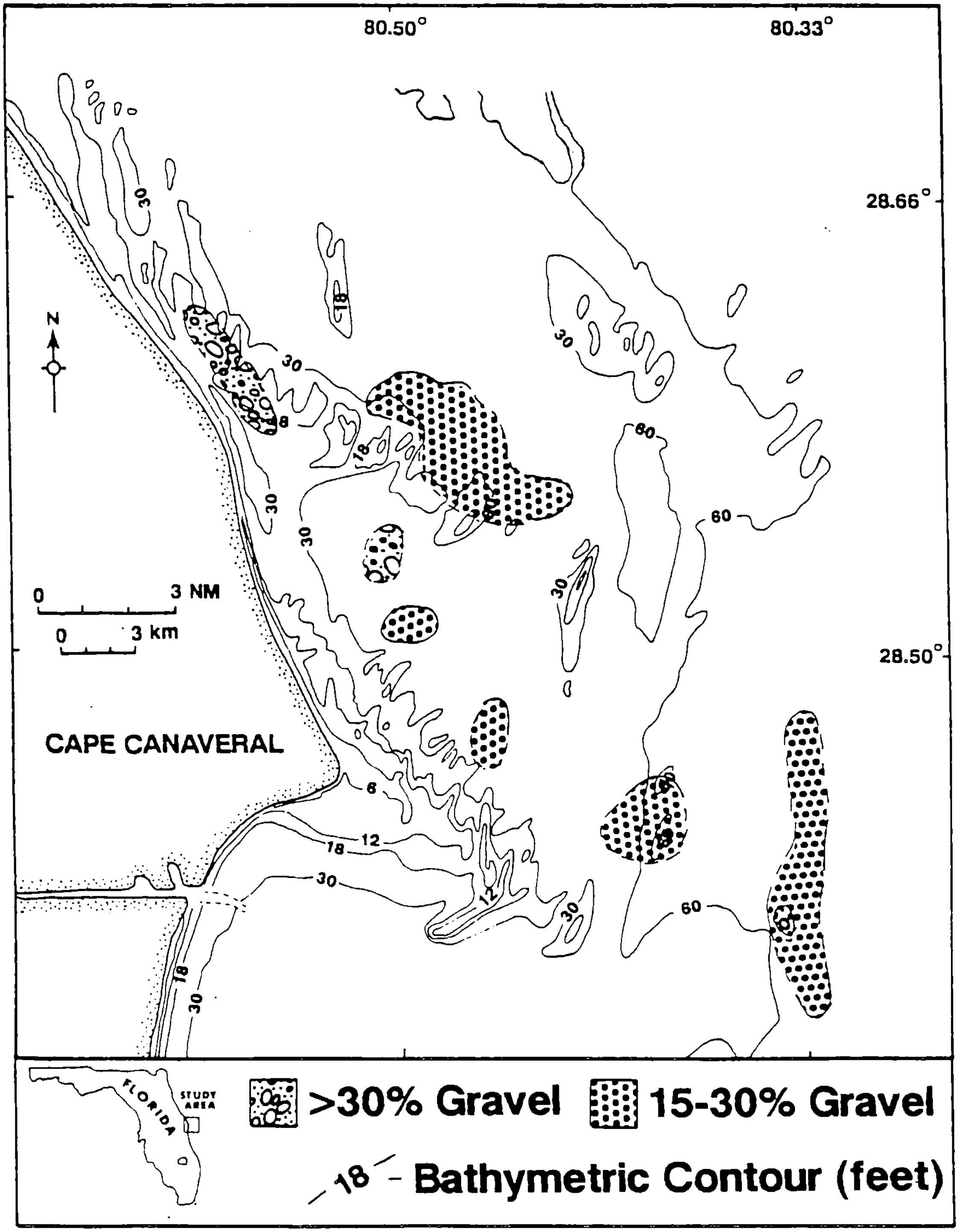

Fig. 9: General distribution of shell-gravel-rich sediment for the upper section of vibracores.

Mud - Upper Core Section

Figure 10 shows areas with >5% mud. It can be seen that the major areas with muddy sediment lie primarily in deep (>30 ft.) water down drift of Chester Shoal and downdrift of, and along the flanks of Southeast Shoal.

Sand - Lower Core Section

Areas with >90% sand are still associated with shoal bodies, but are not as regionally extensive as those of the upper core sections (Figure 11). Overall, the Southeast Shoal appears to have the greatest quantity of sand-rich sediment, with a minimum 3 m mantle of sediment covering much of the shoal that is at least 70% sand, and much of it >90% sand. The grain-size distribution for these samples is shown in Figure 12.

Gravel - Lower Core Section

The main shell-gravel-rich zone is a band which parallels the coastline offshore of False Cape (Figure 13). This same area is also gravel-rich in the upper core sections and in the surface samples, suggesting a long-term accumulation of shell gravel.

Mud - Lower Core Section

Both Southeast Shoal and Chester Shoal are associated with regions which have >5% mud (Figure 14). As with the upper core sections, this corresponds to areas in relatively deep water, down drift of Chester Shoal and along the flank of Southeast Shoal. Overall, sediments are slightly more muddy in the lower

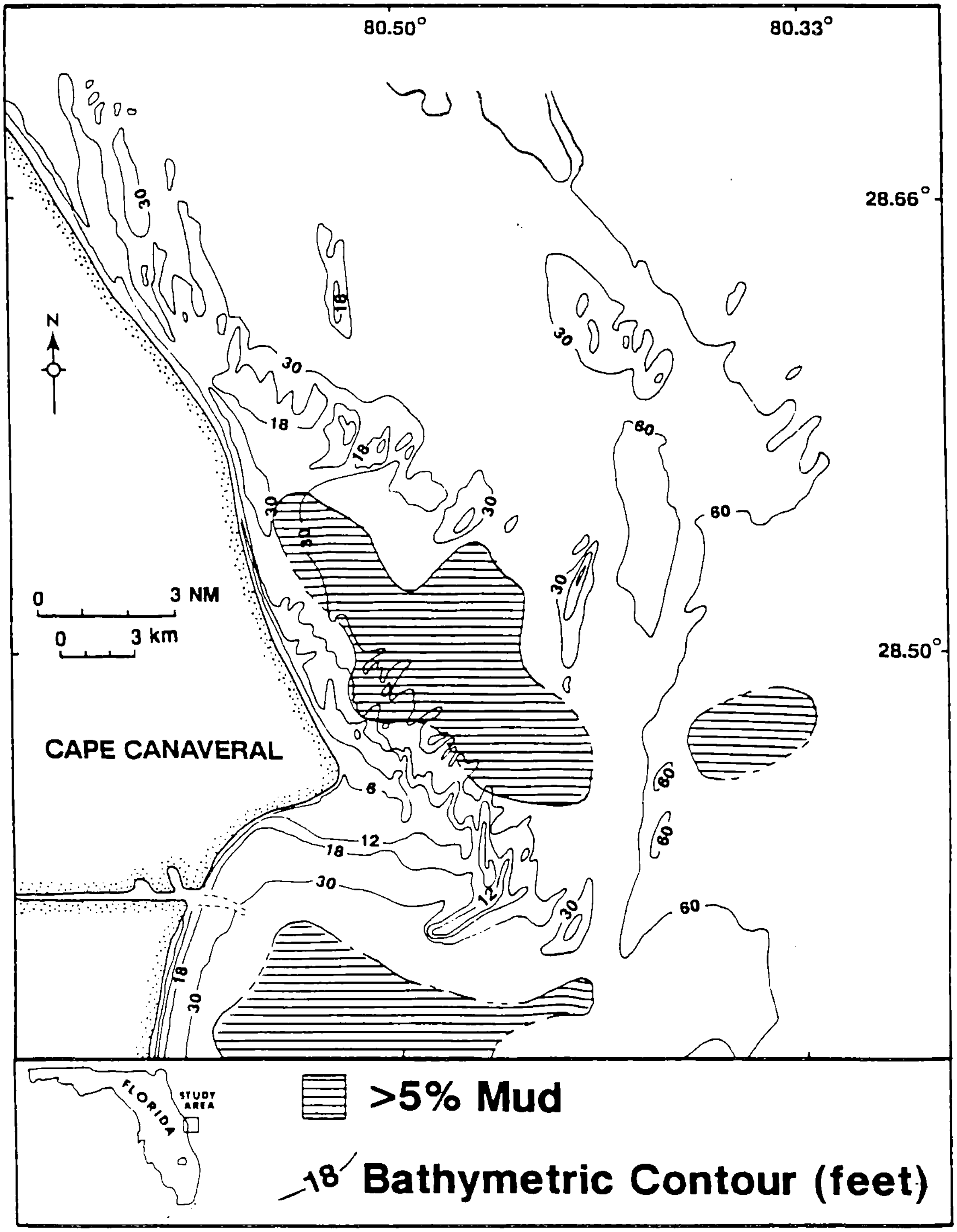

Fig. 10: General distribution of mud-rich sediment for the upper section of vibracores.

