

## URANIUM-SERIES AGES OF PLEISTOCENE MARINE DEPOSITS ON THE ISLANDS OF CURAÇAO AND LA BLANQUILLA, CARIBBEAN SEA

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### ABSTRACT

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Sequences of 3, resp. 5 Pleistocene limestone terraces crop out on La Blanquilla and Curaçao. All represent Pleistocene reefs which have been uplifted. Diagenesis of the corals shows a sequence of increasing alteration with elevation (or age) of the terraces.

Samples of corals in growth position were collected for dating of the Lower and Middle Terraces of Curaçao, and of the Limestone Terraces 1 and 2 of La Blanquilla. <sup>230</sup>Th age determinations indicate that the Lower Terrace of Curaçao (10 m above sea level) and the Limestone Terrace 1 at La Blanquilla (7-10 m above sea level) formed contemporaneously at about 130,000 years ago, and are time-equivalent to Terrace III of Barbados and to the main limestone terrace of La Orchila island, all deposited during the last interglacial.

No equivalents of Barbados I and II Terraces were found; they are probably below sea level, indicating that the Netherlands Leeward Islands and La Blanquilla were less uplifted than Barbados. The age of the higher terraces of Curaçao and La Blanquilla is uncertain because of diagenetic changes, but may be estimated as about 325,000 years for the Limestone Terrace 2 of La Blanquilla and about 570,000 years for the Middle Terrace of Curaçao.

### INTRODUCTION

Marine limestone terraces crop out on most of the larger islands north of the Venezuelan coast (southern Caribbean Sea; Fig. 1), particularly on the Netherlands Leeward Islands (Aruba, Curaçao, and Bonaire), La Orchila, La Tortuga, and La Blanquilla (MARTIN, 1888; SIEVERS, 1898; MOLENGRAEFF 1929; RUTTEN, 1931, 1940; ZULOAGA, 1953; ALEXANDER, 1961; DE BUISONJÉ, 1964, 1974; MALONEY & MACSOTAY, 1967; MALONEY, 1971; BANDOIAN & MURRAY, 1974). All of these authors describe the terraces and their limestone in varying degrees of detail. The reports by de Buissonjé, in particular, are the most detailed reports to date on the terraces of the Netherlands Leeward Islands, the largest sequence of terraces in the southern Caribbean area. However, there have been few attempts at dating the terrace limestones by radiometric methods (MURRAY, 1969; DE BUISONJÉ, 1974). For this reason, a project was begun in 1972 to study the marine terraces of the Venezuelan Antilles and to determine radiometric ages of ter-

rases in the southern Caribbean region, in order to facilitate their correlation with well-known sequences in the Caribbean and elsewhere. So far, results have been published for La Orchila and La Blanquilla (SCHUBERT & VALASTRO, 1976; SCHUBERT, 1976). In this report, we present radiometric age data for La Blanquilla and Curaçao. The geomorphology, climate, and basement geology of these islands are well described in publications by MOLENGRAEFF (1929), WESTERMANN (1932), PIPERS (1933), WILHELMY (1954), DE BUISONJÉ & ZONNEVELD (1960), ZONNEVELD (1968), BEETS (1972), DE BUISONJÉ (1974), SANTAMARIA & SCHUBERT (1974), SCHUBERT & MOTICSKA (1972, 1973), SCHUBERT (1974, 1976), and ZONNEVELD ET AL. (1977). The Holocene reefs of the Netherlands Antilles and their zonation, and the relation of this zonation to the Pleistocene reefs represented in the terrace limestones, were studied by SCATTERDAY (1974) and BAK (1977).

Much literature has accumulated on the Netherlands Leeward Islands. Therefore, only a summary of the geology of their marine terraces is given below. The reader is referred to the references above for detailed information, in particular the articles by DE BUISONJÉ (1964, 1974) and the recently published Guide to the Field Trips on Curaçao, Aruba, and Bonaire, Netherlands Antilles, for the 8th Caribbean Geological Conference (1977).

