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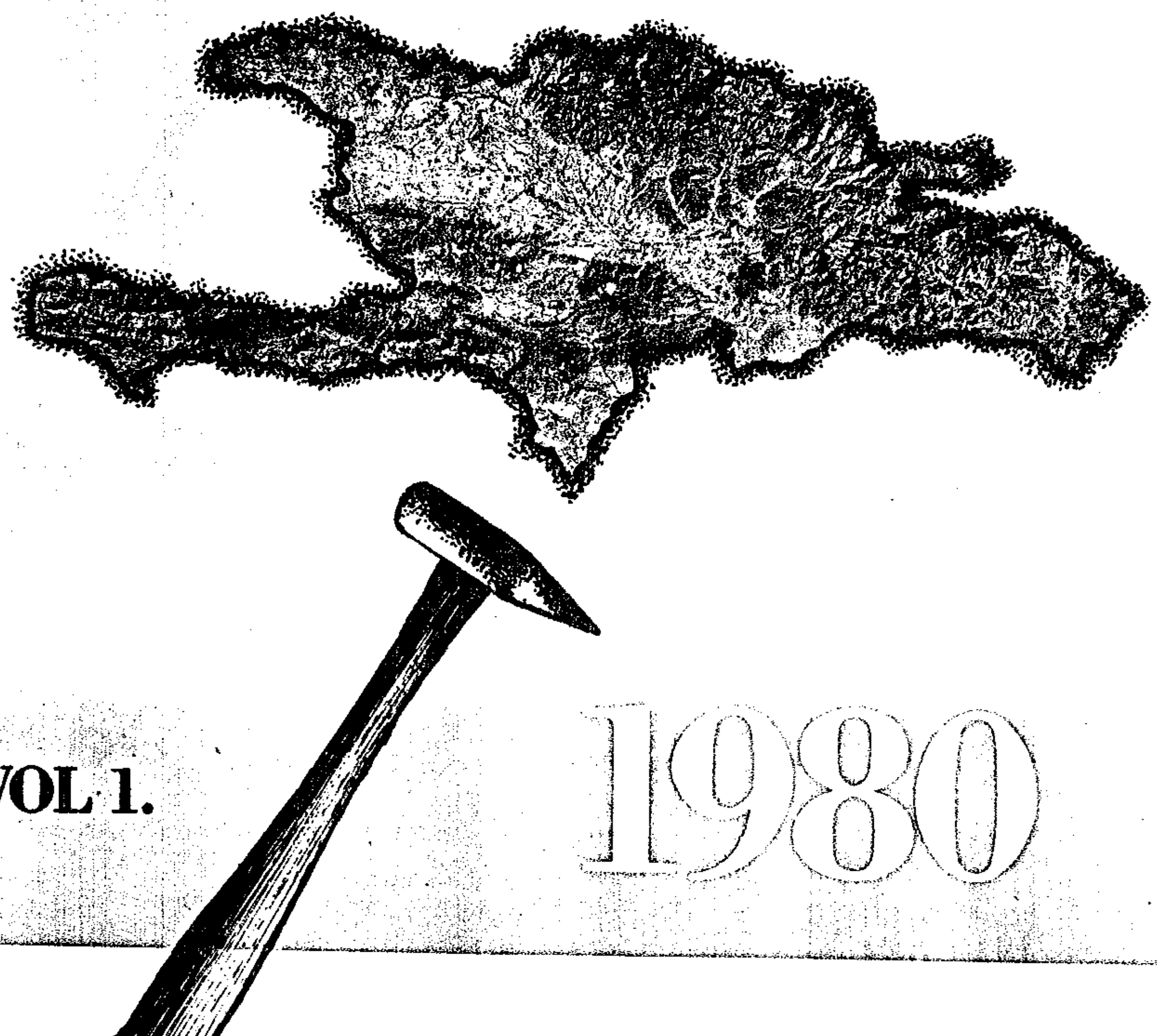