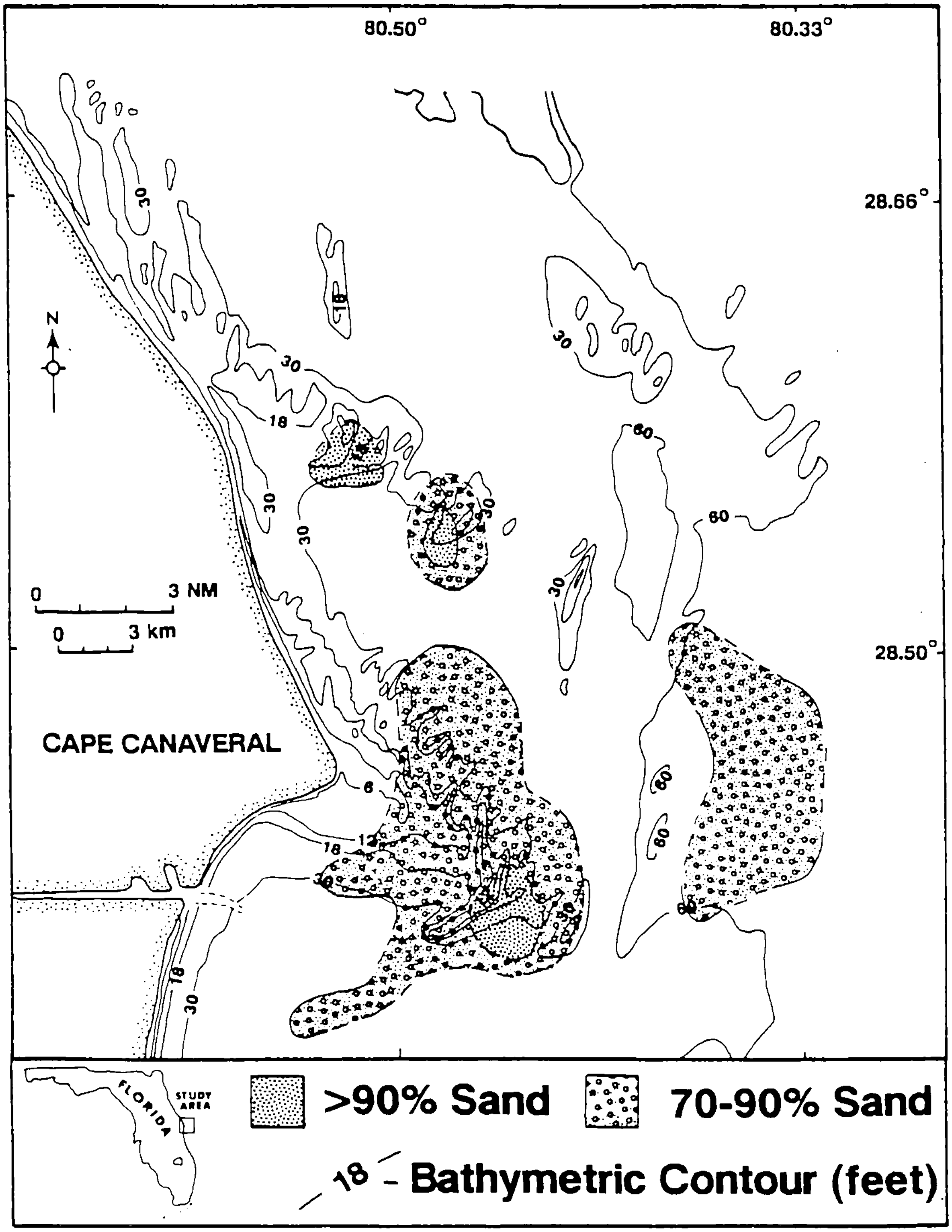

Fig. 11: General distribution of sand-rich sediment in the lower section of vibracores.

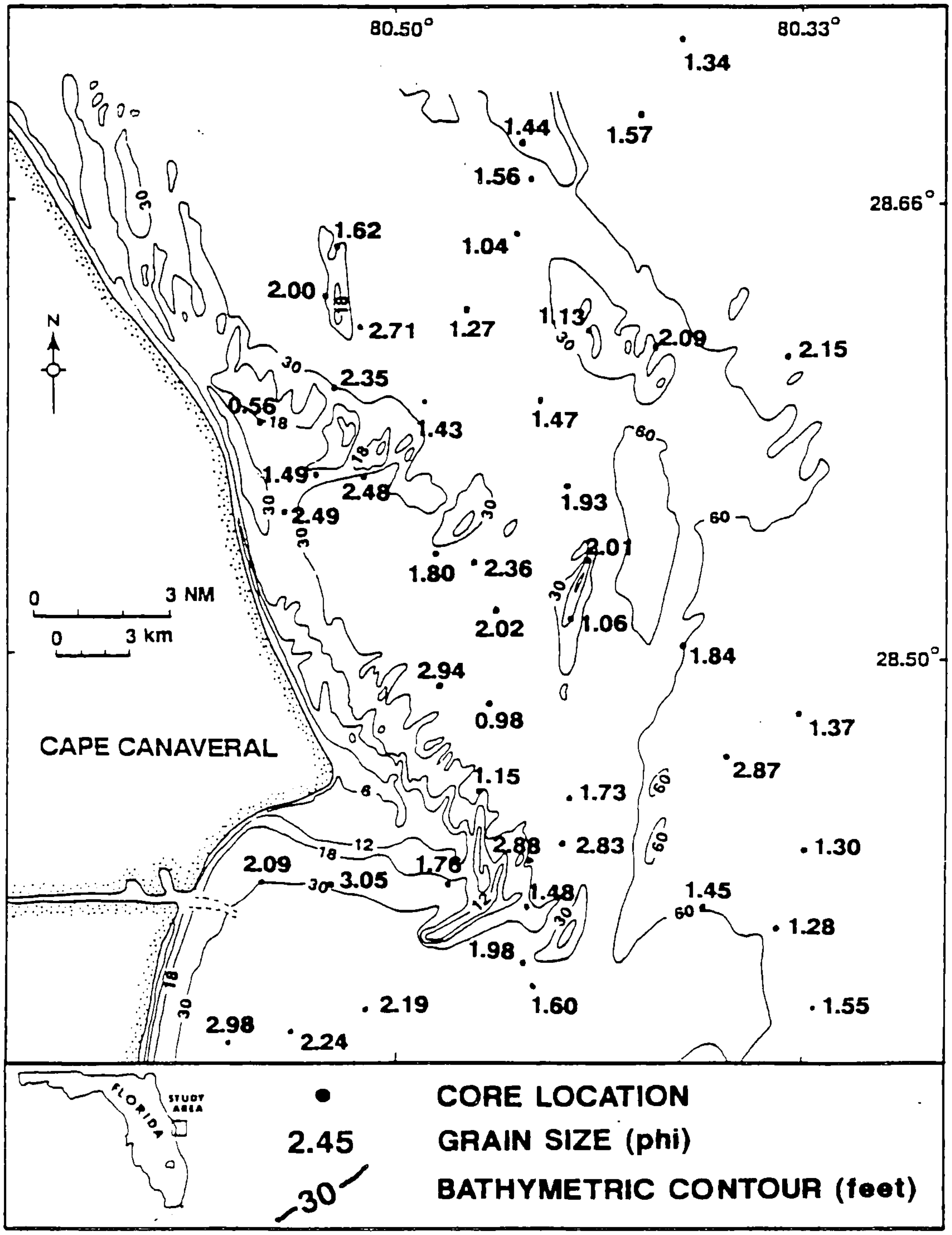

Fig. 12: Distribution of mean grain size (phi) for the lower section of vibracores.

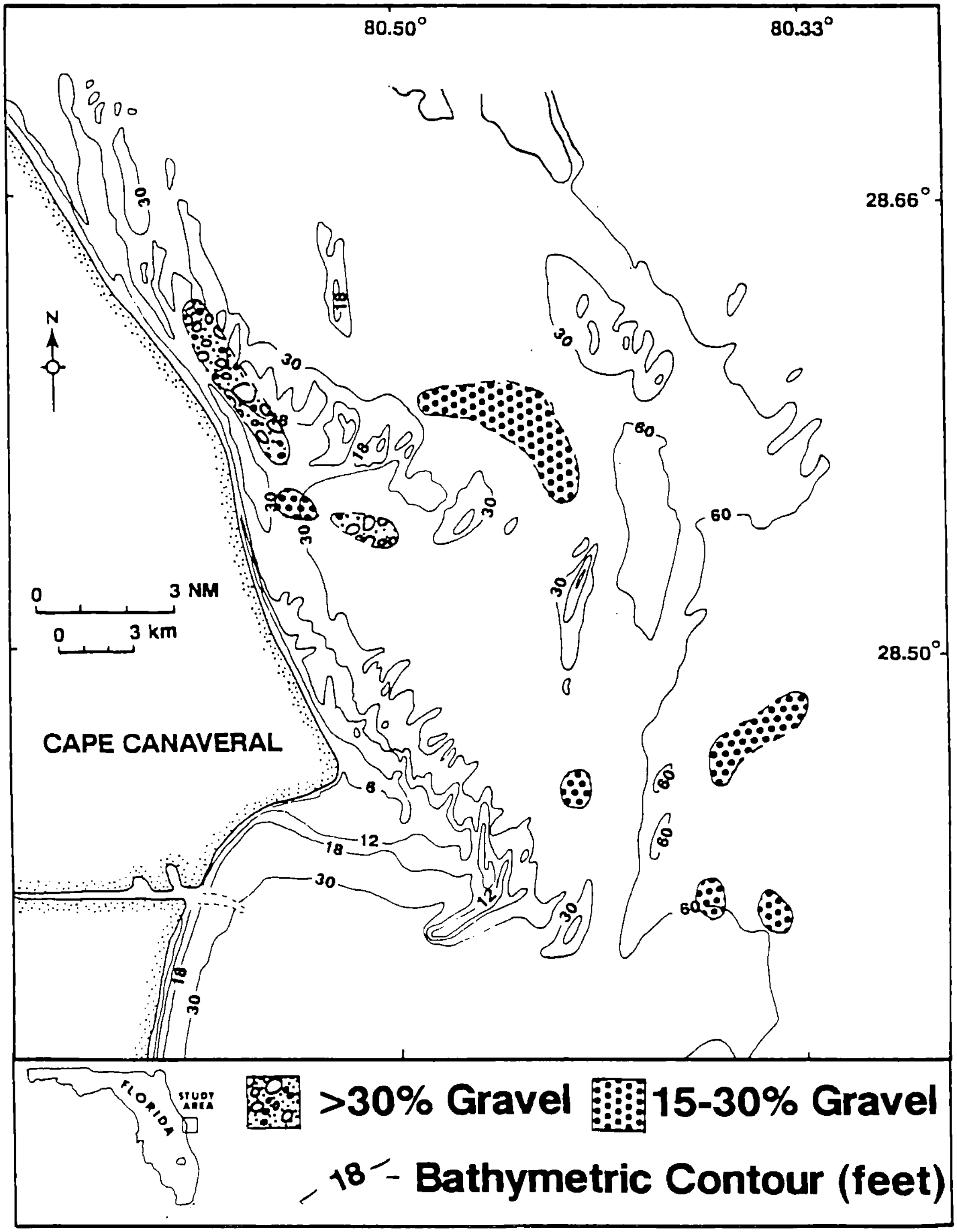

Fig. 13: General distribution of shell-gravel-rich sediment for the lower section of vibracores.