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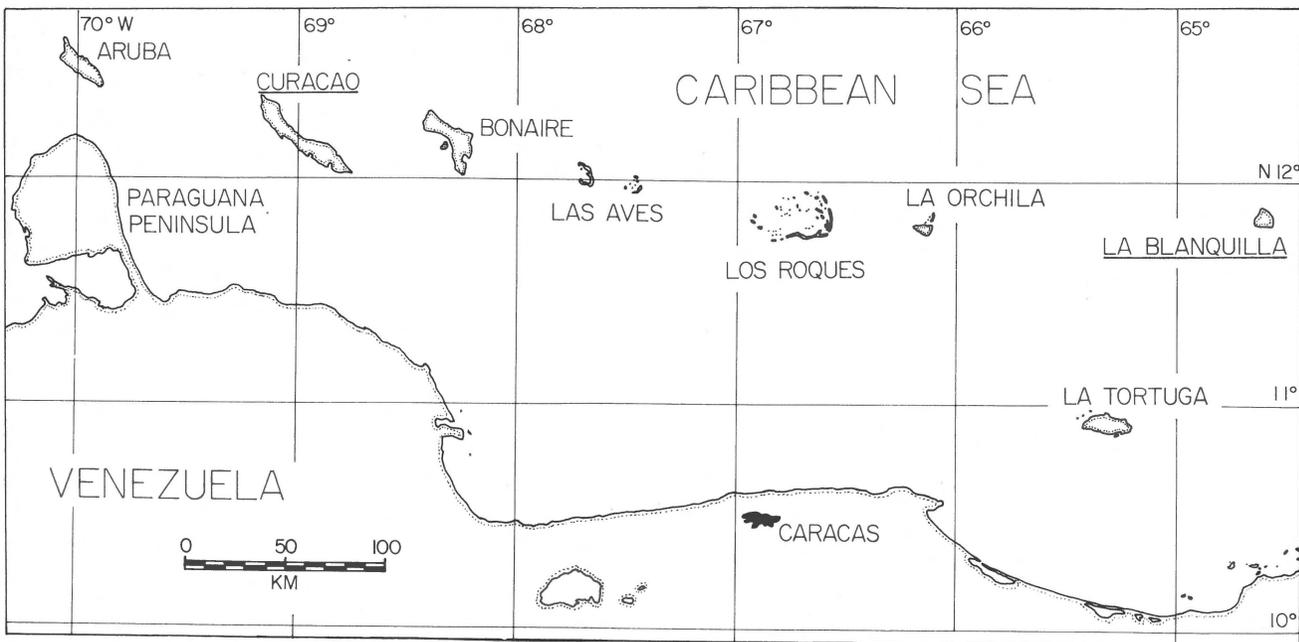


Fig. 1  
Index map of part of the southern Caribbean Sea.

## SUMMARY OF GEOLOGICAL DATA

### Curaçao

The Quaternary geology of the Netherlands Leeward Islands has been described in detail by DE BUISSONJÉ (1964, 1974), and a recent excellent summary has been written by HERWEIJER ET AL. (1977).

The main conclusion reached by these authors is that the islands of Aruba, Curaçao, and Bonaire have undergone a slow emergence which is reflected in the existence of several emerged terraces and reef talus. Accumulation reef terraces are found along the windward coast (north and east), and emerged reef talus and erosional terraces are found on the leeward side (south) (Fig. 2). The oldest reef sediment (s.l.) is the Seroe Domi Formation, which consists of limestone and dolomitized limestone of middle Miocene to Pliocene age. A Quaternary age is assigned to the younger part of this formation. The fossil content, structure, and sedimentary features of the Seroe Domi Formation indicate that it represents submarine reef talus deposits.

On top of this formation and over the igneous-sedimentary basement of the islands, accumulation terraces, marine denudational terraces, and planation surfaces were formed during the combined eustatic sea level changes and tectonic uplift. Five levels of accumulation terraces have been defined (with equivalent erosional terraces on the leeward side of the islands: Lower Terrace (10 m), Middle Terrace I (25 m), Middle Terrace II (25 to 45 m), Higher Terrace (50 to 80 m),

and Highest Terrace (90 to 150 m). In general, the terrace limestone represents reef deposition (as shown by its coral zonation) at shallow depth; and the limestone was later cut into a cliff, with a solution notch where the next younger reef limestone was deposited, as the islands rose. The terrace limestones show a coral zonation which resembles the present-day zonation in reefs (SCATTERDAY, 1974; BAK, 1977). The lower Terrace, for example, consists of an outer barrier zone (composed mainly of *Acropora palmata* in growth position), a middle lagoonal zone (mainly consisting of *Montastrea annularis* in growth position), and an inner beach-lagoonal zone containing colonies of *Siderastrea siderea* and *S. radians*). Beach rock is frequently associated with the latter two zones.

