Rev. Biol. Trop., 44, Suppl. 3: 11-17, 1996

Bottom topography and sediments around Isla del Caño, Pacific of Costa Rica

Jorge Cortés[1], Ana Cecilia Fonseca[1,2] and Dierk Hebbeln[3]

[1] Centro de Investigación en Ciencias del Mar y Limnología (CIMAR), and Escuela de Biología, Universidad de Costa Rica, San José, Costa Rica.

[2] Sistema de Estudios de Posgrado, Programa en Biología, Universidad de Costa Rica.

[3] Fachbereich Geowissenschaften, Universität Bremen Postfach 330 440, D-28334 Bremen, Germany.

(Rec. 4-VII-1995. Rev. 14-II-1996. Acep. 27-V-1996)

Abstract: The bottom topography around Isla del Caño, to a distance of 11 km was determined during the Costa Rica expedition of the German Research Vessel Victor Hensen. A map resulting from that survey is presented in this paper. Additionally, sediment samples were taken using a box corer, along three transects, one on the north side of the island, one on the southwest and one on the east. The sediments around Isla del Caño are of terrigenous origin, with small contributions of carbonates from the island's coral reefs.

Key words: Caño Island, bottom topography, map.

Isla del Caño is a 3.2 km² island located 15 km off the southern section of the Pacific coast of Costa Rica (Fig. 1). It has been studied for over ten years. The topography of the shallow areas (< 30 m) was determined, while surveying the coral reefs around the island (Guzmán 1986, Guzmán & Cortés 1989). The deeper areas, or zones farther off the island have not been surveyed before. As part of the German Research Vessel Victor Hensen expedition, the bottom topography around the island (up to 11 km from the shore) was determined and mapped.

Samples of bottom sediments from the shallow reef areas had been studied previously (Guzmán 1986, Guzmán *et al.* 1987). With the capability of deep sampling using the box corer aboard the RV Victor Hensen, sediment samples were taken near the island to study the influence of the island on sediment composition in adjacent areas.

Isla del Caño has five coral reef platforms (Guzmán & Cortés 1989). Two on the north shore, one on the east side, and two small ones on the south side. The north coral reefs are relatively extensive and one of them has many large microatolls of the coral *Porites lobata*. The coral reef on the east side is the largest and has the highest live coral coverage. The reefs on the south are poorly developed probably due to the intense wave action on this side of the island. Live coverage is low but the green calcareous algae, *Halimeda discoidea*, covers extensive areas. Bioerosion, mainly by *Lithophaga* spp., is intense on the island (Guzmán & Cortés 1989).

In this paper we present a topographic map of the ocean bottom around Isla del Caño, and the grain size distribution and composition of bottom sediments around the island.

MATERIAL AND METHODS

Mapping: A total of nine bottom profile transects (each 9.3 km long, and starting 1.85 km off the island) was done around Isla del Caño (Fig. 1), using a 18 kHz ELAC echosounder. The ship position was determined by GPS (Global Positioning System). The echosounder profiles and the positions were processed with the Surfer software to generate a map of the bottom topography.