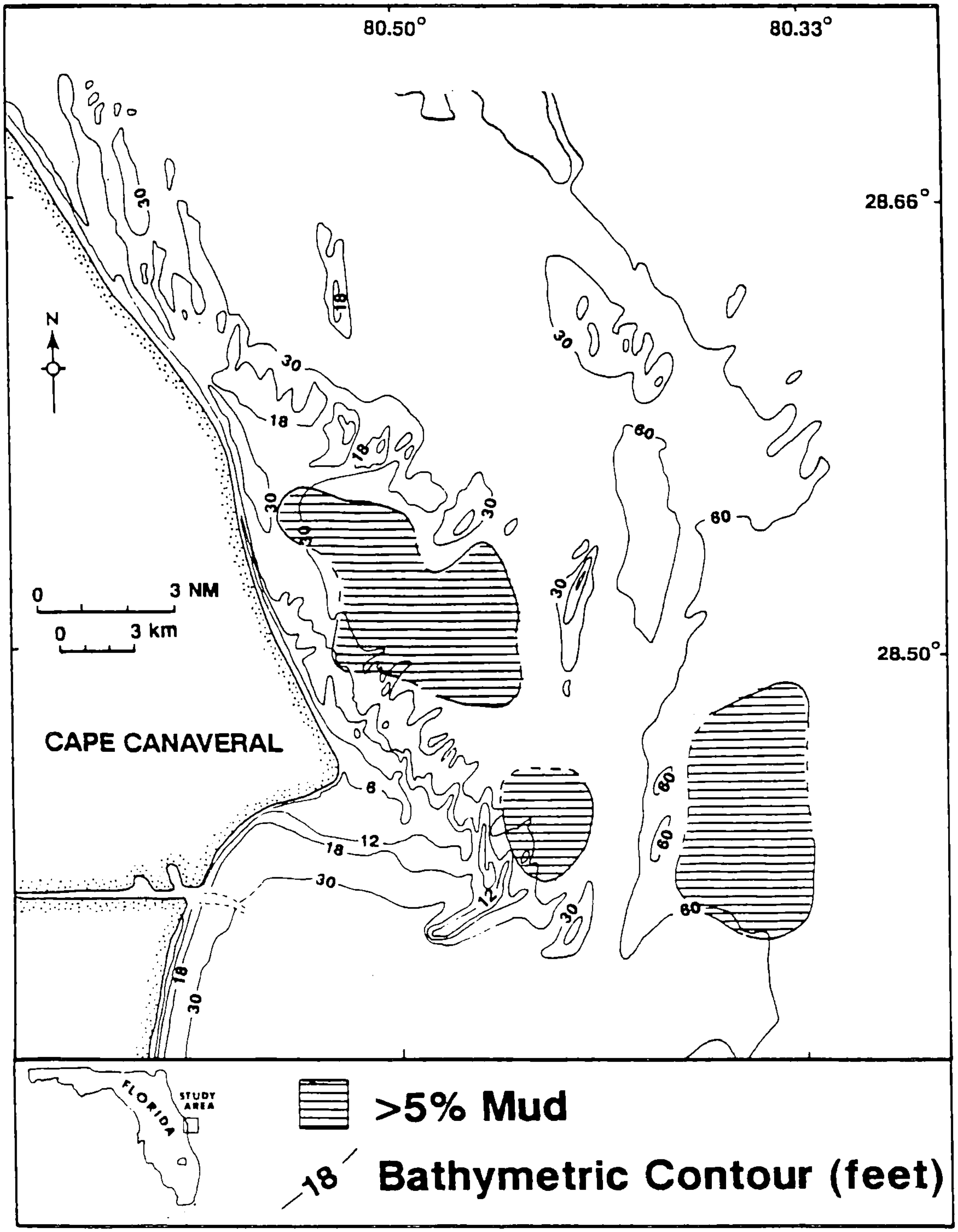

Fig. 14: General distribution of mud-rich sediment for the lower section of vibracores.

core sections than in the upper.

Heavy Minerals

The results of the heavy-mineral analysis are detailed in Table 6.

DISCUSSION

Sand and Gravel

It can be seen from a comparison of the sediment distribution maps that some areas show relatively constant trends with sediment depth. Sand distribution between upper and lower core sections (Figures 7, 11) shows part of Chester and Southeast Shoals to contain very sandy (>90%) sediments to a depth of at least 3 m. Overall, the upper 1.5 m of sediment in the Cape Canaveral is more sand-rich than the lower 1.5 m of sediment.

The gravel portion of all samples is dominated by shell material. It consists of both whole and broken shells, along with minor amounts of lithic fragments (limestone and phosphate). The gravel fraction ranges between approximately 1 and 60 weight percent of the samples analyzed, averaging approximately 13.5 weight percent (Tables 1 and 3).

Gravel distribution is quite similar between the upper and lower cores (Figures 9, 13). There is apparently a zone of very shell-gravel-rich sediment running shore-parallel for about 10 km just offshore of False Cape.

Mud-rich zones occupy non-shoal areas in both upper and lower core sections (Figures 10, 14). The area between Chester and Southeast Shoals is mud-rich, as is an area farther offshore.

TABLE 6

Heavy mineral (>2.96 specific gravity) content of 84 core samples from offshore of Cape Canaveral, Florida (P, present but less than .01%; N, none determined; THM, total heavy minerals; RHM, recovered heavy minerals).

Footnotes:

1: includes leucoxene (altered ilmenite)

2: aluminosilicates (may include sillimanite, kyanite, andalusite)

3: may include magnetite, phosphorite, sulfides, unidentified grains, coated grains, spinel, quartz, etc.

4: sum of economically valuable heavy minerals (ilmenite, rutile, zircon and monazite)

