

SHORT COMMUNICATIONS

JAMAICA'S PLEISTOCENE REEF TERRACES

R.V. CANT¹⁾

Changes in the volume of the ice caps during the Pleistocene gave rise to fluctuations of the world's sea level. Evidence of these eustatic changes is preserved in the stranded and submerged shorelines that occur in many parts of the world. In Jamaica a well-developed series of elevated fringing reefs records stages of high sea level. Where the Pleistocene sequence is relatively complete the younger reefs off-lap the older ones down towards the coast line.

Four major reef terraces can be recognised (fig. 1), the lowest of which is the most extensive. The distribution and elevation of these around the island (fig. 2) suggests that Jamaica was tilted towards the south during the Pleistocene, the north coast being uplifted and the south coast subsiding. Superimposed on the tilt pattern localised block faulting has disrupted terrace continuity.

When the terracè records of Cuba (Hayes c.s., 1918;

Not drawn to scale.

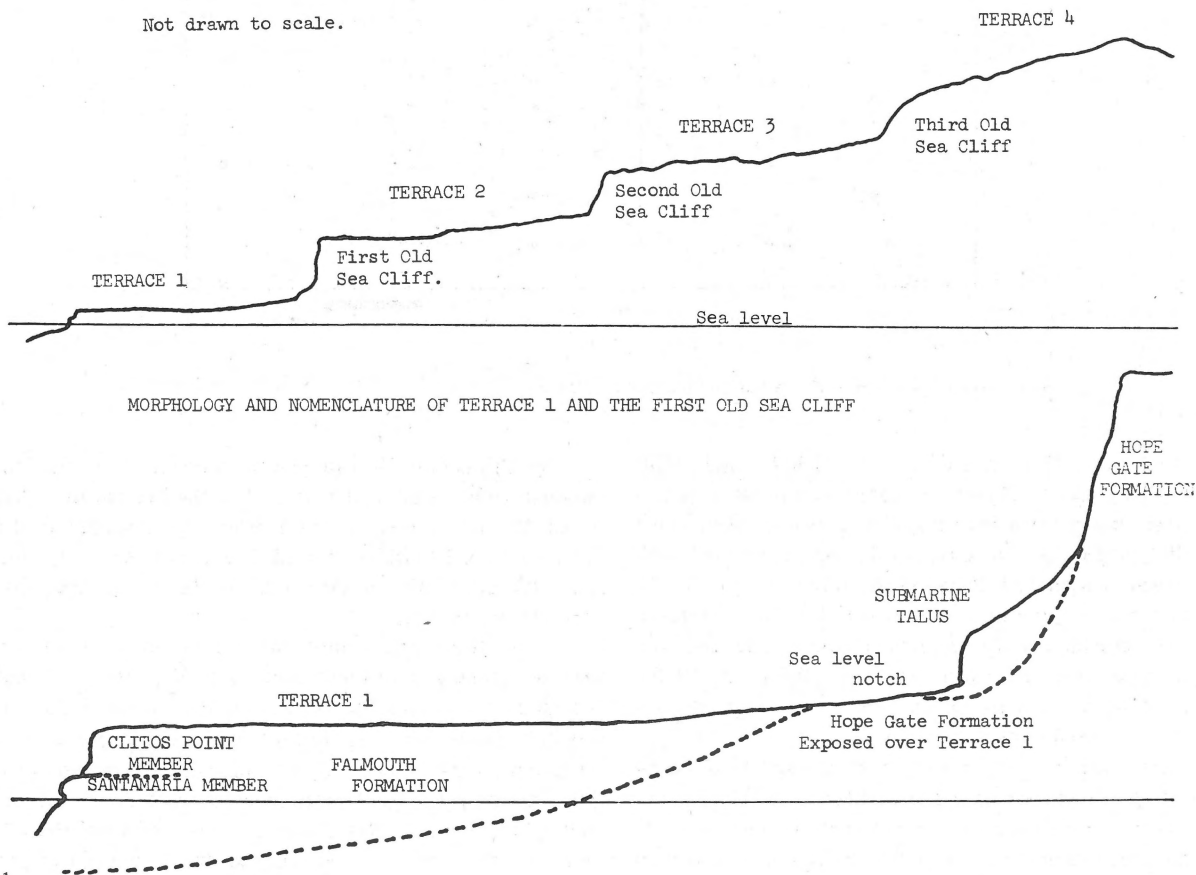
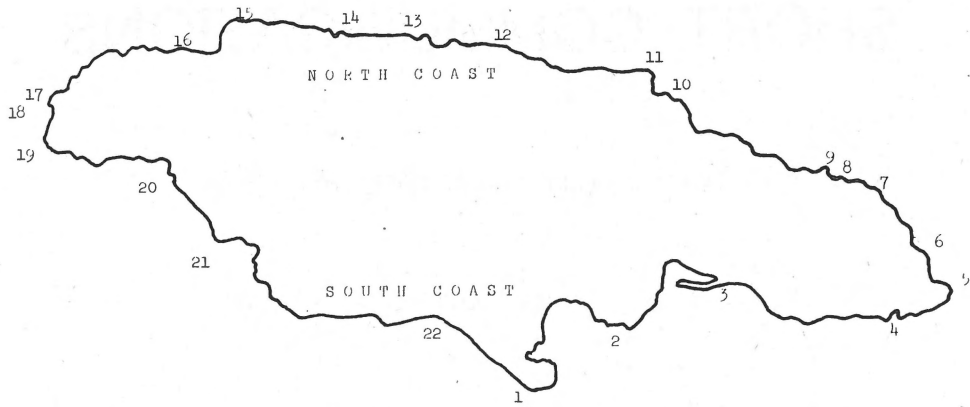