Recently, structural or sedimentological discontinuities were found within the Lower and Middle Terraces (J. P. Herweijer, oral communication, 1977); therefore, the depositional history of the terraces is more complex than was previously thought. These features are currently under study by Herweijer and his colleagues. The possibility of such discontinuities, which may represent time breaks in the depositional history, should be investigated also on La Blanquilla and in other terrace sequences, because it may reveal that one terrace complex is the equivalent of several marine deposition and planation events. This information is important, particularly when attempting to correlate terrace sequences with others developed in areas of more rapid uplift than the southern Caribbean (for example, Barbados and New Guinea: MATTHEWS, 1973; CHAPPEL, 1974; BLOOM ET AL., 1974).

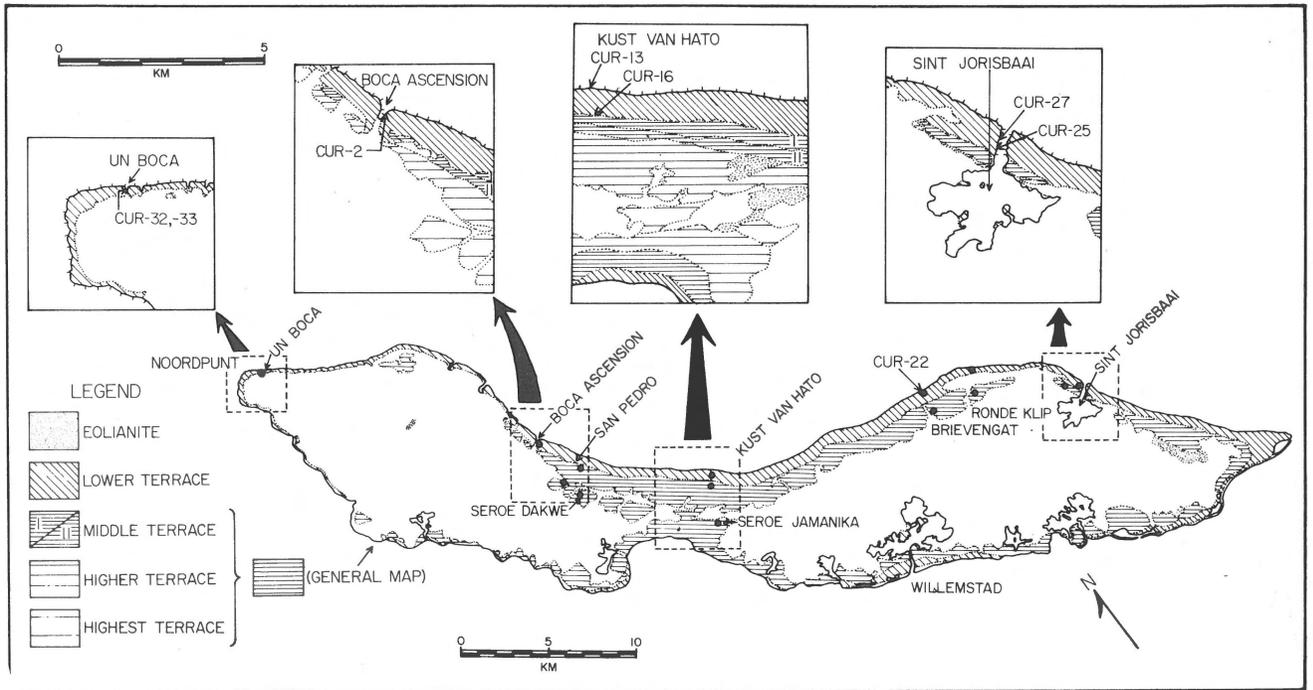


Fig. 2  
Generalized Quaternary geologic map of Curaçao (simplified from de Buissonjé, 1974). The black dots indicate sampling localities; numbers represent samples analyzed.

### La Blanquilla

Three limestone terraces crop out on La Blanquilla island (Fig. 3). They consist of reef limestone with subordinate quantities of calcarenite, biomicrite, and beach rock. The existence of coral formations on La Blanquilla was mentioned previously (SIEVERS, 1898; RUTTEN, 1931, 1940); more recently; these formations were described in more detail: ZULOAGA (1953) listed fossil identifications on the basis of which he postulated a Pleistocene to Holocene age; uranium-series ages suggest that these terraces are no younger than Pleistocene. MALONEY (1971) proposed the name La Blanquilla Formation for the limestone, a name which was formally defined by SCHUBERT (1976).

