SURVEY OF THE GEOLOGY OF HAITI

GUIDE TO THE FIELD EXCURSIONS IN HAITI

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By

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233 km. Plaine du Nord. This area of the northern Plain is alluvial and became emergent at the end of the Pleistocene. The city of Cap-Haitien is at the northerwestern outskirt of the Plain where an outlier of Cretaceous sedimentary rocks forms a smaller mountain chain called "Morne du Haut du Cap" which formed a separate island offshore prior to the Holocene emergence of the region.

263 km. Gateway at the south side of the city of Cap Haitien (ex Cap Francais) often called the Paris of the Antilles (West Indies) during the colonial time. Observe fault contact between hemipelagic cherty sequence and porphyritic igneous rock. Shortly after independence from France, Haiti became divided and Cap Haitien became the capital of the Northern Kingdom led by Henri Christophe the builder of the Citadelle. The city was then called Cap Henri. Its present name became in use after the death of Henri Christophe in 1820.

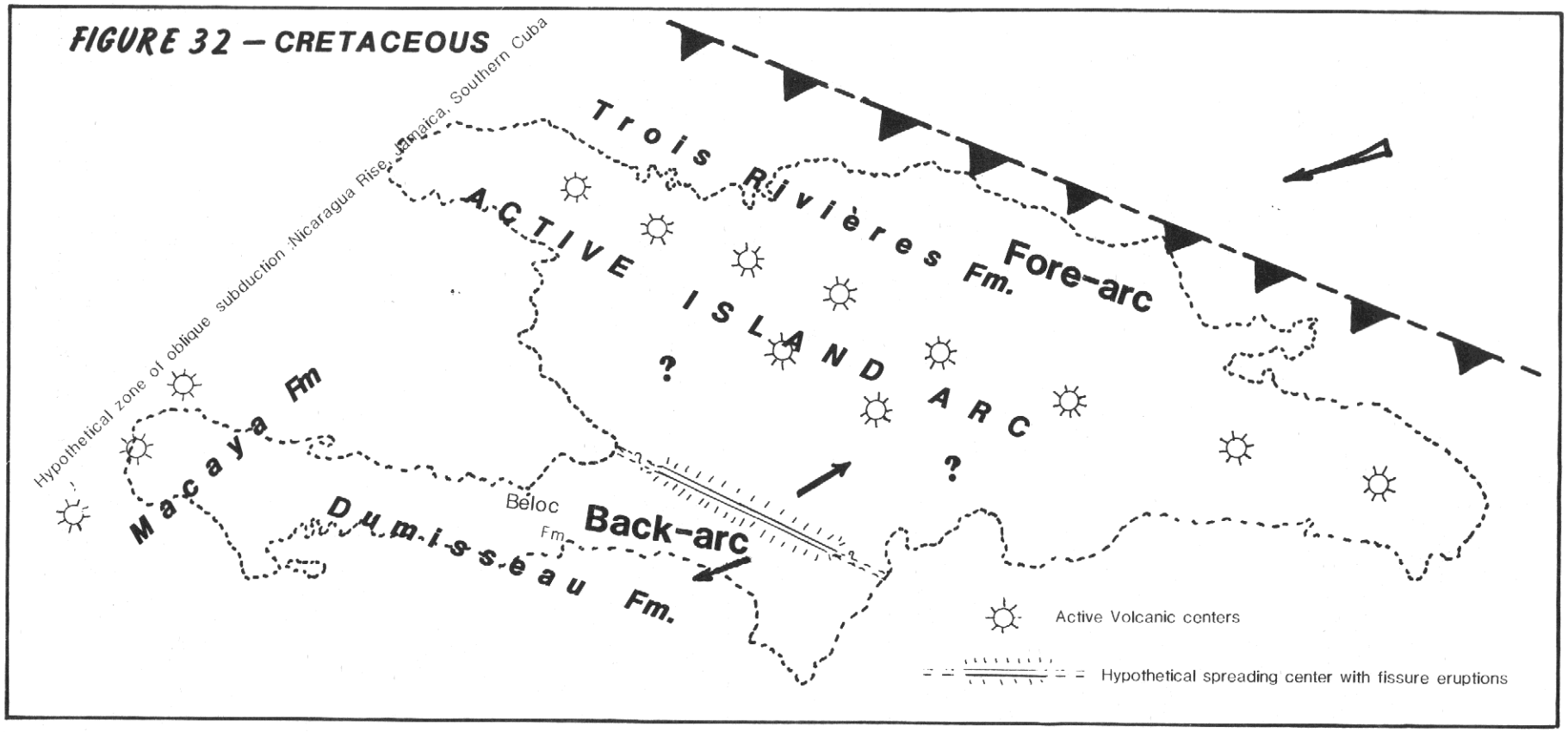
Most of the city lies on alluvium accumulated along northeast-trending fault systems transecting the Morne Calvaire/Morne du Cap outlier. Contacts between the island-arc igneous suite and Cretaceous rocks attributable to the Trois Rivières formation are also fault controlled in the area. As pointed out by Woodring et al (1924) a typical sequence of the latter formation occurs along the shore near Carénage, the most northerly section of the city. It consists of interbedded brown to yellow silstone, claystone, fine sandstone marl, dense black and blue chert stringers. Maximum thickness of beds is about 25 centimeters, but there are levels where closely spaced chert beds may reach thicknesses of several meters. Like similar chert beds found in the Dumisseau Formation (Maurrasse et al., 1979a) in the Southern Peninsula, the thick chert beds are apparently of volcanogenic origin. Nonetheless, while the series observed at Cap Haitien can be attributed to a hemipelagic sequence deposited in the fore-arc basin of an island-arc system, those observed in the Southern Peninsula are pelagic and thought to have been deposited in the back-arc area (Maurrasse, 1982c).

