

FIGURE 1. ISOPACH MAP SHOWING THE THICKNESS IN FEET OF THE CABO ROJO WEST SAND DEPOSIT, AND SAMPLE LOCALITIES.

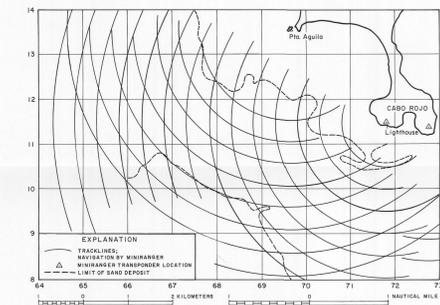


FIGURE 2. MAP SHOWING TRACKLINES OF HIGH-RESOLUTION SEISMIC-REFLECTION PROFILES.

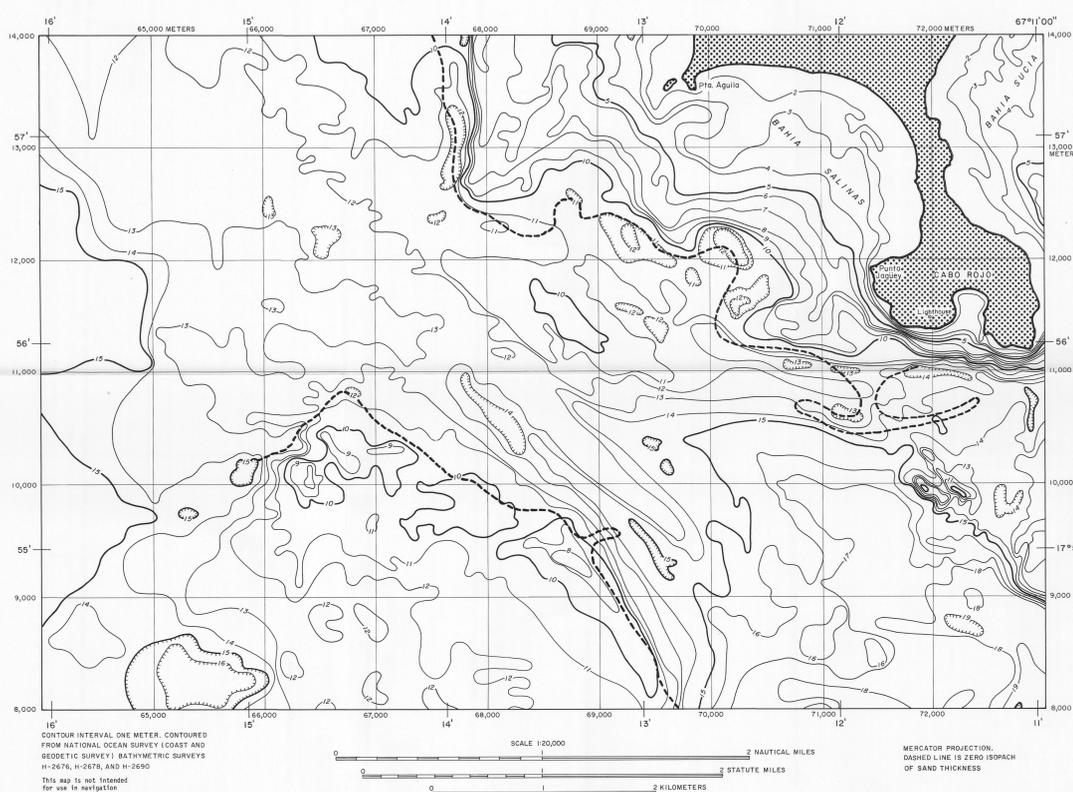


FIGURE 3. BATHYMETRIC MAP SHOWING THE DEPTH IN METERS OF WATER OVER THE CABO ROJO WEST SAND DEPOSIT AND SURROUNDING AREAS.