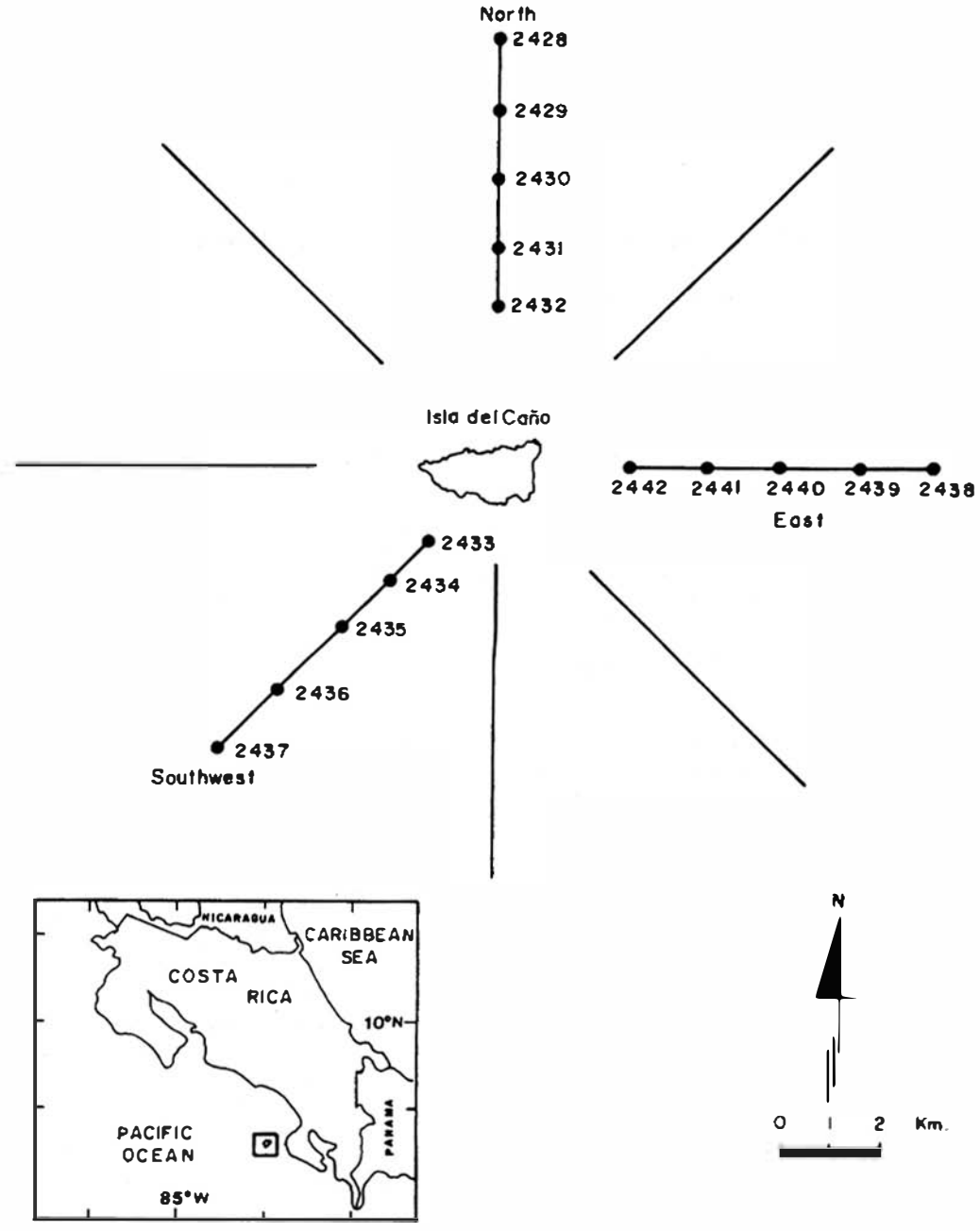

Fig. 1. Isla del Caño and its location in Costa Rica. The echosounder profiles and the bottom sediment sampling stations are indicated.

Bottom sediment samples: The north, southwest and east transects of the bottom profiling were also sampled every 1.85 km using a Box Corer, with a sampling volume of 50 x 50 x 50 cm, to collect bottom sediment. The position and depth of the sampling stations are presented in Table 1 and Figure 1. The north transect run almost parallel to the Pacific coast of Costa Rica; the southwest transect off shore from the island; and the east transect perpendicular to the continental coast line (Fig 1).