The terraces are subhorizontal, rising with a slope of less than  $10^\circ$ ; they extend from an outer cliff to an inner contact with the next higher terrace or the basement Garantón Trondhjemitic (of Late Cretaceous to Paleocene age). Their elevations above sea level are as follows: 7 to 10 m (Limestone Terrace 1); 11 to 15 m (Limestone Terrace 2); and 25 to slightly above 30 m (Limestone Terrace 3). The surface of all three terraces is very rough, containing numerous solution structures. Along the cliff of Limestone Terrace 1 is evidence of wave erosion, such as semicircular inlets due to collapse of the terrace, natural bridges, and arches; and a prominent solution notch is being formed at present sea level. All three

terraces rest unconformably on the Garantón Trondhjemitic; this contact is characterized by a basal conglomerate above the igneous rock, which consists of rounded pebbles or granitic rocks, limestone, and metamorphic rocks (mainly mica schist and amphibolite, probably derived from the Los Hermanos islands, 15 km southeast of La Blanquilla: MALONEY, 1971; SANTAMARIA & SCHUBERT, 1974).

Limestone Terrace 3 is the oldest of the sedimentary deposits of La Blanquilla and crops out in the central and highest parts of the island (Fig. 3). In the eastern part it is in contact with Limestone Terrace 2 along a 1-10-m-high cliff. The limestone consists mainly of amorphous microcrystalline masses and patches of macroscopic calcite crystals, derived from solution and recrystallization of the original carbonate minerals (aragonite and high-Mg calcite). Remnants of corals, and less frequently of marine shells, can be recognized in places. Among the corals, the following were identified: *Diploria* sp., *Montastrea cavernosa*, and *Solenastrea bournoni* (?). The thickness of Limestone Terrace 3 varies between 2 and 6 m.

Limestone Terrace 2, of intermediate age, crops out in the northern and eastern parts of La Blanquilla (Fig. 3), and in two small patches in the western part. The external edge of the terrace forms a low (up to 1.5 m) cliff, along which the terrace is in contact with Limestone Terrace 1. Ancient shorelines on this terrace are marked by linear features parallel to the general eastern curvature of the island, as seen in aerial photo-