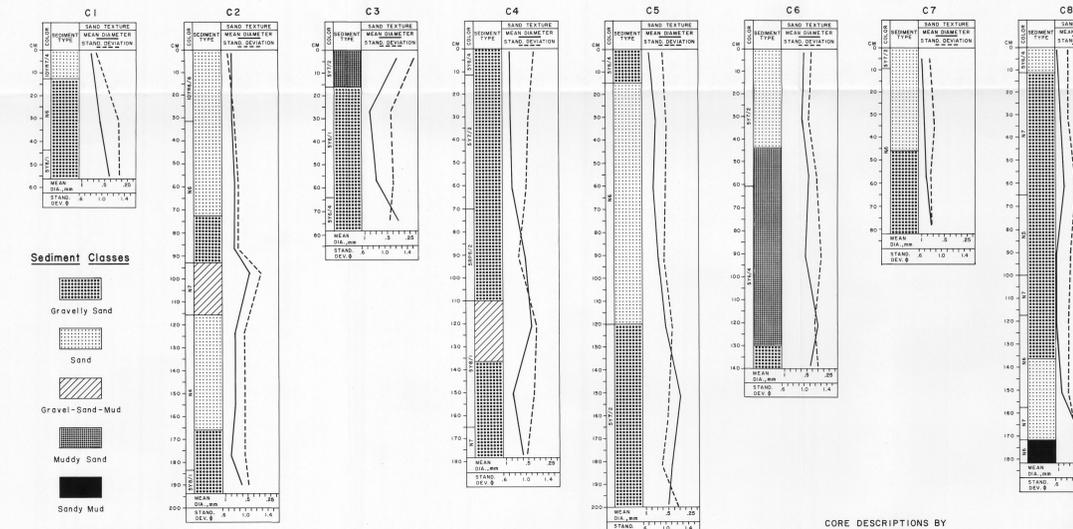


FIGURE 4. DESCRIPTIONS OF CORE SAMPLES.

Introduction

This report presents detailed information on a deposit of well-sorted coarse sand in water depths of 10-20 m in an area between 1 and 6 km west and southwest of the promontory of Cabo Rojo, the southwestern corner of Puerto Rico.

Sand for concrete, road-building, and other uses is in short supply in Puerto Rico (Committee on the Sea, 1974), and the Cabo Rojo West sand deposit appears to be of considerable potential economic value. On the basis of existing information, mining of this deposit would seem to be potentially less damaging to the environment than mining of any other large deposit of clean, well-sorted sand near Puerto Rico.

The deposit was discovered and has been investigated by the Marine Geology Project, conducted jointly by the Commonwealth of Puerto Rico Department of Natural Resources and the U.S. Geological Survey.

The Cabo Rojo West sand deposit was first detected during examination of a reconnaissance seismic-reflection profile covering the broad insular shelf off the south half of the west coast of Puerto Rico. A reconnaissance high-resolution seismic-reflection profile survey using radar navigational control in February 1973 confirmed the existence of the deposit. Beginning in April 1973 a detailed high-resolution seismic-reflection profile survey using precision electronic navigational control was made, a suite of more closely spaced seismic profiles (numbered in the 400-series in figure 1) was taken, and an attempt was made to drill the deposit.

This report presents information on the location and limits of the deposit, its depth, thickness, and volume; the particle-size distribution of the sand; results of drilling and results of suitability for making concrete.

In this report the measurement units used to be most convenient and familiar to the reader has been used, whether in the English or the metric (SI) system. Both systems are in common use in Puerto Rico. The Puerto Rico plane-rectangular coordinate system in meters is given precedence over latitude and longitude because of its greater practicality in engineering and local surveying applications. It is simply a coordinate system that uses meters or feet north-south and east-west.

The system is based on a Lambert conformal projection of the island of Puerto Rico. The system is based on a Lambert conformal projection of the island of Puerto Rico. The system is based on a Lambert conformal projection of the island of Puerto Rico. The system is based on a Lambert conformal projection of the island of Puerto Rico.