SUMMARY AND CONCLUSIONS

The geologic transects of Haiti discussed in this field guide provide the basic information necessary to understand the fundamental differences between the northern and southern portions of Hispaniola separated by the prominent Cul-de-sac/Enriquillo depression (figure 3). The transects also allow for further paleogeographic interpretation of the western area of Hispaniola with extrapolation on the eastern area of the island as a whole

The geologic data at hand clearly show that during late Mesozoic time an active island-arc system(s) existed in the northern portion of Hispaniola north of the present Cul-de-Sac/Enriquillo depression. It was characterized by extensive alkaline and calcalkaline eruptive activities. On the other hand the geologic record of that time in the Southern portion of the island exhibits tholeiitic basalts suggestive of an origin from a possible back-arc environment for their petrogenesis (Maurrasse, 1982c; Maurrassee et al.,

PALEOGEOGRAPHY OF HISPANIOLA



1979a). Although subaerial volcanoes may have developed in the island arc during Early to Middle Cretaceous times, most of the areas which constitute present Hispaniola were under deep water. Terrigenous sediments accumulated in the fore-arc and intravolcanic basins of the arc system. Such sediments are typified by the series of the Trois Rivieres Formation in Haiti and the Los Ranchos Formation in the Dominican Republic. The first clear evidence of lands in the island-arc system is given by the presence of plant fossils in a lens of black limestone in the Platanal Member of the Los Ranchos Formation (cf. page 11) of Early Cretaceous age. In addition to sub-aerial built-up of volcanoes, the islands may have also been the results of pre-Albian tectonic disturbances as discussed in page 11.

The presumed south-dipping descending lithoshere along the island arc is inferred to have created a downward body force on the underthrusted proto-Caribbean plate which was then pulled toward the trench. This phenomenon of trench suction evidently created intraplate extension normal to the island-arc. Necking led to pressure release at the base of the proto-Caribbean lithospheric plate. Further strains caused rupture and abundant fissure eruptions associated with back-arc spreading induced by magnatic decompression in areas of maximum tensile stresses. The Dumisseau Formation (p. 13) provide the record of such activities, the Macaya Formation (p. 12) accumulated farther west in the fore-arc basin of another subduction zone including the Nicaragua Rise and Jamaica. There is no evidence of land masses in the southern areas of Hispaniola at that time (Figure 32).