TABLE 1

Position and depth of the sediment sampling stations, around Isla del Caño (see Figure 1)

Station	Latitude	Longitude	Depth
NORTH TRANSECT			
2428	08°48.0'N	83°53.0'W	68 m
2429	08°47.0'N	83°53.0'W	71 m
2430	08°46.0'N	83°53.0'W	64 m
2431	08°45.0'N	83°53.0'W	57 m
2432	08°44.0'N	83°53.0'W	47 m
SOUTHWEST TRANSECT			
2433	08°41.2'N	83°52.9'W	40 m
2434	08°40.5'N	83°53.6'W	82 m
2435	08°39.8'N	83°54.3'W	98 m
2436	08°39.1'N	83°55.0'W	108 m
2437	08°38.4'N	83°55.7'W	109 m
EAST TRANSECT			
2438	08°42.5'N	83°46.5'W	47 m
2439	08°42.5'N	83°47.5'W	46 m
2440	08°42.5'N	83°48.5'W	43 m
2441	08°42.5'N	83°49.5'W	45 m
2442	08°42.5'N	83°50.5'W	42 m

The percent $CaCO_3$ was determined by the weight lost method. All samples were washed with distilled water to remove salts, and then approximately 10 g dry weight of each sample were digested in 25 ml of HCl. The residual was filtered (Whatman paper filter #2), washed, dried, and re-weight (Seisser & Rogers 1971).

Grain size distributions were accomplished by standard sieve technique, with the following sieve sizes: 9500, 4000, 2000, 1000, 710, 500, 355, 250, 180, 125, and 75 µm (McManus 1988). Sediment classification is based on grain size, sorting, gradation level, carbonate percentage, and size and relative proportions of bioclasts and lithoclasts.

The bioclastic and lithoclastic components of the sediments were determined by visual inspection. Samples were sifted using the 420, 250, 149 mm sieve sizes, to analyze the material retained in each sieve. The basic components were identified using a binocular microscope at the following magnitudes: 8, 12, 20, 32, 50X. Two groups were determined, bioclasts: shell and coral fragments, sea urchin spines, fish scales, polychaete tubes, foraminiferans, calcareous algae, sponge spicules, and plant debris; and lithoclasts: rock fragments (silicious or carbonaceous), sedimentary conglomerates, quartz and piroxene. A representative fraction of the retained material was extracted from each sieve in order to count the mineral components. Each component was separated in different containers to count the grains and to determine the percentile relation in each sieve. This percentage was extrapolated to a percentage in relation to the total weight using the cumulative frequency distribution curve of grain size diameters previously determined. In direct relation to the sample heterogeneity, the number of grains used by sample to obtain the final results varied from 10 to 522.

RESULTS AND DISCUSSION

The bathymetric map (Fig. 2) and the block diagram (Fig. 3) of Isla del Caño show an elevated area to the southeast of the island not reported previously, and a deep basin to the southwest. Putative shallow banks to the west and southwest were not seen in the depth soundings. Probably they are closer to the shore than indicated by local residents.

Results of the sediment analyses are presented in Fig. 4 and Table 2. The grain size analyses show that on the profile north of Isla del Caño the coarsest sediments, mainly sand, are found on the most distant station 2428, approximately 11 km off the north coast of