USGS CORE NUMBER	CERC CORE NUMBER	DEGREES LONGITUDE (WEST)	DEGREES LATITUDE (NORTH)	CORE LENGTH (cm)	BULK SAMPLE WEIGHT (g)	WEIGHT PERCENT GRAVEL	WEIGHT PERCENT HEAVY MINERALS TOTAL (THM)	WEIGHT PERCENT HEAVY MINERALS RECOVERED (RHM)	PERCENT EPIDOTE		PERCENT GARNET		PERCENT PYROBOLES		PERCENT ILMENITE[1]		PERCENT TOURMALINE		PERCENT STAUROLITE		PERCENT ALSIL[2]		PERCENT ZIRCON		PERCENT RUTILE		PERCENT MONAZITE		PERCENT OTHERS[3]		PERCENT EHM[4]	
									THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	BULK	RHM
1	107	-80.33040	28.37096	294	16502	17.81	0.12	0.11	37.8	38.0	5.6	5.7	4.6	4.6	21.1	21.2	3.0	3.0	2.8	2.8	10.5	10.4	6.5	6.5	2.4	2.4	P	P	5.7	5.5	0.04	34.0
2	108	-80.36950	28.35790	267	18725	18.78	0.17	0.14	35.7	35.8	3.3	3.3	6.5	6.4	24.1	24.4	3.2	3.1	2.5	2.5	13.0	13.0	5.3	5.3	2.0	2.0	P	P	4.5	4.3	0.06	39.3
3	100	-80.47730	28.35630	154	4313	14.38	0.38	0.09	22.2	27.5	2.3	2.8	3.9	3.1	23.8	29.7	2.1	2.6	1.5	1.9	26.2	17.4	5.4	6.7	7.3	2.9	N	N	5.2	5.3	0.05	50.0
4	97	-80.57010	28.35630	138	3405	16.39	0.23	0.12	29.9	31.6	6.4	7.1	6.2	6.2	20.5	22.9	3.7	2.6	5.7	6.0	12.9	10.0	8.2	8.6	3.9	2.1	P	P	2.6	2.9	0.04	35.0
5	98	-80.54180	28.36130	241	7491	16.70	0.25	0.22	24.7	25.0	4.6	4.7	7.2	7.3	29.8	30.2	2.7	2.6	7.8	7.9	10.5	9.8	7.9	7.9	3.7	3.5	0.41	0.42	0.8	0.7	0.10	43.9
6	99	-80.51080	28.37058	283	9080	19.65	0.22	0.13	27.9	27.9	8.5	9.1	5.7	6.0	22.4	23.9	3.4	2.8	7.6	7.3	9.1	7.9	6.1	6.2	6.8	6.4	0.07	0.07	2.4	2.3	0.05	38.4
7	110	-80.57700	28.38500	409	24976	12.59	0.14	0.06	41.6	41.9	2.4	2.5	12.4	11.8	15.8	16.2	2.4	2.3	3.1	3.1	9.7	9.6	8.1	8.0	1.6	1.6	P	P	3.0	3.0	0.02	27.4
9	109	-80.54380	28.39288	366	15425	3.35	0.34	0.24	31.4	31.3	1.1	1.1	13.7	13.5	24.2	24.5	1.5	1.6	1.2	1.2	16.9	17.0	5.4	5.4	1.9	1.9	P	P	2.6	2.5	0.11	43.5
10	115	-80.55390	28.41635	225	7718	2.59	0.14	0.09	23.2	23.5	9.5	9.7	4.4	4.4	28.1	28.6	3.2	3.3	4.0	4.1	10.5	9.7	10.6	10.7	3.5	3.2	N	N	3.0	2.9	0.04	41.5
11	115A	-80.55390	28.41635	308	12031	7.74	0.18	0.10	21.5	22.2	7.7	8.2	10.9	11.2	26.3	27.7	1.9	2.0	3.2	3.4	14.9	12.3	7.6	8.0	3.1	2.2	P	P	2.8	2.8	0.04	42.2
12	111	-80.52590	28.41434	309	12485	3.39	0.55	0.21	20.0	20.4	9.1	9.6	7.5	7.8	26.7	28.2	3.9	4.1	3.6	3.8	11.3	8.8	10.2	10.4	4.3	3.4	P	P	3.4	3.4	0.09	40.4
13	194	-80.51090	28.40066	349	18880	2.26	0.96	0.50	32.2	31.8	0.7	0.7	10.4	9.6	29.7	30.7	2.1	2.2	1.0	1.0	12.8	12.9	6.5	6.5	2.2	2.2	P	P	2.4	2.4	0.23	45.8
14	101	-80.47730	28.38515	238	13899	6.72	0.52	0.34	31.8	31.8	2.7	2.8	5.9	5.6	29.5	29.8	2.1	2.1	2.3	2.3	13.2	13.3	7.2	7.2	3.6	3.5	P	P	1.7	1.6	0.16	46.6
15	192	-80.42780	28.37344	160	7996	8.52	0.16	0.15	35.2	35.3	4.5	4.5	3.9	3.9	25.6	25.7	3.7	3.6	3.0	3.0	12.6	12.7	4.1	4.1	3.4	3.4	P	P	4.0	3.9	0.06	41.8
16	193	-80.44390	28.37828	311	16885	6.71	0.36	0.20	27.0	26.6	1.7	1.8	4.1	3.2	29.6	30.5	2.7	2.7	1.6	1.6	18.4	18.7	8.3	8.4	3.4	3.5	0.01	0.01	3.2	3.1	0.10	52.7
17	103	-80.44750	28.38537	318	17252	4.24	0.28	0.16	21.3	21.0	7.1	7.2	2.0	1.9	25.8	26.4	6.6	6.7	7.8	8.0	6.6	6.2	12.8	12.9	6.3	6.0	P	P	3.7	3.8	0.06	38.6
18	114	-80.44550	28.40561	347	25088	4.63	0.11	0.10	40.6	40.8	4.5	4.5	3.9	3.9	19.8	19.9	4.0	3.8	4.2	4.2	11.3	11.2	5.3	5.3	3.1	3.2	P	P	3.4	3.2	0.03	34.2
19	102	-80.44550	28.40561	324	24323	12.69	0.13	0.12	37.9	38.0	4.0	4.0	3.8	3.8	22.4	22.5	3.2	3.1	2.8	2.8	13.6	13.5	6.1	6.1	3.6	3.6	P	P	2.7	2.6	0.05	39.6
20	123	-80.46490	28.44996	306	23633	14.29	0.15	0.13	26.9	26.9	7.4	7.4	3.0	3.0	27.5	27.7	2.9	2.8	5.7	5.7	9.9	9.8	10.0	10.1	2.2	2.2	P	P	4.4	4.3	0.05	39.7
21	113	-80.44500	28.42395	280	14982	3.74	0.22	0.16	22.5	22.6	8.0	8.2	4.9	5.0	23.3	23.8	4.8	4.8	8.3	8.3	13.0	12.5	8.1	8.2	3.7	3.4	0.10	0.10	3.2	3.2	0.06	39.7
22	112	-80.43150	28.43034	232	12939	8.60	0.36	0.15	24.8	25.5	3.4	3.6	5.5	5.1	28.5	30.7	1.5	1.5	3.0	3.2	16.5	14.4	8.0	8.6	5.0	3.8	N	N	3.8	3.6	0.07	48.9
24	104	-80.41190	28.40007	142	7264	18.41	0.07	0.05	32.2	32.3	5.6	5.6	1.3	1.3	18.8	19.0	5.3	5.3	6.1	6.1	7.6	7.6	9.2	9.3	9.7	9.8	P	P	4.1	3.6	0.02	36.5
25	96	-80.42880	28.44758	228	10669	16.41	0.22	0.11	23.4	23.4	5.9	6.3	2.0	2.0	26.5	28.2	6.1	6.3	7.6	7.8	9.1	7.5	9.1	9.2	6.2	5.3	0.06	0.06	4.0	4.0	0.04	41.0
26	105	-80.37850	28.40587	270	13847	19.47	0.10	0.09	27.9	28.0	5.4	5.4	3.5	3.5	25.0	25.2	4.6	4.6	7.2	7.2	7.7	7.5	8.4	8.5	4.8	4.8	P	P	5.5	5.4	0.03	37.5
27	106	-80.34610	28.39993	277	14755	20.20	0.06	0.05	33.7	34.0	6.2	6.3	4.6	4.6	16.5	16.7	6.0	6.0	5.7	5.7	8.1	7.4	6.0	6.0	5.0	5.1	P	P	8.3	8.2	0.01	29.2
28	116	-80.33450	28.42940	245	11804	26.65	0.05	0.04	29.7	30.2	3.7	3.8	2.1	2.2	21.3	21.8	6.2	6.1	4.7	4.7	9.4	9.0	7.9	8.0	4.8	4.7	P	P	10.2	9.6	0.01	35.5
30	93	-80.33680	28.47983	266	14755	32.92	0.05	0.04	26.8	27.3	6.1	6.1	2.7	2.8	21.8	22.3	3.2	3.0	5.8	5.9	8.8	7.8	7.2	7.3	5.4	5.5	N	N	12.0	12.0	0.01	35.6
31	92	-80.36630	28.46304	260	9988	16.45	0.42	0.40	11.1	11.1	21.4	21.5	5.5	5.5	36.5	36.7	3.7	3.7	3.6	3.6	6.0	5.9	8.1	8.1	2.0	1.9	P	P	2.1	2.1	0.18	44.5
32	91	-80.39480	28.44871	227	4767	14.24	0.28	0.23	21.6	21.4	7.0	7.1	2.0	2.0	27.1	27.6	6.4	6.5	8.8	8.9	8.5	8.1	11.7	11.8	5.4	5.2	N	N	1.5	1.5	0.10	40.9
33	140	-80.34980	28.50503	205	9988	5.41	0.07	0.04	19.8	20.0	6.9	7.0	4.3	4.3	20.0	20.3	12.5	12.5	10.9	11.0	9.6	8.8	7.6	7.7	2.9	3.0	0.12	0.13	5.4	5.2	0.01	32.2
34	117	-80.38350	28.50534	299	19295	2.25	0.21	0.14	22.1	21.9	5.5	5.6	4.8	4.9	21.9	22.3	6.7	6.5	10.1	9.9	11.0	11.0	6.8	6.8	5.9	6.0	P	P	5.2	5.2	0.06	39.2
35	118	-80.38880	28.51752	239	16452	12.69	0.24	0.17	32.6	32.7	1.8	1.8	8.0	7.8	26.5	26.9	3.0	3.0	3.8	3.8	9.1	9.1	8.7	8.7	2.2	2.2	P	P	4.2	4.0	0.06	38.2
36	176	-80.42800	28.51423	423	29811	6.93	0.13	0.09	20.0	19.9	6.4	6.4	2.5	2.5	28.4	28.7	5.1	4.9	11.3	11.3	5.4	5.4	9.2	9.2	7.2	7.3	P	P	4.5	4.3	0.04	41.4
37	122	-80.43330	28.49636	183	13299	1.74	0.12	0.08	31.2	31.4	6.4	6.5	5.1	5.2	15.5	15.7	6.8	6.7	13.5	13.5	6.0	5.7	4.8	4.8	4.2	4.2	P	P	6.5	6.2	0.02	25.6
38	160	-80.46060	28.48169	353	17252	14.34	0.22	0.18	20.6	20.7	7.2	7.3	1.7	1.7	25.4	25.6	6.4	6.3	7.3	7.3	12.9	12.4	7.8	7.8	7.7	7.7	P	P	3.0	3.0	0.08	45.7
39	161	-80.48240	28.48804	323	17252	19.57	0.18	0.16	18.1	18.1	7.3	7.4	7.0	7.0	25.4	25.6	8.3	8.4	3.3	3.3	10.2	10.0	11.8	11.8	2.7	2.6	P	P	5.9	5.9	0.06	38.2
40	124	-80.51410	28.48624	174	11319	7.01	1.38	1.09	34.9	34.8	1.3	1.3	7.6	7.3	30.7	31.0	1.0	1.0	2.1	2.1	7.8	7.9	8.6	8.6	3.2	3.2	P	P	2.8	2.7	0.46	42.1
42	125	-80.52300	28.49930	287	18385	8.06	0.98	0.78	28.5	28.5	0.7	0.7	6.5	6.3	31.9	32.2	1.0	1.1	1.8	1.8	10.5	10.5	12.6	12.6	2.5	2.5	P	P	3.9	3.9	0.35	45.2
43	162	-80.51480	28.50308	181	8626	11.53	0.67	0.18	16.6	17.2	10.1	11.3	5.2	5.5	21.8	24.4	3.9	4.4	5.1	5.7	18.3	13.6	9.4	10.5	5.1	2.7	P	P	4.4	4.7	0.07	40.7
44	167	-80.49850	28.51109	156	6810	6.89	0.16	0.10	18.6	19.0	5.9	6.1	5.5	5.6	25.5	26.2	3.6	3.8	8.6	8.9	10.6	8.8	10.1	10.2	4.0	3.9	P	P	7.6	7.4	0.04	38.9
45	177	-80.45820	28.51550	150	12258	35.81	0.19	0.14	20.2	20.4	5.1	5.2	2.8	2.9	31.0	31.8	5.0	5.0	5.4	5.4	11.4	10.9	10.7	10.8	5.9	5.5	P	P	2.6	2.1	0.07	48.2
46	126	-80.53380	28.52759	313	15697	2.19	0.47	0.25	32.0	32.0	1.0	1.0	10.3	9.9	28.6	29.2	0.7	0.7	1.0	1.1	9.3	9.3	8.9	9.0	1.9	1.9	P	P	6.1	5.8	0.10	40.4
47	129	-80.50350	28.54242	299	17827	18.97	0.53	0.39	32.0	31.8	1.8	1.8	11.2	10.9	24.5	24.9	2.8	2.9	2.8	2.8	8.8	8.8	8.9	8.9	2.5	2.5	P	P	4.6	4.6	0.14	36.2
48	164	-80.48320	28.53741	299	23105	3.29	0.20	0.18	23.8	23.8	3.5	3.5	3.3	3.3	28.5	28.7	5.2	5.1	8.7	8.7	7.6	7.5	11.7	11.0	4.3	4.3	P	P	3.3	3.3	0.07	40.5
49	130	-80.46760	28.53331	283	17637	5.76	1.06	0.49	30.5	29.9	2.1	2.2	7.2	5.6	27.2	28.8	2.9	3.0	2.5	2.6	11.6	12.0	9.4	9.6	2.2	2.3	P	P	4.4	4.1	0.21	43.0