This early setting was apparently severely modified by Santonian-Campanian time when back-arc and island arc activities gradually ceased in the region. Major dislocations occurred at that time giving rise to individualized blocks, some of which became temporarily shallow-banks in the Southern portion of present Hispaniola, but there were still no emerged lands in this area. Pelagic conditions of sedimentation remained over most of the Southern Peninsula from the Maastrichtian (Stops 6,7,8) through the Paleocene/Eocene when differential uplift may have given rise to the first scattered islands in that area (Figure 33).

From the Paleocene on, time of elevation of the different areas which will eventually lead to present day Hispaniola will differ. The predominant paleogeographic characteristics of the Early Tertiary was that of structurally controlled banks and islands separated by deep-water basins (figures 33,34). Such situation is comparable but not quite analogous, to the present-day Bahamas archipelago, which does not comprise volcanic islands. Pelagic chalk accumulated in the deep areas away from the terrigenous materials coming from eroding islands and banks which collected in the adjacent intervening troughs or deep basins. The Abuillot and Marigot Formations are examples of the terrigenous deposits, whereas the Jérémie and Neiba Formations (Stops 4,6,7,8, 19 and figures 15,17) examplify the pelagic series of that time. Shallow-water limestones deposited over the banks are represented by the Plaisance Formation (Stop 20) in Haiti and the Hidalgos Formation in the Dominican Republic. Paleo-oceanographic condition over these carbonate banks prevented the development of bioherms, a situation which persisted indeed in the area until the latest Piiocene. A modern analog of such a situation is perhaps best illustrated by Cay Sal bank off the coast of Cuba in the Straits of

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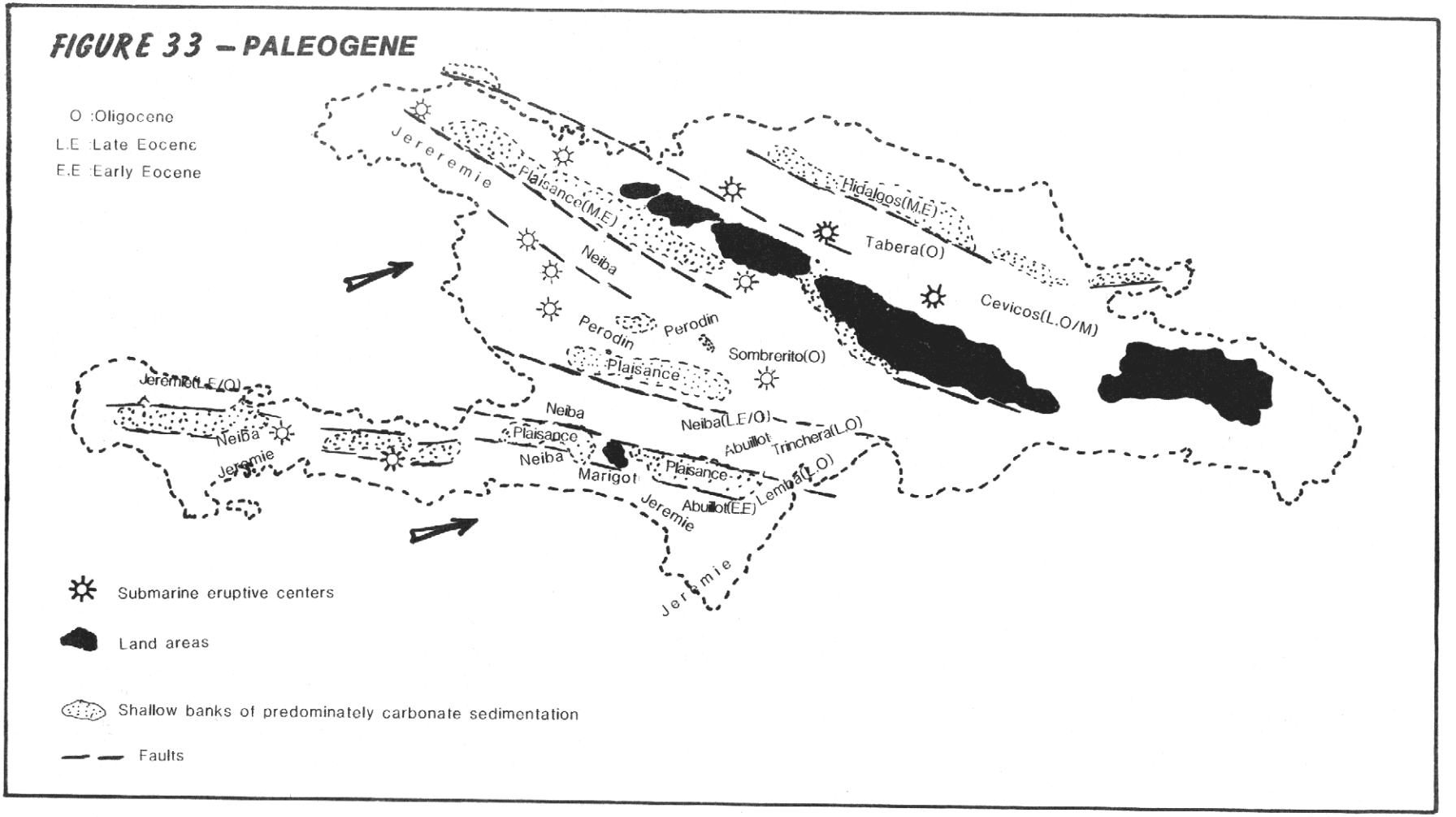