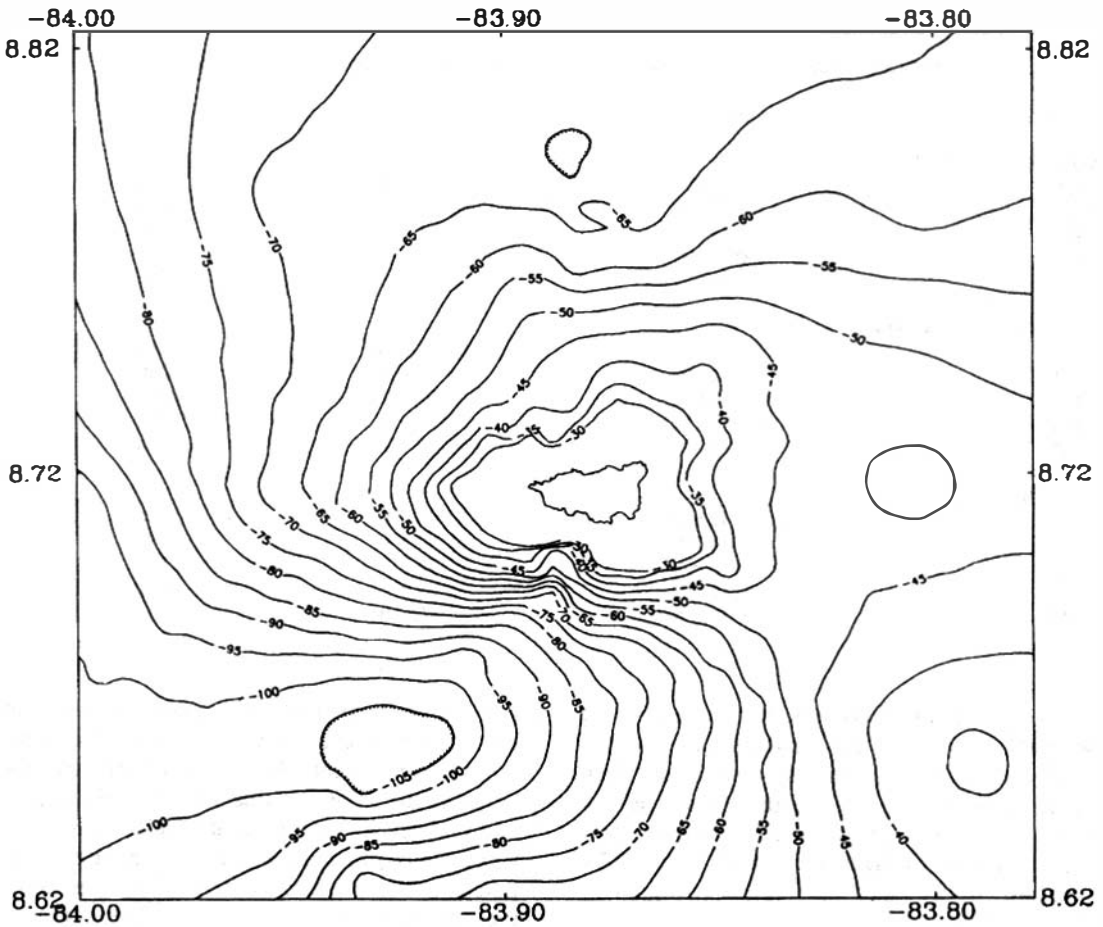

Fig. 2. Bathymetry around Isla del Caño. Depth in meters.

TABLE 2

Sediment characteristics and classification at stations around Isla del Caño

STATION	CLASSIFICATION	% Fines	% $CaCO_3$	% Bio.	% Litho.
NORTH TRANSECT					
2428	poorly sorted and graded carbonate lithoclastic clayey sand with bioclasts	31.9	27.7	28	71
2429	well sorted clay with lithoclastic medium sand and bioclastic coarse sand	64.9	14.2	27	73
2430	poorly sorted clay with lithoclastic medium sand with bioclasts	64.4	21.4	22	78
2431	poorly sorted sandy silt with lithoclastic sand and bioclasts	80.0	24.1	16	84

Table 2 (continued)