USGS CORE NUMBER	CERC CORE NUMBER	DEGREES LONGITUDE (WEST)	DEGREES LATITUDE (NORTH)	CORE LENGTH (cm)	BULK SAMPLE WEIGHT (g)	WEIGHT PERCENT GRAVEL	WEIGHT PERCENT HEAVY MINERALS TOTAL (THM)	WEIGHT PERCENT HEAVY MINERALS RECOVERED (RHM)	PERCENT EPIDOTE		PERCENT GARNET		PERCENT PYROBOLES		PERCENT ILMENITE[1]		PERCENT TOURMALINE		PERCENT STAUROLITE		PERCENT ALSIL[2]		PERCENT ZIRCON		PERCENT RUTILE		PERCENT MONAZITE		PERCENT OTHERS[3]		PERCENT EHM[4]	
									THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	THM	RHM	BULK	RHM
50	175	-80.44870	28.53719	158	9424	0.89	0.29	0.24	28.1	28.3	2.0	2.0	8.4	8.4	23.0	23.1	5.3	5.3	7.0	7.0	8.4	8.0	9.3	9.3	3.6	3.7	P	P	5.0	4.8	0.08	34.8
51	150	-80.42160	28.53574	238	15217	3.98	0.16	0.14	19.7	19.7	5.3	5.3	3.5	3.5	23.8	23.9	7.0	7.0	12.3	12.4	11.0	10.8	7.3	7.3	4.9	5.0	P	P	5.3	5.1	0.06	39.7
52	151	-80.42540	28.54766	187	6810	8.24	0.07	0.06	20.7	20.7	5.8	5.9	1.4	1.4	17.8	18.0	14.8	14.4	14.5	14.5	7.4	7.5	5.5	5.5	7.4	7.5	0.19	0.19	4.4	4.5	0.02	33.2
53	174	-80.44230	28.55765	117	6810	16.87	0.05	0.04	25.1	24.9	2.3	2.3	3.4	3.5	26.0	26.8	7.2	7.2	4.3	4.3	15.2	14.4	8.4	8.7	2.3	2.1	N	N	5.9	5.8	0.02	43.3
54	152	-80.43060	28.56209	277	12031	16.39	0.14	0.10	18.6	18.8	8.5	8.7	1.1	1.0	26.3	26.9	7.3	7.2	10.4	10.6	6.1	5.1	12.2	12.3	6.7	6.5	P	P	3.0	2.9	0.04	38.5
57	120	-80.33330	28.55056	285	17037	5.65	0.52	0.37	33.8	33.9	1.0	1.0	12.6	12.4	25.4	25.7	1.1	1.1	2.1	2.1	9.1	9.2	9.1	9.1	2.4	2.3	P	P	3.5	3.2	0.14	37.2
58	142	-80.33260	28.58720	196	10215	10.23	0.07	0.04	24.7	24.4	4.0	4.0	4.6	4.7	19.8	20.0	8.2	8.0	9.6	9.6	8.0	8.1	10.4	10.5	4.8	4.8	N	N	5.8	5.9	0.01	32.9
59	131	-80.34060	28.61090	327	17933	8.64	0.09	0.05	24.4	24.5	5.5	5.6	4.8	4.8	21.1	21.6	7.3	7.2	9.4	9.3	8.5	8.1	[illegible]	9.1	5.6	5.7	N	N	4.5	4.0	0.02	35.4
60	143	-80.34630	28.62227	135	5448	8.41	0.10	0.08	24.9	25.1	3.8	3.9	9.8	9.9	21.7	21.9	7.5	7.5	6.9	7.0	10.0	9.8	8.6	8.7	3.6	3.6	P	P	3.2	2.8	0.03	35.3
61	144	-80.38360	28.63447	195	10215	28.04	0.16	0.12	23.4	23.6	3.6	3.6	4.6	4.6	17.8	18.0	11.2	11.2	9.2	9.2	11.0	10.5	7.8	7.9	3.5	3.5	N	N	7.8	7.9	0.04	32.0
62	148	-80.38360	28.59251	200	9307	6.29	0.09	0.09	21.6	21.6	2.7	2.7	2.1	2.1	26.2	26.2	8.2	8.2	7.5	7.5	15.0	15.0	6.0	6.0	4.2	4.2	N	N	6.6	6.6	0.04	45.4
63	127	-80.54420	28.55093	324	12939	7.23	0.19	0.16	22.9	22.9	4.5	4.5	3.4	3.4	33.2	33.5	3.9	3.9	2.1	2.2	11.2	10.9	7.2	7.2	4.8	4.7	P	P	6.8	6.8	0.08	49.0
64	147	-80.39410	28.61413	344	22978	17.57	0.30	0.23	28.5	28.5	2.0	2.0	7.7	7.5	27.6	27.8	3.6	3.7	3.2	3.2	11.1	11.2	8.4	8.4	2.4	2.4	P	P	5.4	5.4	0.10	41.4
65	146	-80.40004	28.62803	125	8031	14.26	0.16	0.13	32.2	32.3	3.4	3.5	4.6	4.5	25.5	25.7	3.8	3.8	6.1	6.1	10.3	10.3	7.0	7.0	3.0	3.0	P	P	4.1	3.8	0.05	39.0
66	139	-80.42040	28.61887	430	28981	7.15	0.12	0.11	15.4	15.4	9.0	9.0	2.1	2.1	23.8	23.8	7.6	7.6	14.9	15.0	7.2	7.1	5.8	5.8	7.2	7.2	P	P	7.0	7.0	0.04	38.1
69	171	-80.46990	28.62639	226	13847	12.39	0.10	0.08	24.4	24.5	7.4	7.4	4.4	4.4	20.4	20.5	9.1	9.1	8.4	8.5	5.9	5.5	8.6	8.6	5.4	5.4	2.54	2.56	3.6	3.5	0.03	34.0
70	172	-80.45830	28.60067		10442	14.46	0.13	0.10	26.8	26.9	3.7	3.7	2.5	2.5	23.8	24.0	8.1	8.0	8.7	8.7	6.4	6.2	9.3	9.3	5.9	5.9	N	N	4.9	4.7	0.04	36.1
72	153	-80.44110	28.59197		14755	22.74	0.05	0.03	17.4	17.6	8.3	8.5	2.4	2.4	23.9	24.6	11.1	10.9	11.2	11.4	10.0	9.2	7.6	7.7	4.8	4.7	P	P	3.3	3.1	0.01	38.4
73	173	-80.44650	28.57220	121	4313	17.97	0.06	0.05	21.5	21.7	4.1	4.1	2.3	2.3	22.1	22.3	11.2	11.2	12.4	12.5	8.5	8.1	8.7	8.8	6.8	6.8	P	P	2.4	2.0	0.02	37.3
74	167	-80.48900	28.59234	115	7264	18.79	0.16	0.11	16.6	16.9	10.6	10.9	1.8	1.9	21.3	21.9	9.1	9.2	12.9	13.1	11.5	10.1	5.0	4.9	6.1	6.1	1.94	2.00	3.3	3.0	0.05	40.1
75	168	-80.49520	28.59682	105	6356	23.13	0.22	0.17	23.3	23.6	9.2	9.3	5.9	6.0	19.6	19.9	10.2	10.3	10.8	10.8	11.1	10.2	4.7	4.7	2.9	2.9	0.04	0.04	2.5	2.3	0.06	33.0
76	165	-80.51280	28.56380	340	25691	3.58	0.38	0.26	23.1	23.0	2.1	2.1	3.2	2.8	29.3	29.7	4.5	4.4	7.5	7.6	8.7	8.7	14.1	14.2	3.4	3.4	P	P	4.0	4.0	0.11	41.9
77	166	-80.53220	28.56517	400	28376	4.52	0.29	0.25	17.8	17.8	5.4	5.4	2.5	2.5	29.1	29.2	5.6	5.5	10.0	10.0	8.1	8.1	11.2	11.3	7.0	7.1	0.02	0.02	3.2	3.1	0.11	44.4
78	128	-80.55530	28.58314	231	16344	34.32	0.07	0.06	16.6	16.9	13.9	14.1	3.0	3.0	22.2	22.6	8.4	8.5	10.4	10.6	8.5	7.5	6.7	6.7	8.9	9.0	0.07	0.07	1.3	1.1	0.02	39.1
79	159	-80.52430	28.59793	341	23188	12.69	0.42	0.40	27.0	27.0	2.5	2.5	3.5	3.5	33.8	33.8	3.4	3.4	4.1	4.1	8.1	8.1	10.6	10.6	4.0	4.0	0.02	0.02	3.1	3.1	0.18	45.9
80	169	-80.51480	28.61995	301	19105	12.12	0.39	0.30	26.1	25.9	2.4	2.4	4.3	4.1	31.5	31.9	2.1	2.1	3.6	3.6	9.0	9.0	13.2	13.3	3.2	3.2	P	P	4.6	4.5	0.13	44.1
81	158	-80.33040	28.37096	295	19733	16.80	0.31	0.20	31.0	31.1	1.4	1.5	7.3	7.0	30.8	31.3	2.2	2.2	2.1	2.2	11.0	10.8	7.9	8.0	2.6	2.6	P	P	3.6	3.4	0.09	44.7
82	157	-80.52740	28.63113	277	20580	9.18	0.17	0.16	32.1	32.1	3.0	3.0	5.6	5.5	24.4	24.5	4.6	4.5	5.3	5.3	10.7	10.7	8.0	8.1	2.8	2.8	P	P	3.6	3.6	0.06	37.9
83	156	-80.52300	28.64940	366	23518	19.80	1.03	0.79	20.2	20.3	8.4	8.3	3.0	3.1	35.5	35.8	5.4	5.2	9.0	8.9	7.2	7.2	4.8	4.8	3.6	3.5	0.05	0.05	2.8	2.8	0.37	46.6
84	170	-80.49440	28.66197	279	19618	37.34	0.17	0.12	32.0	32.6	4.4	4.4	5.0	5.0	27.6	28.1	3.6	3.4	3.7	3.5	6.8	6.9	10.0	10.1	2.6	2.6	P	P	4.4	3.4	0.04	37.6
85	155	-80.47290	28.65940	205	14927	14.65	0.14	0.13	31.7	31.8	4.9	4.9	6.5	6.5	23.8	23.9	3.2	3.2	6.2	6.2	10.2	10.1	6.8	6.8	2.9	2.9	P	P	3.7	3.6	0.05	36.9
87	138	-80.44920	28.65493	361	26303	32.39	0.08	0.05	30.8	31.1	5.8	5.8	3.5	3.5	24.4	24.8	3.7	3.5	4.3	4.1	8.6	8.6	12.0	12.0	2.9	2.9	P	P	4.0	3.7	0.02	36.3
88	137	-80.44290	28.67430	333	21338	17.88	0.17	0.12	23.7	23.8	7.5	7.6	2.2	2.1	26.7	27.0	4.5	4.4	6.0	5.9	9.1	8.9	7.9	7.9	7.5	7.5	P	P	4.9	4.8	0.05	43.4
89	136	-80.44770	28.68740	304	23640	24.34	0.12	0.11	34.5	34.6	5.5	5.5	5.7	5.7	23.2	23.3	3.5	3.5	4.1	4.1	7.7	7.6	9.0	9.0	2.4	2.4	P	P	4.5	4.3	0.04	33.3
90	135	-80.42580	28.67579	187	13004	26.51	0.14	0.09	33.1	33.2	6.1	6.2	4.6	4.5	24.4	24.8	3.5	3.4	3.5	3.4	8.0	8.0	10.1	10.2	2.4	2.5	P	P	4.3	3.9	0.03	35.2
91	134	-80.39890	28.69793	348	26301	11.05	0.16	0.10	35.9	36.1	6.5	6.5	6.8	6.8	20.4	20.7	2.8	2.6	3.9	3.8	10.8	10.8	6.1	6.1	2.6	2.6	P	P	4.3	3.9	0.03	34.1
92	133	-80.38210	28.72486	352	13166	30.14	0.26	0.20	28.3	29.0	3.5	3.5	0.6	0.7	17.1	17.5	5.5	5.3	13.9	14.1	4.3	3.4	10.4	10.5	6.6	6.7	P	P	9.8	9.3	0.06	27.6
93	132A	-80.33620	28.71498	169	8393	6.18	0.09	0.04	24.7	25.2	5.7	5.9	2.9	2.9	25.0	25.8	5.9	5.8	6.1	6.0	7.2	5.9	11.9	12.3	7.0	7.0	N	N	3.7	3.2	0.02	38.7
95	132	-80.33480	28.71640	46	2928	0.85	0.19	0.15	34.0	34.2	2.5	2.5	13.0	13.0	22.3	23.0	3.6	3.2	3.6	3.5	8.6	8.5	7.5	7.6	2.4	2.5	P	P	2.5	2.1	0.05	33.9
		POPULATION STATISTICS																														
			MINIMUM	46	2928	0.85	0.05	0.03	11.1	11.1	0.7	0.7	0.6	0.7	15.5	15.7	0.7	0.7	1.0	1.0	4.3	3.4	4.1	4.1	1.6	1.6	<.01	<.01	0.8	0.7	0.01	25.6
			AVERAGE	258	14850	13.29	0.26	0.18	26.4	26.6	5.2	5.3	5.0	5.0	24.9	25.5	5.0	5.0	6.2	6.2	10.2	9.6	8.4	8.5	4.3	4.1	<.01	<.01	4.3	4.2	0.07	39.2
			MAXIMUM	430	29811	37.34	1.38	1.09	41.6	41.9	21.4	21.5	13.7	13.5	36.5	36.7	14.8	14.4	14.9	15.0	26.2	18.7	14.1	14.2	9.7	9.8	2.54	2.56	12.0	12.0	0.46	52.7
			STD DEV	82	6561	8.75	0.25	0.17	6.3	6.3	3.2	3.3	2.9	2.8	4.3	4.4	2.8	2.8	3.5	3.6	3.3	2.8	2.2	2.2	1.9	1.8	<.01	<.01	1.9	1.9	0.08	5.2