Florida. Biogenic turbidites coming from the banks could occasionally reached the eupelagic environments as are illustrated in outcrops at Stops 11 and 17 (figures 16,17). There is also evidence of extensive volcanic activities during the Paleogene as attest magmatic metasomatism observed at Stop 17, the eruptive events of Stop 18, and agglomerates seen therafter (see also the Perodin Formation). The absence of well defined eruptive centers at the time indicates that fissure eruptions were evidently associated with further dislocations of the upper Mesozic island arc system. Tectonic deactivation of the initial island-arc, and differential isostatic uplift of individualized blocks were apparently related to compression and distention caused by left-lateral motion along the northern boundary of the Caribbean plate (Maurrasse, 1982c). Distention with strike-slip displacement along the northern Caribbean plate megashear also caused pull-apart zones to occur within the dislocated former island arc and the adjacent Caribbean basin. Thus, Hispaniola at that time became characterized by fault-bounded alternating subsiding linear basins separated by rising land masses. The independent and progressive rise of these structural blocks are recorded by the diachrony of facies observed in the different blocks covered by the transects.

The sedimentary regimes of Hispaniola from Middle Paleogene onward were essentially influenced by the structurally controlled physiography. Thick clastic sediments started to accumulate in the basins as evidenced by widespread terrigenous series at that time, such as the Sombrerito, Trinchera, Villa Trina, Lemba and Florentino Formations in the eastern areas of the island (Figure 33).

At the onset of the Miocene the tectonic setting and the sedimentary regimes over Hispaniola were continuation of those which prevailed in Late Paleogene time. However, the sedimentary record of the basins adjacent to the existing land masses (figure 34) indicates that the lower Miocene series accumulated rather in neritopelagic environments, a trend which continued diachronously through the final emergence of all the initial islands into a single land mass by the close of the Pliocene through middle Pleistocene (Figures 19,20). The depositional regime in the subsiding deep-basin also show substantial shallowing in the Late Pliocene as attest most of the series of that time throughout Hispaniola. In addition to tectonic disturbances, the climatic fluctuations of the Neogene also appear to have played a major role in clastic sedimentation of that time. As illustrated by the sequences observed at Stops 2 and 14, periods of neritopelagic to moderately terrigenous hemipelagic sedimentation were periodically interrupted by massive influx of coarse terrigenous detritus which were apparently carried by flood stages of the existing drainage systems (Maurrasse et al. 1982b).