Fig. 1 : Morphology and nomenclature of the Jamaican terrace sequence, not drawn to scale.

¹⁾ Department of Geology, University of the West Indies, Mona, Kingston 7.



- | | | | |
|--------------------------|------------------|---------------------|-----------------|
| 1 Portland Point | 7 Manchioneal | 15 Rio Bueno | 19 Negril Hill |
| 2 The Needles, Hellshire | 8 Alligator Head | 14 Palmouth | 20 Westmoreland |
| 3 Harbour View | 9 Folly Point | 13 East Montego Bay | 21 Luana Point |
| 4 Port Morant | 10 Robins Bay | 16 Hopewell | 22 Round Hill |
| 5 Morant Point | 11 Oracabessa | 17 North Negril | |
| 6 Holland Bay | 12 Llandoverly | 18 Rutland Point | |

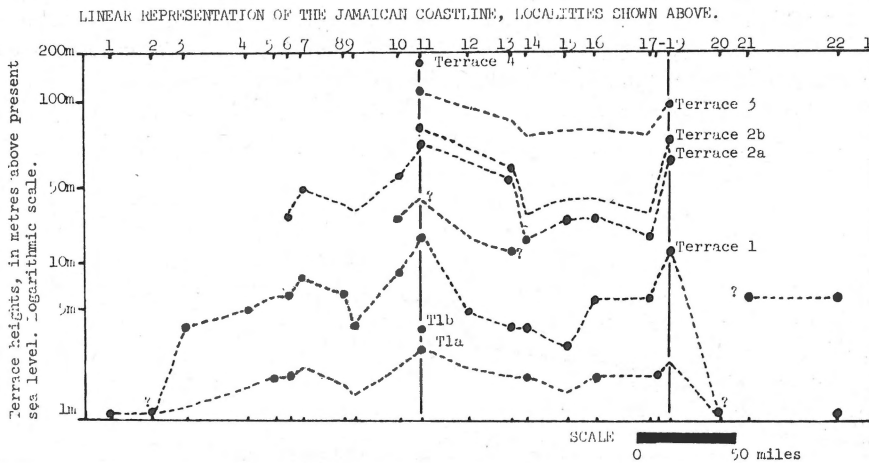


Fig. 2 Attempted correlation of the Jamaican pleistocene terraces.

Fuzzarola— Bermudez c.s., 1964) and Haiti (Woodring c.s., 1924) are compared with those of Jamaica the resulting pattern indicates that there has been uplift along the margins of the Cayman Trough, combined with tilting of the marginal blocks away from the Trough (fig. 3). This supports the theories that attribute this feature to rifting. The crustal upwarp, tensional characteristics and concomitant upwelling of mantle material (Bowin, 1968), could have been initiated by the failure of the crust as a result of differential plate movement.

Altimetric ages of the terraces were obtained from calculations of rates of uplift of the Oracabessa area (Ward c.s., 1971). There is evidence to indicate that the rate of uplift there decreased from 21 cm to 6.5 cm/1000 years less than 100,000 years ago (Cant, 1971).