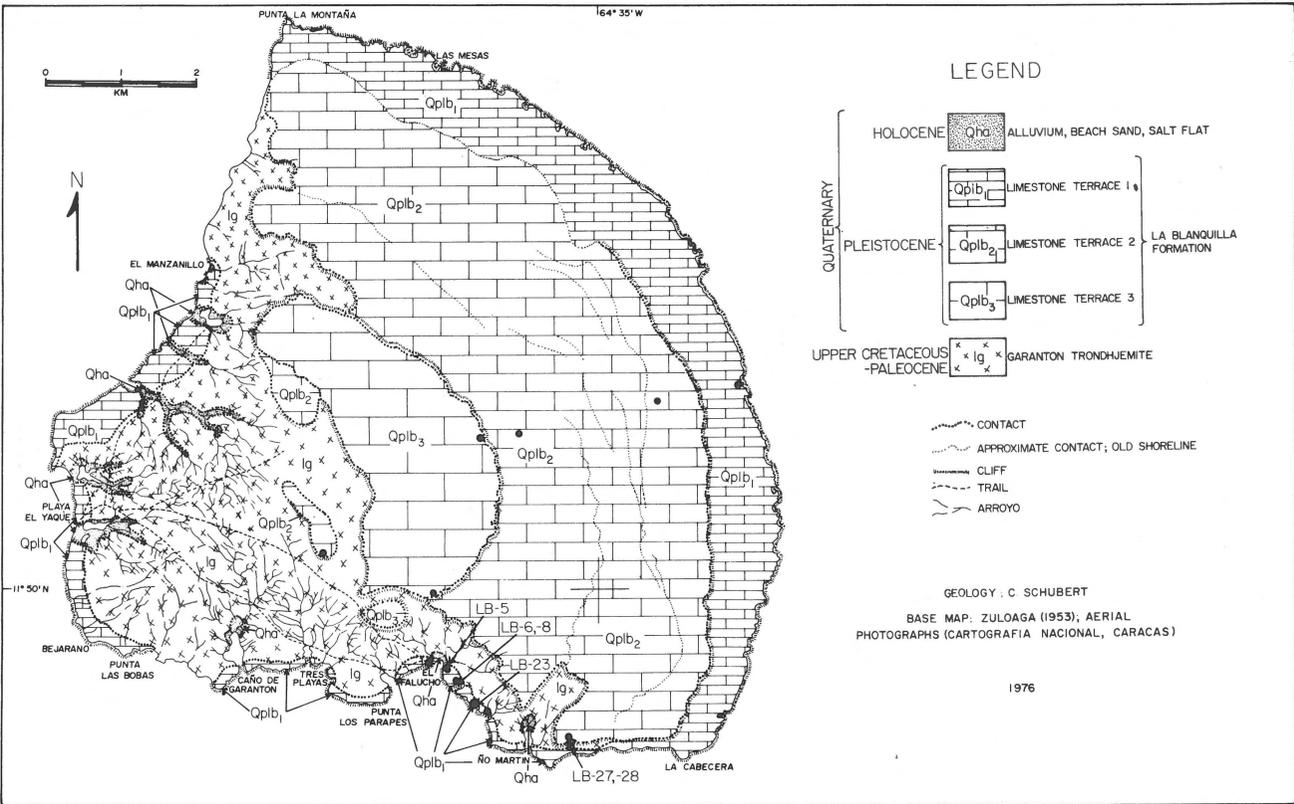


Fig. 3 Quaternary geologic map of La Blanquilla island. The black dots indicate sampling localities; numbers represent samples analyzed.

graphs. Two facies can be recognized in the limestone of Terrace 2: (1) a fossiliferous facies along the external edge (representing a former barrier reef), consisting of a light-tan limestone (similar to Limestone Terrace 3 but with fewer crystalline calcite masses), in which fragments of the following corals were identified: *Acropora palmata*, *Diploria labyrinthiformis*, *Montastrea* sp., and a probable specimen of *Solenastrea*; and (2) an arenaceous facies along the internal belt of the terrace (representing a former reef lagoon and beach deposits). It consists of calcareous conglomerate, calcarenite, and sandy biomicrite. Coquinoid rocks are rare, containing several species of gastropods and pelecypods. Lack of vertical sections through this facies prevented a more detailed analysis. The thickness of Limestone Terrace 2 varies between 1.5 and 5 m.

Limestone Terrace 1, the youngest, crops out along the coast of La Blanquilla (Fig. 3) in the form of a narrow terrace and 7-10 m high cliff. The limestone of Terrace 1 is very fossiliferous, consisting mainly of coral fragments in stratified deposits, interbedded with calcarenite (including fragments of marine shells and corals). In addition, numerous coral colonies are in growth position. The following corals were identified in the limestone: *Acropora cervicornis*, *A. palmata*, *Col-*

*pophyllia natans*, *Diploria* sp., *Montastrea annularis*, *M. cavernosa*, *Siderastrea siderea*, *Solenastrea bournoni*, and *S.* sp. The thickness of Limestone Terrace 1 varies between 5 and 10 m.

DIAGENESIS OF THE TERRACE LIMESTONES

In the field, the evidence of subaerial vadose diagenesis in the three terrace limestones of La Blanquilla and the five terrace limestones of Curaçao is mainly the degree of solution and recrystallization of the coral colonies and fragments included in the limestone. In the lower terraces (Limestone Terrace 1 and Lower Terrace), corals have a fresh appearance, and most of their internal structure (columella, septae, etc.) can easily be recognized. In the next higher terrace (Limestone Terrace 2 and Middle Terrace), the corals show definite evidence of solution; their internal structure is only partially preserved, and the carbonate is brittle. In higher terraces, corals become progressively less easy to identify; and, in Curaçao, in the two highest terraces (Higher and Highest Terraces), diagenesis is so far advanced that corals are almost totally dissolved and altered. Only vestiges of the internal structure remain, and the carbonate is massive and coarsely crystalline. This sequence of

diagenesis reflects the increasing relative age of the terraces. The diagenesis of Limestone Terrace 3 of La Blanquilla is less advanced than that of the Higher and Highest Terraces of Curaçao. This may be significant in relative correlation; it is possible that La Blanquilla only emerged above sea level after several terraces had been deposited and cut in the Netherlands Leeward Islands. In general, the degree of diagenetic alteration is higher in the Curaçao limestones than in the La Blanquilla limestones on equivalent terraces. This may be an indication of a more humid Late Quaternary climate on the former island.

These field diagenetic observations were confirmed petrographically. X-ray diffraction analyses of selected coral samples showed progressive decrease in aragonite content from the lower terraces to the higher ones (100% to 80% in La Blanquilla; 100% to 0% in Curaçao).

In corals of Limestone Terrace 1 and Lower Terrace, aragonite appears as well-formed needles forming spherulitic arrays or, more commonly, as dark brown masses ('chalky aragonite'; JAMES, 1974) still showing the characteristic extinction. Subtle coarsening of aragonite fibers (CHAPPELL & POLACH, 1972) was also observed. Low-Mg calcite was observed only rarely, as blocky cement within pores, as a thin lining of the cavities, and as small meniscus outlines (SCHROEDER, 1973). The trabeculae of the corals have dark, linear 'centers of calcification' (JAMES, 1974) and no evidence of their solution exists. The aragonite crystals radiate outwards from them.