Thus, clastic sedimentation during the Neogene increased not only because of increasingly more emerging areas exposed to erosion, but also because of pronounced climatic fluctuations at that time. Thick clastic sediments, often in excess of 3,000 meters accumulated in the subsiding marine depressions between the rising land masses (figures 34). Large deltas and submarine fans also developed along the steep, fault-bounded margins of the emerging Hispaniolan archipelago. It was apparently also the time when proper geographic and climatic conditions became established to favor bauxitization and subsequent preservation of the soils in developing Karst terranes. Like

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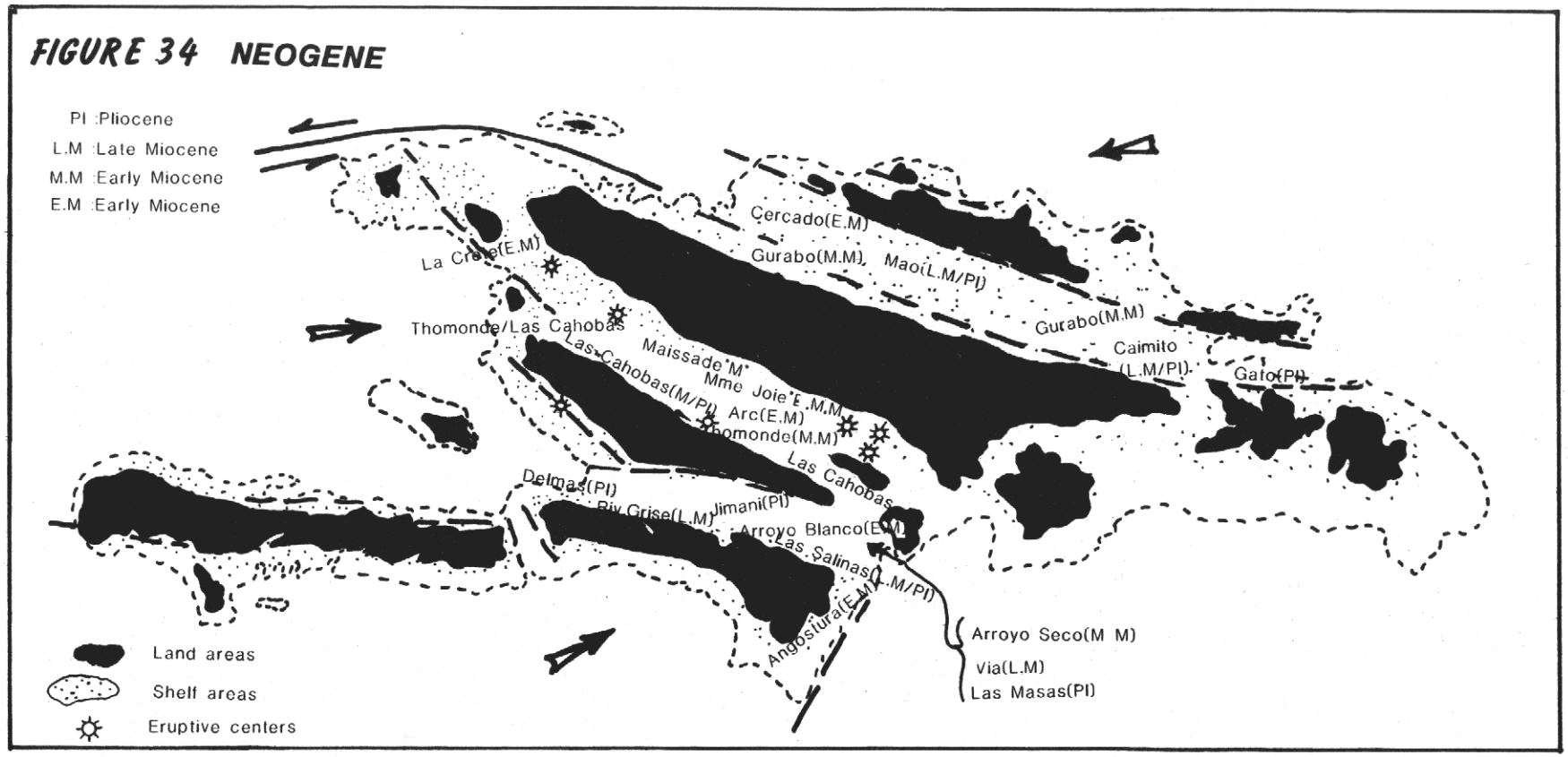