On the evidence of palaeomagnetic reversal data obtained from deep fore-reef deposits exposed east of Oracabessa (Cant, 1971), Terrace 4 has been correlated with a warm period occurring prior to the Brunhes. Terrace 3 is equated

to the Cromerian III Interglacial, Terrace 2 to the Holsteinian Interglacial, and Terrace 1 to the Eemian Interglacial (van Montfrans, 1971). Isotopic age dates obtained for Terrace 1 (c. 130,000 years B.P.) support this correlation, as does the altimetric age estimated for Terrace 2 (200,000 to 310,000 years B.P.).

In the fossil reefs numerous depositional environments can be equated with environments of the modern Jamaica fringing reef. From the surface of the lowest terrace it is possible to identify a sandy back-reef environment, a marine grass environment, patch reefs, and the environments of the reef framework (fig. 4). The specific reef zones or facies (after Goreau, 1959) that were identified from the latter age, the rear zone, the reef rampart, the reef flat, the upper and lower *Acropora palmata* zones, the buttress, the *Acropora cervicornis* zone, and the *Montastrea annularis* zone. Two stratified sequences, the Tropic Winds section and the Don Christophers Point section (Cant, 1971), have been interpreted as deep fore-reef environments in which

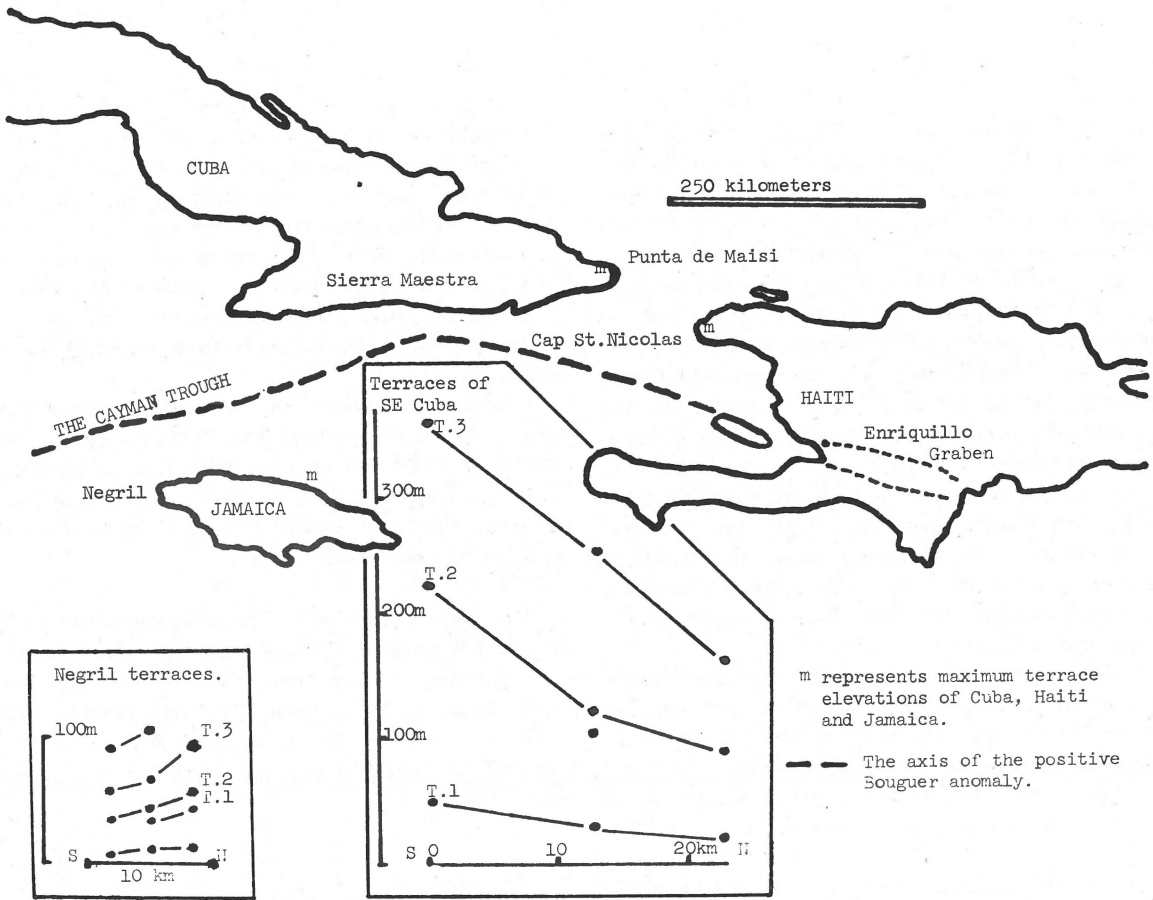


Fig. 3
A comparison of the terrace heights of Negril to those of south east Cuba, showing the tilt of both sequences away from the Cayman Trough.