STATION	CLASSIFICATION	% Fines	% $CaCO_3$	% Bio.	% Litho.
2432	poorly sorted and well graded carbonate lithoclastic sand with bioclastic coarse sand	38.5	31.5	13	87
SOUTHWEST TRANSECT					
2433	poorly sorted and poorly graded carbonate sand with gravel and lithoclasts	3.0	76.2	81	19
2434	poorly sorted sandy silt	70.6	12.8	-	-
2435	poorly sorted sandy silt with lithoclastic sand with bioclasts	88.8	15.7	37	63
2436	poorly sorted sandy clay with bioclastic sand with lithoclasts	94.0	17.9	52	48
2437	poorly sorted sandy silt with bioclastic fine sand with coarse lithoclasts	92.1	16.7	51	49
EAST TRANSECT					
2438	poorly sorted carbonate clay with lithoclastic fine sand and bioclastic coarse sand	53.6	29.7	65	35
2439	poorly sorted and poorly graded carbonate bioclastic medium sand with lithoclastic coarse sand	29.7	45.9	57	43
2440	poorly sorted and well graded carbonate bioclastic medium sand with lithoclasts	8.2	48.8	57	43
2441	poorly sorted and poorly graded lithoclastic fine sand with fine bioclasts	4.5	14.5	42	58
2442	moderately sorted and poorly graded lithoclastic fine sand with bioclasts	2.6	14.6	12	88

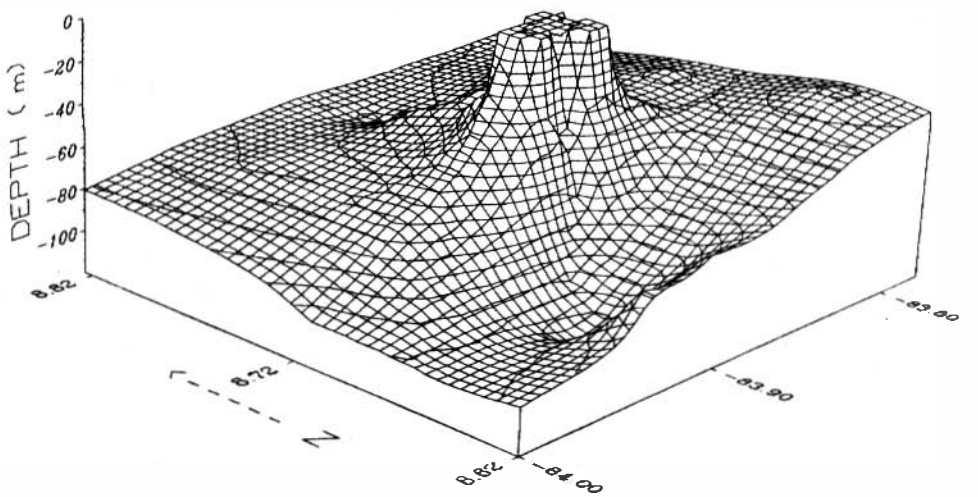

Fig. 3. Block diagram of the bottom around Isla del Caño.