The region of muddy sediment seen to the south of Southeast Shoal for upper core sections (Figure 10) is probably also mud-rich for the lower core sections but most of the cores in that area did not have a lower section.

Seismic Survey

A total of 174 km of high resolution seismic lines were run offshore of Cape Canaveral, mostly across the Southeast Shoal area (Figure 15). Four significant stratigraphic relationships were revealed by the seismic survey. They are:

(1) The Hawthorn Group (Miocene) lies within 20 meters of the sea-floor throughout the study area (Figure 16).

(2) Reflectors within the carbonates of the Ocala Group show significant deformation (below about 80MS; Figure 16).

(3) An unconformity of unknown age is found as an undulate boundary at a depth of about 18-22 m below sea-level (i.e. just below the 20 millisecond time-line in Figure 17). More importantly, this unconformity crops out directly on the sea-floor throughout much of the survey area not covered by shoal sands (Figure 17).

(4) The large sand bodies forming the shoals offshore of Cape Canaveral appear to be relict features. They may even be composed of older (Pleistocene) stratigraphic sections.

The Hawthorn Group is easily identified by a very strong reflector at about minus 40 milliseconds (about 35 m) (Figures 16 and 17). It appears throughout the survey area. The internal stratigraphy within the Ocala Group displays numerous folds

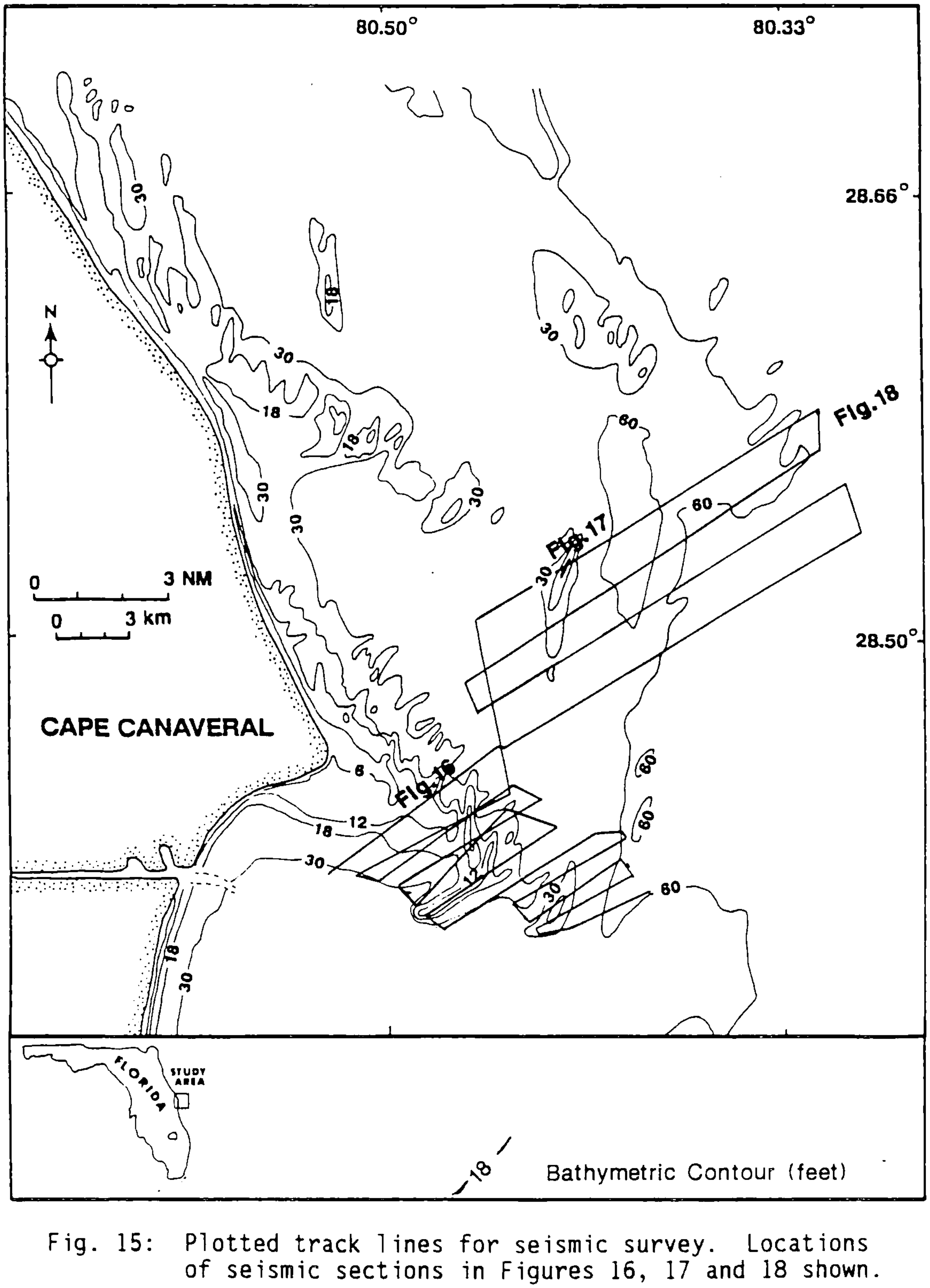

Fig. 15: Plotted track lines for seismic survey. Locations of seismic sections in Figures 16, 17 and 18 shown.