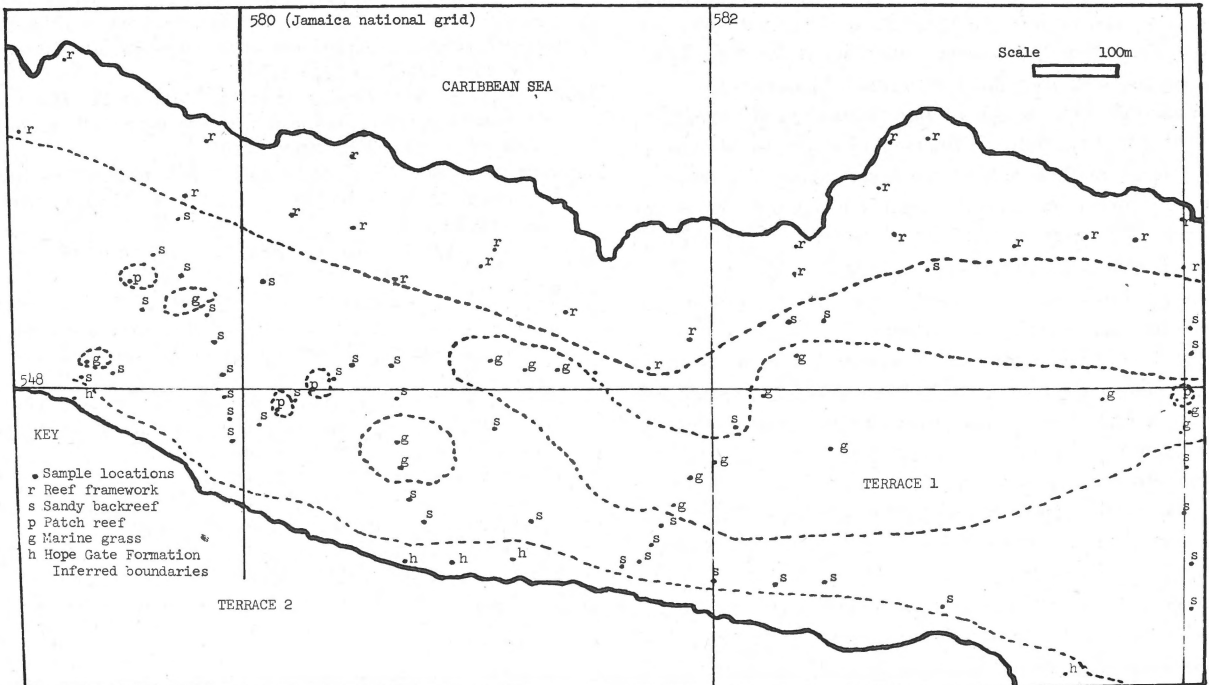


Fig. 4
Distribution of sedimentary environments over Terrace 1 from an area 4000 m east of Oracabessa.

sediments accumulated at -200 and -100 m respectively.

Environmental interpretations of the reef deposits of Terrace 1 make it possible to reconstruct the changes in sea level that took place during the last Interglacial. There are three minor levels incorporated with Terrace 1, each representing separate phases of reef growth. The earliest reef pulse occurred approximately 140,000 years ago, resulted from a sea level 1 to 4 m above that of the present. The second and major phase of reef construction took place during a sea level high (120,000 to 130,000 years ago) that was between 6 to 15 m above the present datum. The final reef pulse resulted from a stabilized sea level of uncertain age (perhaps 105,000 years ago as indicated by Barbados data Mesolella *c.s.*, 1969) 0 to 3 m above that of the present, which occurred prior to the first Wurm stadial. The first two phases of reef growth are separated by a disconformity, and the third displays a regressive relationship to the second. The ranges shown for each eustatic high result from differences in the rates of uplift of each area.

The modern reef is best developed where it has been able to grow over the framework of the late Pleistocene reef. The presence or "availability" of this foundation is dependent upon the local tectonic record. In places erosion has cut a platform through the Pleistocene reef structure over which shallow-water reef zones have developed (Robinson, 1960).