In corals of Limestone Terrace 2 and Middle Terrace (particularly Middle Terrace 1), coralites are more affected by solution. Most of the internal structures are only rudimentarily preserved or are absent. Aragonite is present as the chalky variety or as coarsened fibers, and sparry calcite occurs as irregular masses within the aragonite (up to 50% in La Blanquilla and higher in Curaçao). In addition, low-Mg calcite cement is very common, filling the pores and forming meniscus cement. The trabeculae of the corals are thickened and sparry calcite is beginning to replace them.

In the higher terraces (Limestone Terrace 3, Higher, and Highest Terraces), corals are almost completely to completely altered. Coralites are only partially preserved, and all the internal structures have been dissolved. Aragonite has been almost completely replaced by low-Mg calcite (totally replaced in the Highest Terrace of Curaçao), both fine-grained and coarsely crystalline. The remaining aragonite is coarse. Pores are almost completely filled with low-Mg blocky calcite.

#### AGE OF THE LIMESTONE TERRACES

In general, the authors referred to in the 'Introduction' agree that the marine limestone terraces of the Netherlands Leeward Islands and the Venezuelan Antilles are of Quaternary age. Relative ages were obtained through correlation with standard glacial-interglacial sequences in North America

(ALEXANDER, 1961); by stratigraphic means, including radiocarbon dates from the Lower Terrace of the Netherlands Antilles (DE BUISONJÉ, 1974); or by palaeontological means (ZULOAGA, 1953). As mentioned before, according to our knowledge, only two authors published radiometric ages before 1976. These included uranium-series dates on a sample of *Strombus gigas* ( $93,000 \pm 5,000$  yrs B.P.) and on a sample of *Montastrea* ( $103,000 \pm 5,000$  yrs B.P.) collected from a 5 m high limestone terrace in south Bonaire (MURRAY, 1969). DE BUISONJÉ (1974) reported radiocarbon dates on *Strombus gigas* shells from the Lower Terrace of Aruba and Curaçao ( $39,550 \pm 1,000$ ;  $31,300 \pm 500$ ; and  $36,500 \pm 800$  yrs B.P.), but these can be considered only as minimum ages (SCHUBERT & VALASTRO, 1976). Within the standard terrace sequence of the Netherlands Antilles (DE BUISONJÉ, 1964, 1974), the situation of the 5 m high terrace reported by MURRAY (1969) from Bonaire is known; however, it was tentatively correlated with the Second Terrace of Barbados, which is of similar radiometric age (BANDOIAN, 1973).

The lack of radiometric ages was the main incentive for starting a project to analyze coral samples by the  $^{230}\text{Th}/^{234}\text{U}$  method. The aim was to obtain radiometric ages of as many as possible of the Quaternary marine limestone terraces cropping out on the Netherlands Leeward Islands and the Venezuelan Antilles. To accomplish this, coral samples from within the terraces were carefully collected on Curaçao (September, 1975) and La Blanquilla (December, 1975). The principal criteria in collecting these samples were (1), that the corals were in position of growth; that is, that they were (in the field) demonstrably attached to a basement or otherwise stable surface; and (2) that they appeared fresh (macroscopically and under the hand lens). In the laboratory, the samples were subjected to petrographic and X-ray diffraction analyses in order to determine their degree of diagenetic alteration (see previous section). From these results, it was concluded that only the Lower and Middle Terraces (Curaçao) and Limestone Terraces 1 and 2 (La Blanquilla) offered reasonable prospects of providing significant radiometric ages.

Eight coral samples were selected for dating from the marine terraces of Curaçao, seven from localities of Lower Terrace and one from Middle Terrace 1 (Fig. 2). Six coral samples were selected for dating from the marine terraces of La Blanquilla, four from localities of Limestone Terrace 1 and two from Limestone Terrace 2 (Fig. 3). Results of the analyses and calculated ages are shown in Table I. Uranium and thorium concentrations were determined on a solid-source mass spectrometer by an isotope-dilution technique using enriched  $^{235}\text{U}$  and  $^{230}\text{Th}$  spikes; exceptions were samples Cur-22, Cur-25, and LB-28, which were analyzed by alpha-spectrometry using a  $^{236}\text{U}$  spike. Thorium-230 (using a combined  $^{228}\text{Th}$  and  $^{229}\text{Th}$  spike) and  $^{234}\text{U}/^{238}\text{U}$  activity ratios were measured by alpha-spectrometry after chemical separation and purification using methods described by SZABO & ROSHOLT (1969).