Previous Work

Information on particle-size distribution and on the composition of the sand used in the area of the Cabo Rojo West deposit has been published by Shideler (1980). The deposit is included within the area described in an unpublished thesis by L. O. Fernandez of the North Carolina State University Department of Geosciences, entitled "Investigation of the Cabo Rojo Island sand deposit, southwestern Puerto Rico." No other detailed reports on the area are known. Some information on the sand deposits in the nearby Bahía Salinas area was given by Grove and Trumbull (1974). A general description of the sediments of the insular shelf of Puerto Rico was published by Lonsdale, Pilkey, and Saunders (1974), and Schneidermann (1974, 1976, 1974b, 1974c, 1977) has published abstracts on the Cabo Rojo West deposit.

Most of the area in which the Cabo Rojo West sand deposit is located is covered by the Cabo Rojo 7.5-minute topographic quadrangle map, scale 1:50,000, published by the U.S. Geological Survey (USGS) in cooperation with the Puerto Rico Department of Public Works. The entire area of the sand deposit is shown on National Ocean Survey chart 25871 (formerly Coast and Geodetic Survey chart 901), "West coast of Puerto Rico," scale 1:150,000.

Acknowledgments

We thank Captain Elio Rodríguez and crew of the RV Jean A of the Puerto Rico Department of Natural Resources for their support of the field work. Electronic technician Nicholas Lefteris for installation and operation of seismic and electronic distance-finding equipment and the diving and drilling team of Ron Cires, Jack Kindinger, Neil Lillard, and Ron Miller for making the drill hole. Particle-size and other analyses of sand samples were made by the USGS sedimentology laboratory at Corpus Christi, Tex. Tests of sand for suitability in making concrete were done by the Materials Testing Office of the Highway Authority of the Commonwealth of Puerto Rico, headed by Ing. Antonio Castro Rosero, and we thank him and his staff for their cooperation.

Methods

All field work was done in the Puerto Rico Department of Natural Resources research vessel Jean A.

Reconnaissance sampling of surface sediments was done between April 28 and June 10, 1976. Eight samples numbered 218 and 271, and 21 uniform more closely-spaced set was collected on Feb. 9, 1973 (29 samples numbered 401 and 443). Three bulk samples (284 through 286) were taken on Feb. 11, 1973. A Shipek grab sampler was used to sample the upper 10 to 15 cm of sand. The bulk samples were taken by repeated lowering of the sampler while the ship was allowed to drift in the wind and current, resulting in representative composite samples. Navigation was by radar sample positions shown in figure 1 are considered to be within about 150 m of the true position.

Core drilling was done at eight locations labeled C1 through C8 (in figure 1) using a hydraulically-powered vibrating corer described by Dokken and others (1975). The corer relatively well-sorted sand was difficult to core and to retain in the corer, and the length of cores obtained is 2 m or less, though full-depth penetration of 2 m was obtained several times. Navigation was by Miniranger electronic distance-finding equipment, with plane transponder stations at Punta Aguila and near the lighthouse at Cabo Rojo. Drilling positions shown in figure 1 are considered to be within about 30 m of the true position.

Subsamples from the surface samples and the cores were desalted, dispensed and decolored with 5% sodium hexametaphosphate (saltpen), and were wet-sieved through standard sieves having openings of 2 mm (1 phi) and 63.5 (2.000 mm), 4 phi to separate gravel, sand, and mud (silt and clay). Percentages by weight of these three size grades are shown in figures 6, 7, and 8. Particle-size analysis was then done on the sand-

Sieve analysis, in percent

Sieve size	Sample 284		Sample 285		Sample 286	
	Retained	Passing	Retained	Passing	Retained	Passing
100	100	96	100	98	100	98
40	96	92	92	88	92	88
20	88	84	84	80	84	80
10	80	76	76	72	76	72
4.75	72	68	68	64	68	64
2.0	64	60	60	56	60	56
0.85	56	52	52	48	52	48
0.425	48	44	44	40	44	40
pan	40	36	36	32	40	36

Some conversion factors are given below:

1 inch = 2.54 centimeters
1 foot = 0.3048 meters
1 meter = 3.281 feet
1 kilometer = 0.621371 miles

Thickness and volume of sand

Thickness of the sand deposit in feet is shown in figure 1, and the estimated volume of sand is shown in table 1.