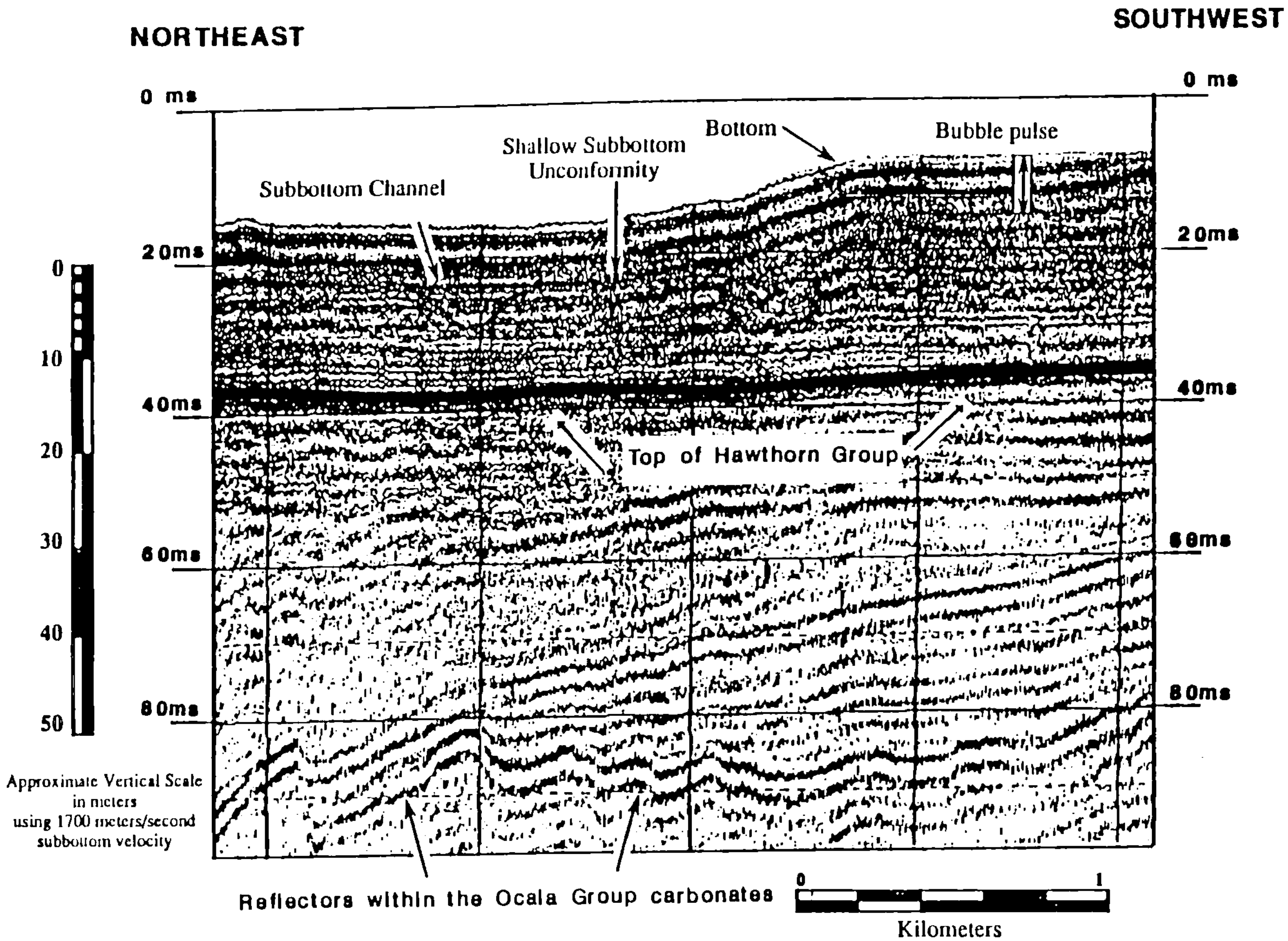

Fig. 16: Seismic profile of a portion of a sand shoal showing a sub-bottom channel, a shallow sub-bottom unconformity and the bubble pulse. Note the deformed Ocala Group carbonates at the bottom of the section.

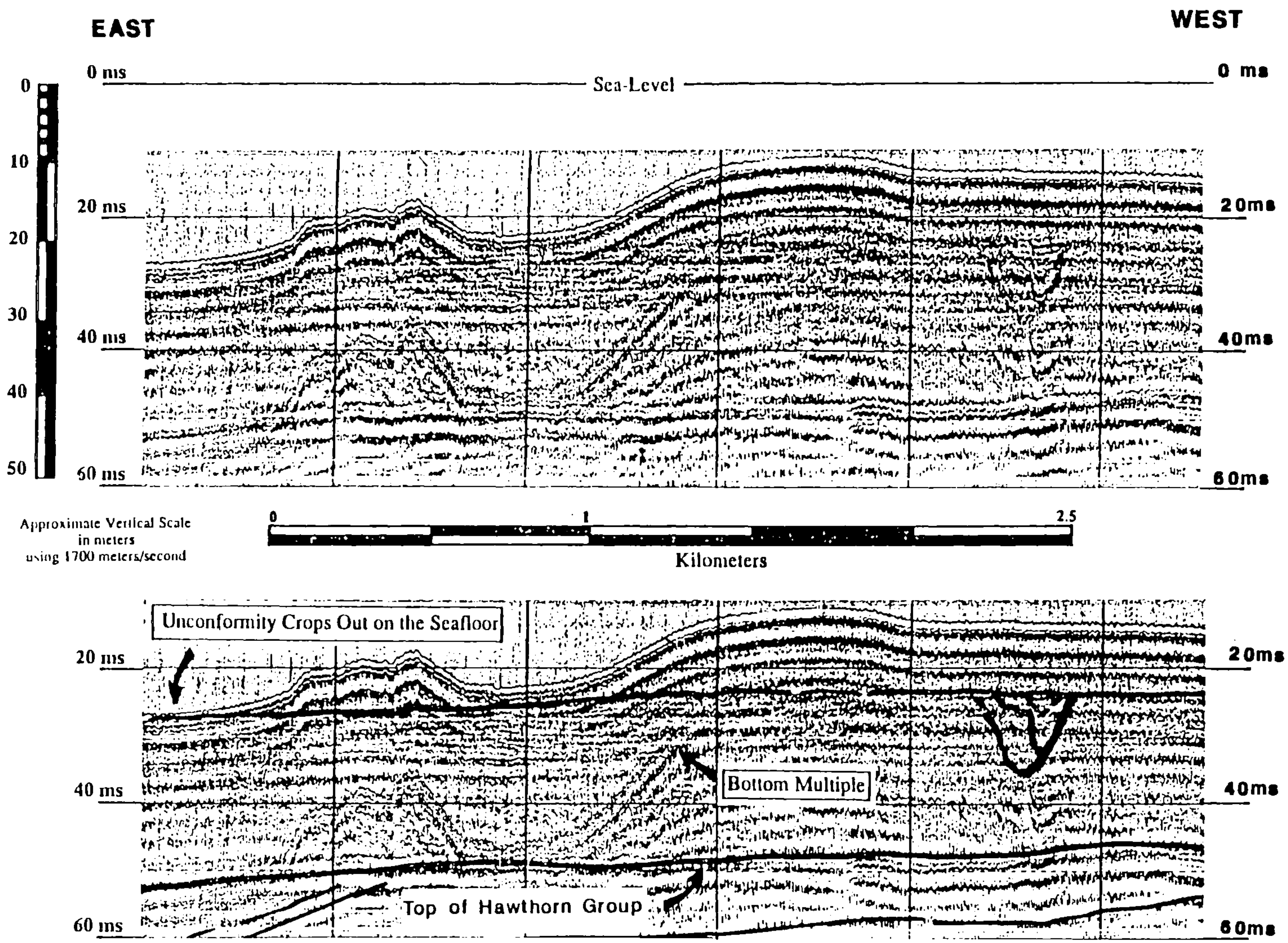

Fig. 17: Seismic profile of a portion of a sand shoal, interpreted section on bottom. Note the emergence of the unconformity on the sea floor.

indicating that this section has experienced dissolution and concomitant collapse (i.e., solution-tectonics). The section overlying these Eocene carbonates is undeformed (Figures 16 and 17). This implies that the dissolution events primarily occurred prior to deposition of the overlying sequences.