Five samples from Lower Terrace of Curaçao (Cur-13, -22,

Table I  
Uranium-series data and calculated ages of corals from Pleistocene marine terraces of Curaçao (Netherlands Antilles) and of La Blanquilla (Venezuelan Antilles).

Sample I.D.	Terrace <sup>1</sup>	Material <sup>2</sup>	Percent Aragonite	Uranium ppm	Thorium ppm	$\frac{^{234}\text{U}^3}{^{238}\text{U}}$	$\frac{^{230}\text{U}^3}{^{234}\text{Th}}$	$^{230}\text{Th}$ -Age <sup>4</sup> x10 <sup>3</sup> years
Curaçao, Netherlands Antilles								
Cur-13	L	Ap	98	6.29 <sup>a</sup> ± 0.06	<0.004 <sup>a</sup>	1.11 ± 0.01	0.706 ± 0.021	128 ± 7
-22	L	D	98	4.51 <sup>b</sup> ± 0.09	<0.02 <sup>b</sup>	1.11 ± 0.01	0.690 ± 0.021	123 ± 7
-25	L	D	98	5.30 <sup>b</sup> ± 0.11	<0.02 <sup>b</sup>	1.12 ± 0.01	0.743 ± 0.022	141 ± 8
-32	L	D	97	5.13 <sup>a</sup> ± 0.05	0.0012 <sup>a</sup> +0.0002	1.10 ± 0.01	0.703 ± 0.021	128 ± 7
-33	L	M	94	5.95 <sup>a</sup> ± 0.06	<0.002 <sup>a</sup>	1.09 ± 0.01	0.700 ± 0.021	127 ± 7
-2	L	Mc	77	5.44 <sup>a</sup> ± 0.06	0.006 <sup>a</sup> ± 0.001	1.10 ± 0.01	0.792 ± 0.024	163 ± 11
-27	L	Ma	98	5.20 <sup>a</sup> ± 0.05	0.0035 <sup>a</sup> ± 0.0007	1.14 ± 0.01	0.855 ± 0.026	193 ± 16
-16	M-I	—	5	3.46 <sup>a</sup> ± 0.04	<0.005 <sup>a</sup>	1.03 <sup>c</sup> ± 0.01	1.03 ± 0.03	>470
La Blanquilla, Venezuelan Antilles								
LB- 5	LT-1	—	98	6.37 <sup>a</sup> ± 0.06	0.0030 <sup>a</sup> ± 0.0006	1.12 ± 0.01	0.737 ± 0.022	139 ± 8
- 8	LT-1	Ma	94	5.23 <sup>a</sup> ± 0.05	<0.003 <sup>a</sup>	1.13 ± 0.01	0.703 ± 0.021	127 ± 7
- 6	LT-1	Ma	98	5.08 <sup>a</sup> ± 0.05	0.0014 <sup>a</sup> ± 0.0003	1.14 ± 0.01	0.791 ± 0.024	160 ± 11
-23	LT-1	Ma	98	7.83 <sup>a</sup> ± 0.08	0.0010 <sup>a</sup> ± 0.0002	1.19 ± 0.01	0.798 ± 0.024	161 ± 11
-27	LT-2	S.M.	89	5.23 <sup>a</sup> ± 0.05	<0.002 <sup>a</sup>	1.11 ± 0.01	1.04 ± 0.03	>400
-28	LT-2	D	72	4.05 <sup>b</sup> ± 0.08	<0.02 <sup>b</sup>	1.06 <sup>d</sup> ± 0.01	1.08 ± 0.03	—

<sup>1</sup> L = Lower Terrace; M-I = Middle Terrace 1; LT-1 = Limestone Terrace 1; LT-2 = Limestone Terrace 2.

<sup>2</sup> Mc = *Montastrea cavernosa*; Ma = *Montastrea annularis*; M = *Montastrea* sp.; Ap = *Acropora palmata*; D = *Diplora* sp.; S.M. = *Siderastrea* or *Montastrea* sp.

<sup>3</sup> Isotopic activity ratios.

<sup>4</sup> Calculated using half-lives of  $^{230}\text{Th}$  and  $^{234}\text{U}$  of 75,200 and 244,000 years, respectively.

<sup>a</sup> Determined by mass-spectrometry, reported as CaO.

<sup>b</sup> Determined by alpha-spectrometry, reported as CaO.