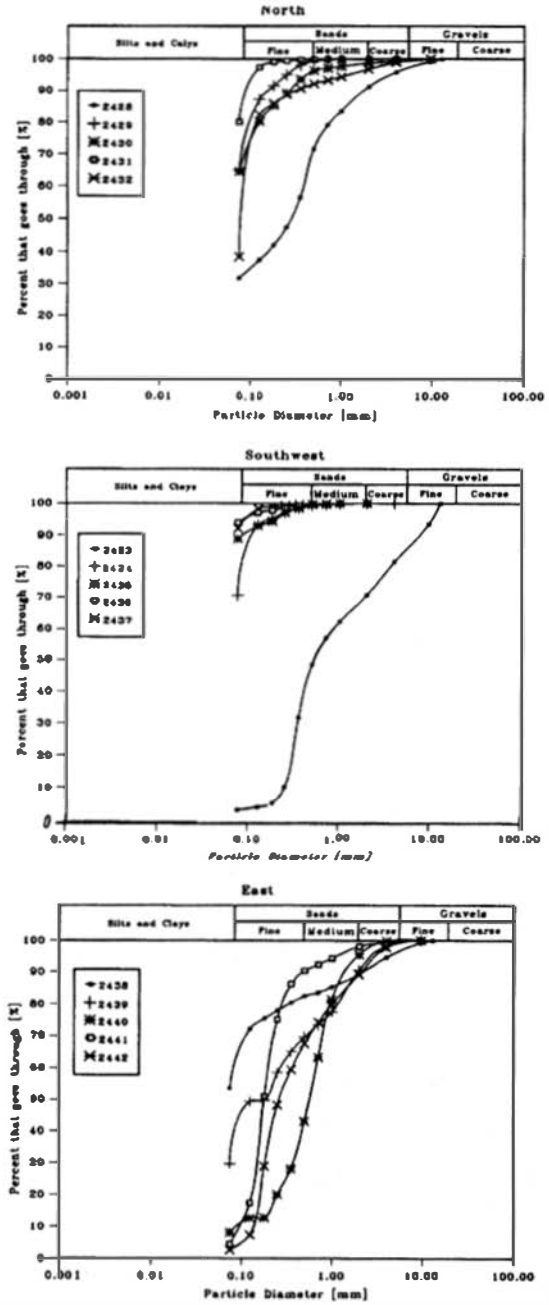

Fig. 4. Grain size distribution of bottom sediments from three transects off Isla del Caño. Top: North transect. Middle: southwest transect, and bottom: east transect.

the island. Along the profile towards the island the sediments become finer and the carbonate fraction increases (Fig. 4a and Table 2).

The sediments from the profile to the southwest are the finest from all around the island. The outer stations (2435, 2436, and 2437) are located in a small basin (Fig. 3). They consist mainly of clay and silt, and contain less than 15% sand, while station 2434 has a slightly enriched fine sand content (Fig. 4b). Exceptional is the innermost station of this profile (2433), which is nearly a pure sand, and has the highest content of $CaCO_3$ (76.2 %). This high carbonate value is due to bioclastic gravel (18.5 % of the total), consisting mainly of bivalves, coral fragments, and sea urchin spines. The south side of the island is subject to more intense wave action than the rest and boring bivalve densities in corals are high (Guzmán & Cortés 1989), resulting in a greater supply and transport of carbonate material.

East of the island the sediments are generally coarser (mainly sand) than on the other profiles and the carbonate fraction increases toward the island, except at the two stations closest to it, which have the lowest carbonate values (Fig. 4c and Table 5). The coral reefs on the east side of the island have been recovering from the 1983 El Niño, and have the highest live coral coverage (Guzmán & Cortés 1989). Near shore sediments from this area have high carbonate concentrations (71 to 85 %) (Guzmán *et al.* 1987). Apparently these sediments are not being transported directly off shore, but more to the north due to prevailing current direction.

Isla del Caño is a pinnacle surrounded by sediments mainly of terrigenous origin, with some contribution of carbonates from the coral reefs on the island.

ACKNOWLEDGEMENTS

We thank B. Bofill, D. Beese, Captain G. Sietas and the crew of RV Victor Hensen for the help in the field. P. Denyer, J. Alvarado, R. Mora, J. Hernández, J. Macías, S. Hernández and L. G. Salazar from the Escuela Centroamericana de Geología, Universidad de Costa Rica, helped with the analyses of the sediment samples and with the generation of the topographic map. The reviews by J.A. Vargas and three anonimous reviewers helped improve the manuscript. Finally, we thank the support of the Universidad de Costa Rica (project 808-94-564) and CONICIT (project 90-326-BID). This is CIMAR Contribution No. 236.

RESUMEN

La topografía del fondo de la Isla del Caño, a una distancia de 11 km, se estudió durante la misión a Costa Rica del Buque Oceanográfico Alemán Victor Hensen. Se presenta en este trabajo un mapa resultado de ese sondeo. Adicionalmente, se tomaron muestras de sedimentos utilizando un nucleador de caja a lo largo de tres transectos, uno dellado norte de la isla, otro del lado suroeste y uno del lado este. Los sedimentos alrededor de la Isla del Caño son de origen terrestre con pequeñas contribuciones de carbonatos de los arrecifes de coral de la isla.

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