The unconformity found to crop out on the seafloor is characterized by several channels (Figure 17), which are probably fluvial in origin. This interpretation is based on the geometries exhibited in the subbottom data and size-similarity to modern coastal fluvial systems. The age of the unit underlying this unconformity is unknown. A portion of the heavy minerals present may be due to reworking of this stratigraphic unit.

The internal stratigraphy of the large sand bodies was masked by the large bubble pulse throughout the survey. No significant reflectors were identified within these features (Figures 16 and 17). They appear to be relict features because small sand waves were found on top of the large sand bodies (Figure 18). This implies that active sand transport in the form of migrating sand waves occurs over the large sand bodies, and that the large features are either dormant sand bodies or coherent Pleistocene stratigraphic sections which have escaped shoreface erosion. Unfortunately, the seismic data were not able to differentiate which scenario is more probable.

Heavy Minerals

The average total heavy-mineral (THM) content of the 140 samples from offshore of Cape Canaveral is 0.26 weight percent; the recovered heavy-mineral (RHM) content averages 0.18 weight

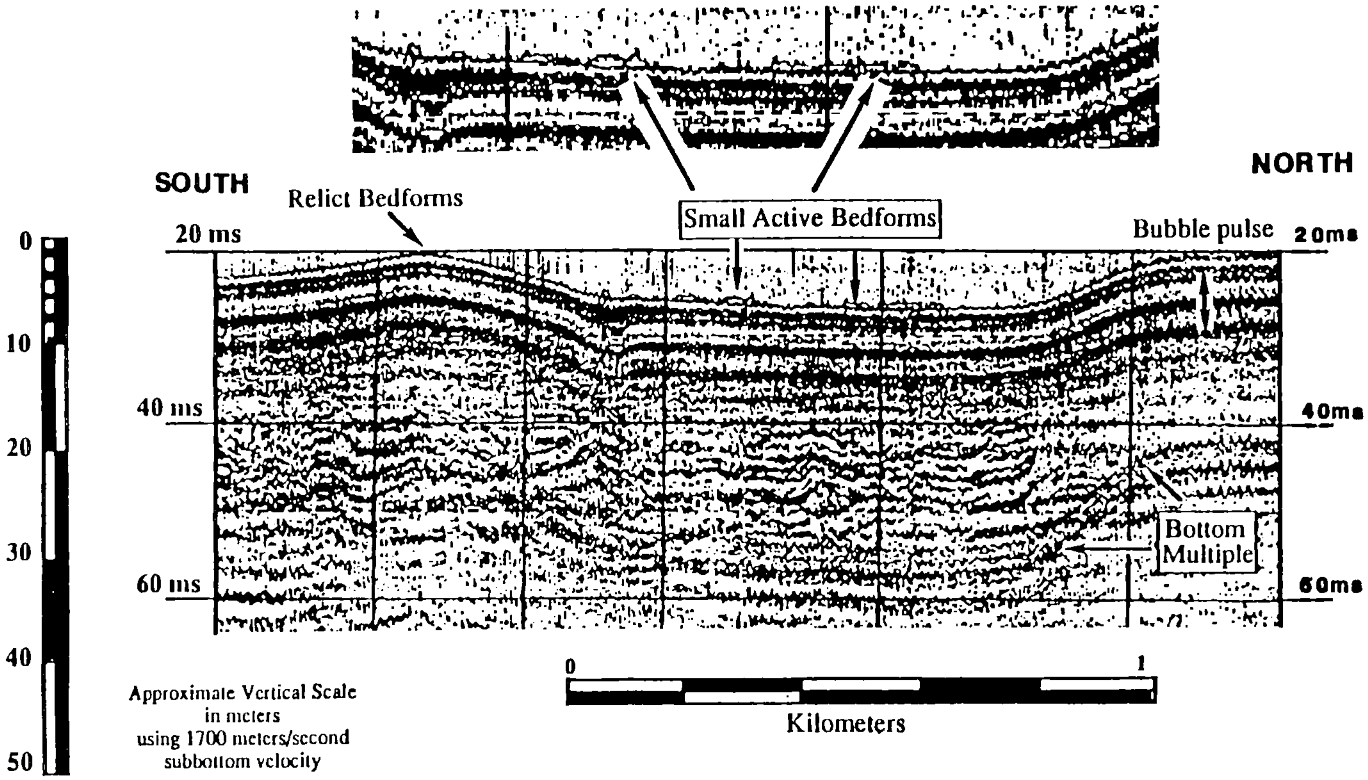

Fig. 18: Seismic profile of a portion of a sand shoal. Inset shows small, active bedforms on top of older, possibly inactive shoal bodies.

percent (minimum, average, maximum and standard deviation values are given in Table 6 - Population Statistics). About 75 percent, on the average, of the THM was recovered by the methods described in an earlier section. Individual samples were more (or less) susceptible to the recovery of their heavy-mineral content by our methods of recovery: some heavy-mineral species, specifically the aluminosilicates, were less likely to be recovered by the spiral concentrator because of their poor hydrodynamic shape. Data for individual mineral species expressed as percentages of the RHM and THM are given in Table 6. Table 7 summarizes values for THM and RHM for all samples and also according to depth interval (either upper or lower 1.5 m section). The data for individual sections for the Phase I study are given in Nocita et al. (1989a) Grosz et al. (1989a), and Kohpina (1989). The data and population statistics included in this report for the entire sample population are on a whole core basis (Table 6). The heavy-mineral species present in these samples, in decreasing order of abundance are epidote, ilmenite, aluminosilicates, zircon, pyroxene/amphibole, staurolite, garnet, tourmaline, rutile, monazite, and others (including magnetite, phosphorite, sulfides, unidentified opaques, non-opaques, quartz, coated grains, etc.)

Economic Heavy Minerals

The minerals of highest economic importance that are present in the Cape Canaveral offshore area include ilmenite, rutile, zircon and monazite. Monazite is present in only minute quantities and so does not figure in calculations of economic

TABLE 7

Data for Total heavy minerals (THM) and Recovered heavy minerals (RHM) tabulated for all samples, in the upper 1.5 m sections and the lower 1.5 m sections.

	ALL SAMPLES (N=140)				UPPER 1.5 m SAMPLES (N=84)				LOWER 1.5 m SAMPLES (N=56)			
VARIABLE	MIN	AVG	MAX	STD	MIN	AVG	MAX	STD	MIN	AVG	MAX	STD
Wt% RHM	0.01	0.18	1.10	0.18	0.01	0.19	1.09	0.18	0.02	0.18	1.10	0.18
Wt% THM	0.02	0.27	1.48	0.26	0.02	0.26	1.38	0.26	0.03	0.27	1.48	0.28

heavy-mineral (EHM) abundances. There is the possibility that some monazite is being overlooked, perhaps being mistaken for epidote. This is based on preliminary geochemical analyses which show elevated quantities of certain elements common to monazite (A. Grosz, unpub. data). However, at this time, the available data indicate average quantities of monazite of significantly less than 1 weight percent of the RHM.

Ilmenite averages 26.7 weight percent of the RHM fraction. This is second only to epidote in absolute abundance and is the highest value for any of the EHM fraction. An examination of the spiral lights (material rejected by the spiral) shows virtually no ilmenite. This suggests that the weight percent RHM value closely represents the THM value.

Zircon averages 9 weight percent of the RHM fraction and is second to ilmenite in EHM abundance. The spiral-light estimates for zircon were almost all less than 10 weight percent, most being less than 5 weight percent. This suggests efficient recovery of zircon by the spiral concentrator.

Rutile is the third most abundant economic heavy mineral, averaging about 4.2 weight percent of the RHM fraction. Recovery of rutile by the spiral concentrator appears to have been inconsistent amongst samples. Although most of the spiral-light values for rutile are quite low (<5%), there are some that are 20 or 30 weight percent.

A recent study by Kohpina (1989) showed that there is no appreciable fractionation of either economic or non-economic heavy minerals with core section (upper vs. lower). This same conclusion was reached during the first phase of the Cape Canaveral project (Nocita et al., 1989a) but Kohpina's conclusions are based not just on semi-quantitative weight percents but also detailed statistical analysis. Kohpina (1989) also showed statistically through factor analysis that certain groups of heavy minerals are commonly found in abundance together. This is due to consideration mainly of grain size and specific weight of the heavy minerals. The average EHM content for these samples is 39.2 weight percent of the RHM; .07 weight percent of the bulk sample.

CONCLUSIONS

The heavy-mineral assemblage offshore of Cape Canaveral consists dominantly of epidote, ilmenite, aluminosilicates, pyroxene/amphibole, and zircon. The assemblage is qualitatively and quantitatively different than those found offshore of Virginia (Grosz and Escowitz, 1983; Berquist and Hobbs, 1988) and off shore of New York (Grosz, et al., 1988), but is qualitatively similar to suites found offshore of Jacksonville, Florida and South Carolina (Grosz and Escowitz, 1983).

Although the heavy-mineral species which occur offshore of Cape Canaveral are similar to those found in onshore economic deposits such as Trail Ridge and Green Cove Springs, absolute abundances and concentrations appear to be almost ar order of magnitude lower on the average for the offshore deposits.

The results of the analyses show a very low potential for detrital heavy-mineral resources in sediments offshore of Cape

Canaveral. Values for the economically important heavy-mineral species (ilmenite, rutile, zircon and monazite) calculated as percentages of the heavy-mineral concentrates and of bulk sediment samples are below values for sediments from other areas on the Atlantic Inner Continental Shelf (Grosz and Nelson, 1989; Grosz et al., 1989b; Grosz and Escowitz, 1983; Grosz, 1987; Luepke and Grosz, 1986).

Sand and gravel deposits on the shore attached shoal bodies are mud-poor, sand-rich, and over a wide area maintain these characteristics to a depth of at least 3 meters. Without deeper core data it is not possible to say how thick the desirable sediments are. It is not uncommon for nearshore dredging of beach nourishment sand to extend down to a sediment depth of 6 m or more.

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