in the Paleogene, renewed volcanic activities through the Neogene were apparently related to major restructuration along the main fault systems. Much of the volcanic products of subaerial eruptions in the northern regions may have been carried south, south-westward by the Trade winds and accumulated over existing reliefs. The ashes greatly contributed to the initial lateritic soils at the origin of the bauxites, as observed on the Plateau de Rochelois near Paillant (Figures 18,31).

By Late Pliocene time the general configuration of the island of Hispaniola began to approach closely that of the present. Nonetheless, relicts of subsiding basins collecting terrigenous detritus from the adjacent emerging islands still persisted in certain areas (Figure 35). The Cul-de-Sac/Enriquillo depression, for instance, became totally closed only during the Pleistocene. Plio-Pleistocene uplift coupled with concomitant glacio-eustatic sea-level fluctuations led to the raised reef terraces (Figure 5) so characteristic of the western and southern areas of present Hispaniola. Like in the early period, uplift rate during the Pliocene and Pleistocene varied in the different areas of Hispaniola. On the whole the northern areas uplifted at a much faster rate than the southern areas (Dodge et al 1983). The discrepancy is believed to be related to crustal tilting of the northern Caribbean plate boundary in the regions adjacent to the Cayman trench (Horsfield, 1977). The Pleistocene represents the crucial stage in the development of Hispaniola because then the various islands of the archipelago became consolidated by further constriction of the intervening basins. Compressional forces also caused additional reverse faulting thrusting and tilting of pre-existing structures. Folding of the thick clastic wedges of the basins or through-shaped depression also occurred at that time. Reactivation of some of the fault-systems may have been accompanied by distention, further mantle decompression and volcanism, as attest the eruptive centers north of the Cul-de-Sac/Enriquillo depression. The newly raised areas and those already emergent prior to the Pleistocene yielded sediments to the neighboring basins which finally developed alluvial plains by progradation of the delta systems, a process still active along the margins of Hispaniola. Delta progradation has been accelerated in recent times by deforestration of the upland areas as can be examplified in the bay of Port-au-Prince. Hispaniola is still tectonically active as is indicated by a history of destructive earthquates which occurred in the past hundred years along the Trans-Xaragua fault system, and most of the fault systems in the northern portion of the island and their seaward extension into the canal de la Tortue (Figure 3).

As a brief recapitualation it can be said that the portion of Hispaniola north of the Cul-de-Sac/Enriquillo depression has been formed by a multistage process of accretion which started with an early primitive island arc system beginning about Late Jurassic or Early Cretaceous. Trench suction and associated necking of the back-arc area apparently led to back-arc spreading in the region now comprising the Southern Peninsula of Haiti and its eastern extension in the Baoruco mountains of the Dominican Republic. Late Santonian to Campanian restructuration of the incipient Caribbean plate resulted in dislocation of the preexisting tectonic setting and the development of volcanic islands and banks in the northern region forming the initial archipelago which evolved into the northern portion of Hispaniola. Similar