A study of the diagenesis of the deposits of each of the terraces in different parts of the island has resulted in the recognition of a progressive diagenetic sequence consisting of four main stages (Cant, 1971). The first corresponds to the original marine environment. The conditions of the sediment at this stage can be inferred from features in the Pleistocene material and from the Recent sediments themselves. It includes organic and inorganic submarine lithification.

The second stage, which is characterised by the reef sediments of the Falmouth Formation (Terrace 1), shows far greater variation than any of the other stages. The mineralogy varies from being partially stabilized to completely stabilized, and the diagenetic processes evident in these rocks include subaerial cementation, incongruent dissolution of high magnesium calcite allochems, algal dolomitization, and the inversion and solution of aragonite.

Stage 3 and stage 4 are characterised by rocks of the Hope Gate Formation (Terrace 2) and Terraces 3 and 4 respectively. These stages show completely stabilized mineralogies and are defined by the ratios of calcite to dolomite and the relationships that these two minerals show to one another. In those samples of stage 3 diagenesis that comprise both calcite and dolomite, drusy dolomite lines allochem surfaces and the inner walls of micrite envelopes. This initial phase of dolomite precipitation gives way to granular void-filling calcite. The dolomite probably corresponds to the phase of early vadose cementation that was recently reported from the Pleistocene of Barbados (Benson and Matthews, 1971).

Two important features exhibited by stage 4 diagenesis are dedolomitization and microspar development.

A simple mechanism of dolomite formation is proposed in which magnesium is leached from one horizon within the reef and subsequently precipitated as dolomite at another (Cant, 1971). This mechanism is under the direct control of vadose percolation and the quantity of magnesium available. It can account for all the diagenetic features exhibited by the deposits of the higher terraces, including dedolomitization.

Complete stabilization of the Pleistocene deposits would appear to take approximately 200,000 years in Jamaica. Studies of older reef material (? Pliocene or Miocene) indicate that diagenesis continues after stabilization has been achieved, eventually leading to redistribution of magnesium to other geological horizons.

The financial support for this study came from a University of the West Indies Postgraduate Award. The research topic was suggested and supervised by E. Robinson. W.S. Moore of the Institute of Fundamental Research, Bombay, age-dated corals collected by the author, and R.V. Burne and W.T. Horsfield offered practical suggestions for the improvement of the manuscript.

REFERENCES

- Benson, L.V., and R.K. Matthews (1971) - Electron microprobe studies of magnesium distribution in carbonate cements and recrystallization skeletal grainstones from the Pleistocene of Barbados, West Indies Jour. Sed. Petrology, 41, p. 1018-1025.
- Bowin, C.O. (1968) - Geophysical study of the Cayman Trough, J. Geophys. Res. 73, 0. 5159-5173.
- Cant, R.V. (1971) - Aspects of the Geology of the Pleistocene marine terraces of Jamaica, W.I. Unpublished Ph.D. thesis, University of the West Indies, 328 p.
- Fuzzarola-Bermudez, G., C. Judoley, L.P. Mijailovskaya, A. Nunez Jimenez, J.B. Solsona (1964) - Geologia de Cuba, Le Havana, Cuba, 239 p.
- Goreau, T.F. (1959) - The ecology of Jamaican fringing reefs, 1. Species composition and zonation: Ecology, 40, p. 67-90.
- Hayes, C.W., T.W. Vaughan and A.C. Spencer (1918) - Geology of Cuba; a reprint of the chapters on physiography and general geology from the "Report on a geological reconnaissance of Cuba 1901". Habana, 123 p.
- Mesolella, K.J., R.K. Matthews, W.S. Broecker and D.L. Thurber (1969) - The astronomical theory of climatic change. Barbados data. Jour. Geol. 77, p. 250-274.
- Montfrans, H.M. van (1971) - Palaeomagnetic dating in the North Sea Basin. Earth and Planetary Science Letters, II, p. 226-235.
- Robinson, E. (1960) - Observations on the elevated and modern reef formations of the St. Ann coast. Geontes, 3, p. 18-22.
- Ward, W.T., P.J. Ross and D.J. Colquhoun (1971) - Interglacial high sea levels - an absolute chronology derived from shoreline elevations. Palaeogeography, Palaeoclimatol., Palaeoecol., 9, p. 77-99.
- Woodring, W.P., J.S. Brown and W.S. Burbank (1924) - Geology of the Republic of Haiti, Port-au-Prince, Rep. of Haiti. Dept. of Works 631 p.