The greatest observed thickness of the sand is 27 ft, and it is 10 to 12 ft thick over large areas. Thinning to zero from a thickness of 10 to 16 ft takes place over a very short distance on the northeastern and especially on the southwestern margins of the sand deposit.

The total volume of sand estimated to be in the deposit is 80,243 million m³. (This figure results from adding numerous individual estimates of sand in each square kilometer and in two-foot thickness categories. The bottom horizontal line of table 1 shows that 78 percent of the total volume of sand is in beds between 6 and 18 ft thick.)

Drilling results—The deposit was drilled with a hydraulically-powered vibrating corer (described by Dokken and others, 1975) at eight locations. Penetrations of 10 ft were obtained several times. Core retention was poor, however, and no core longer than 2 m was recovered. Results of the drilling are shown in figure 4. In general the drilling



FIGURE 5. MEDIAN DIAMETER OF SAND-SIZE FRACTION (0.625-2.0 MM) OF SURFICIAL BOTTOM SEDIMENT PARTICLES.

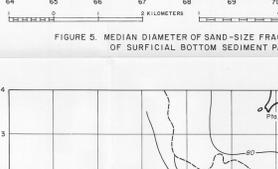


FIGURE 6. WEIGHT PERCENTAGE OF THE SURFICIAL BOTTOM SEDIMENT THAT IS OF SAND SIZE (0.625-2.0 MM).

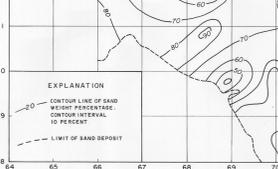


FIGURE 7. WEIGHT PERCENTAGE OF THE SURFICIAL BOTTOM SEDIMENT THAT IS OF SILT AND CLAY SIZE (SMALLER THAN 0.625 MM).

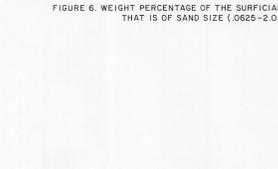


FIGURE 8. WEIGHT PERCENTAGE OF THE SURFICIAL BOTTOM SEDIMENT THAT IS OF GRAVEL SIZE (LARGER THAN 2.0 MM).



FIGURE 9. CARBONATE CONTENT OF SURFICIAL BOTTOM SEDIMENT, IN WEIGHT PERCENT.

Table 1.—Estimated volume of sand in the Cabo Rojo West sand deposit, by square kilometers and thickness categories

Expressed in thousands of cubic meters. Square kilometers are designated by the coordinates of their southwestern corners, in thousands of meters.

Square kilometers	Thickness category, in feet																Total in each category
	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28					
8-69	108	16	329	147	274	1,034										2,830	
8-70	207	99	241	94	1,236											2,849	
8-71	208	284	284	284	284											1,137	
8-68	297	289	435	245												1,267	
8-69	422	627	411	1,127												2,627	
8-70	425	1,127														1,552	
8-71	114	292														406	
8-72	1,420	802	265	410	392											3,289	
8-73	10	60	107	208	364	1,050										1,739	
8-74	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-75	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-76	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-77	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-78	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-79	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-80	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-81	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-82	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-83	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-84	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-85	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-86	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-87	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-88	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-89	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-90	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-91	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-92	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-93	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-94	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-95	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-96	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-97	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-98	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-99	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
8-100	1,100	1,100	1,100	1,100	1,100	1,100										7,700	
Total	3,126	8,851	1,976	23,293	6,615	1,781	7,953	2,237	4,727	3,174	4,343	776				80,243	
Percent	4	11	10	29	8	1	10	29	8	1	10	29				100	

MAPS SHOWING CHARACTERISTICS OF THE CABO ROJO WEST OFFSHORE SAND DEPOSIT, SOUTHWESTERN PUERTO RICO

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1982