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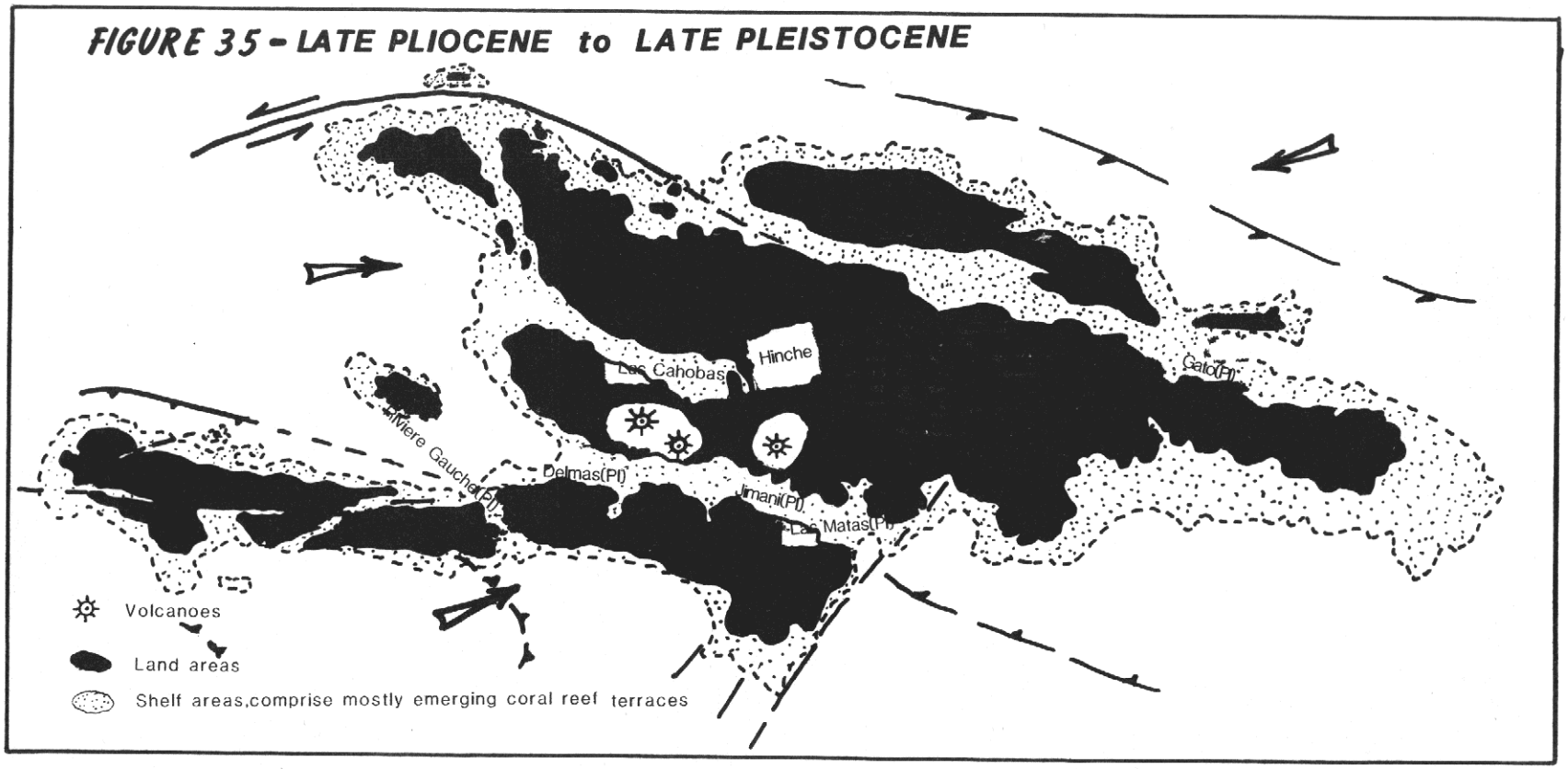

dislocation in the back-arc area also led to the development of banks probably by Late Cretaceous and certainly as early as the Paleocene. Raised volcanic islands and banks yielded clastic sediments to adjoining subsiding structural depressions. Late calcalkaline magmatism also occurred in relation to various tectonic episodes throughout the Tertiary. The rifted depressions finally became consolidated with the preexisting islands and emerging banks of the archipelago during the Pleistocene.