<sup>c</sup>  $^{234}\text{U}$  is  $570,000 \pm 120,000$  years assuming  $^{234}\text{U}/^{238}\text{U}$  ratios of  $1.15 \pm 0.02$  for seawater.

<sup>d</sup>  $^{234}\text{U}$  age is  $325,000 \pm 70,000$  years.

-25, -32, and -33) have yielded an average  $^{230}\text{Th}$  age of  $129,000 \pm 6,000$  years old; however, the results of the other two samples (Cur-2 and -27) were excluded from the calculation of the average. Sample Cur-2 had 23% calcite indicating partial recrystallization; that is, a possible loss or gain of uranium and/or daughter elements. The age result of sample Cur-27 was rejected because the  $^{234}\text{U}/^{238}\text{U}$  ratio of  $1.14 \pm$

0.01 is too high for its geologic age; it is about the same value that one measures in seawater at present; that is,  $1.15 \pm 0.02$  (SZABO, 1969). The average  $^{234}\text{U}/^{238}\text{U}$  ratio of the other six samples is  $1.106 \pm 0.015$ , indicating an initial value of 1.153, which is concordant with the calculated geologic age of 129,000 years.

By the same argument, the age results of samples LB-6 and

-23 from Limestone Terrace 1 of La Blanquilla were rejected because of their high  $^{234}\text{U}/^{238}\text{U}$  ratios of 1.14 and 1.19, respectively. The other two samples from the same terrace (LB-5 and -8) have yielded an apparently reliable average  $^{230}\text{Th}$  age of  $133,000 \pm 7,000$  years.

From these results, it is inferred that the Lower Terrace at Curaçao and the Limestone Terrace at La Blanquilla were formed contemporaneously during the last interglacial of the Pleistocene, about 130,000 years ago. Furthermore, the results of this dating support the correlation of these terraces at Curaçao and at La Blanquilla with Terrace III at Barbados (MESOLLELA ET AL., 1969), with the main limestone terrace at La Orchila (SCHUBERT & VALASTRO, 1976), and with oxygen isotope stage 5e (SHACKLETON & OPDYKE, 1973), which has been correlated directly with Terrace III of Barbados by oxygen isotope measurements (SHACKLETON & MATTHEWS, 1977). No equivalents of Barbados I and II terraces were found on Curaçao or La Blanquilla. They may be beneath present sea level, indicating that the islands of the southern Caribbean are being uplifted at a lower rate than the island of Barbados.

Both samples (LB-27 and -28) from the Limestone Terrace 2 of La Blanquilla contain high percentages of calcite, 11 and 28, respectively. The apparent  $^{230}\text{Th}$  age of sample LB-27 is older than 400,000 years, but the  $^{234}\text{U}/^{238}\text{U}$  ratio of 1.11 is too high for this age. The  $^{230}\text{Th}/^{234}\text{U}$  activity ratio is in excess (1.08) in sample LB-28; the  $^{234}\text{U}/^{238}\text{U}$  ratio of 1.06, however, yields a finite  $^{234}\text{U}$  age of  $325,000 \pm 70,000$  years by assuming an initial ratio of 1.15 for seawater. If this age is accepted as reliable, then the Limestone Terrace 2 of La Blanquilla may be correlated with the 350,000 year old coral reef complex at Barbados (BENDER ET AL., 1973) or with deep sea oxygen stage 9 (SHACKLETON & OPDYKE, 1973). Coral growth that corresponds to the 200,000 year old coral reef complex at Barbados or to oxygen stage 7 is missing, probably because the world sea level was not very high during this time period, as suggested by SHACKLETON & OPDYKE (1973).

Dating was attempted on one sample from Middle Terrace 1 of Curaçao (LB-16). The recrystallization of aragonite to calcite is nearly complete in this sample. The calculated  $^{230}\text{Th}$  age is more than 470,000 years. The calculated  $^{234}\text{U}$  age, assuming  $^{234}\text{U}/^{238}\text{U}$  of 1.15 for seawater, is  $570,000 \pm 120,000$  years. If the  $^{234}\text{U}$  age is accepted as reliable, the Middle Terrace 1 of Curaçao may be correlated with the coral terrace of the Second High Cliff at Barbados (BENDER ET AL., 1973) and with oxygen isotope stage 11 (SHACKLETON & OPDYKE, 1973). The 200,000 and 350,000 year old terrace groupings of Barbados are apparently absent at Curaçao. In view of the recent report of discontinuities in the Curaçao terraces (as discussed earlier), it is possible that these terrace groupings are part of the higher terrace complex.

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