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Cenozoic facies distribution in the Southern Peninsula of Haiti and the Barahona Peninsula, Dominican Republic ***

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ABSTRACT

Studies of Neogene lithofacies exposed in areas of the eastern block of the Southern Peninsula of Hispaniola have shown that varying environments, including pelagic lithotopes, occurred there until the latter part of Early Pliocene, and possibly until the Late Pliocene. The faunal constituents of the rocks in most areas around the region here designated as the "La Selle Baoruco block" show almost generalized pelagic conditions throughout until the close of Early Miocene. The northern regions, however, were variably influenced by terrigenous supplies from the paleo-drainage system of an existing La Selle-Baoruco island.

Facies developing in the region from the Middle Miocene onward, show definite divergence which can be correlated with differential uplifts of fault-controlled sub-blocks, and the superimposed effects of increased terrigenous supplies due to paleoclimatic changes from that time. Like the adjacent Beata Ridge (Roemer *et al.*, 1976) it is evident that differential block faulting tectonism has been prevalent throughout the Neogene evolution of the La Selle-Baoruco block. The close similarity between the tectonic style of the Beata Ridge and this region is compatible with models of rotational couple in case of simple shear associated with compression, as may be expected in a wrench-fault tectonic system.

RESUMEN

Estudios de las litofacies del Neogene expuestas en áreas del block oriental de la Presquile du Sud, han demostrado que ambientes variables, incluyendo lithotopos pelágicos, han ocurrido en esa unidad hasta la última parte del Plioceno temprano y posiblemente hasta el Plioceno tardío. Los constituyentes faunísticos de las rocas en la mayor parte de las áreas alrededor de la región, que en este trabajo se designa "Block La Selle-Baoruco", muestran casi siempre condiciones pelágicas generalizadas a través de su totalidad, hasta casi el cierre del Mioceno temprano. Las regiones al Norte, de cualquier forma, fueron influenciadas variablemente por aporte de terrígenos de un sistema de paleo-drenaje de una existente "Isla La Selle-Baoruco".

El desarrollo de facies en la región, a partir del Mioceno medio, hacia arriba, muestran una divergencia definida la cual puede ser correlacionada con levantamientos diferenciales de sub-blocks, controlados por fallas y los efectos super-impuestos de aportes incrementados de terrígenos sean debidos a cambios paleoclimáticos de ese tiempo. De la misma manera que la adyacente Cresta de Beata (Roemer *et al.*, 1976), es evidente que el tectonismo diferencial de fallas ha estado prevaleciente a través de toda la evolución del neogeno del "Block La Selle-Baoruco". Las grandes similitudes entre los estilos tectónicos de la Cresta de Beata y esta región, son compatibles con modelos de par-rotacional en el caso de simple cizallamiento, asociado con compresión, como puede esperarse en un sistema tectónico de fallas de torsión.

INTRODUCTION

The southern regions of the island of Hispaniola form a distinct physiographic province separated from the northern parts by a prominent depression, the "Cul-de-Sac/Enriquillo Graben" (Figures 1, 2). This graben was an open seaway until the late Pleistocene, as attests the presence of well preserved modern coral assemblages which occur along its edges.

Although the areas south of the graben were also affected by late Pleistocene deformations (Maurrasse, 1981c), they appear to have been emergent throughout the Neogene. In their present geographic setting these areas are characterized by extremely rugged reliefs, with only occasional small alluvial plains related to the major rivers. Geomorphologically, both high reliefs and depressions of these southern regions are largely structurally controlled, albeit the action of differential weathering in the axis of the Presquile du Sud (Maurrasse *et al.*, 1979) where igneous rocks occur. Taking account of the geomorphic features of the areas south of the "Cul-de-Sac/Enriquillo Graben", they can be subdivided into two major physiographic provinces separated by a structural low, the Jacmel/Fauché depression (Figure 2). The western portions constitute the "Massif de la Hotte", the eastern portions include the "Massif de la Selle" in the Republic of Haiti, and the "Sierra de Baoru-

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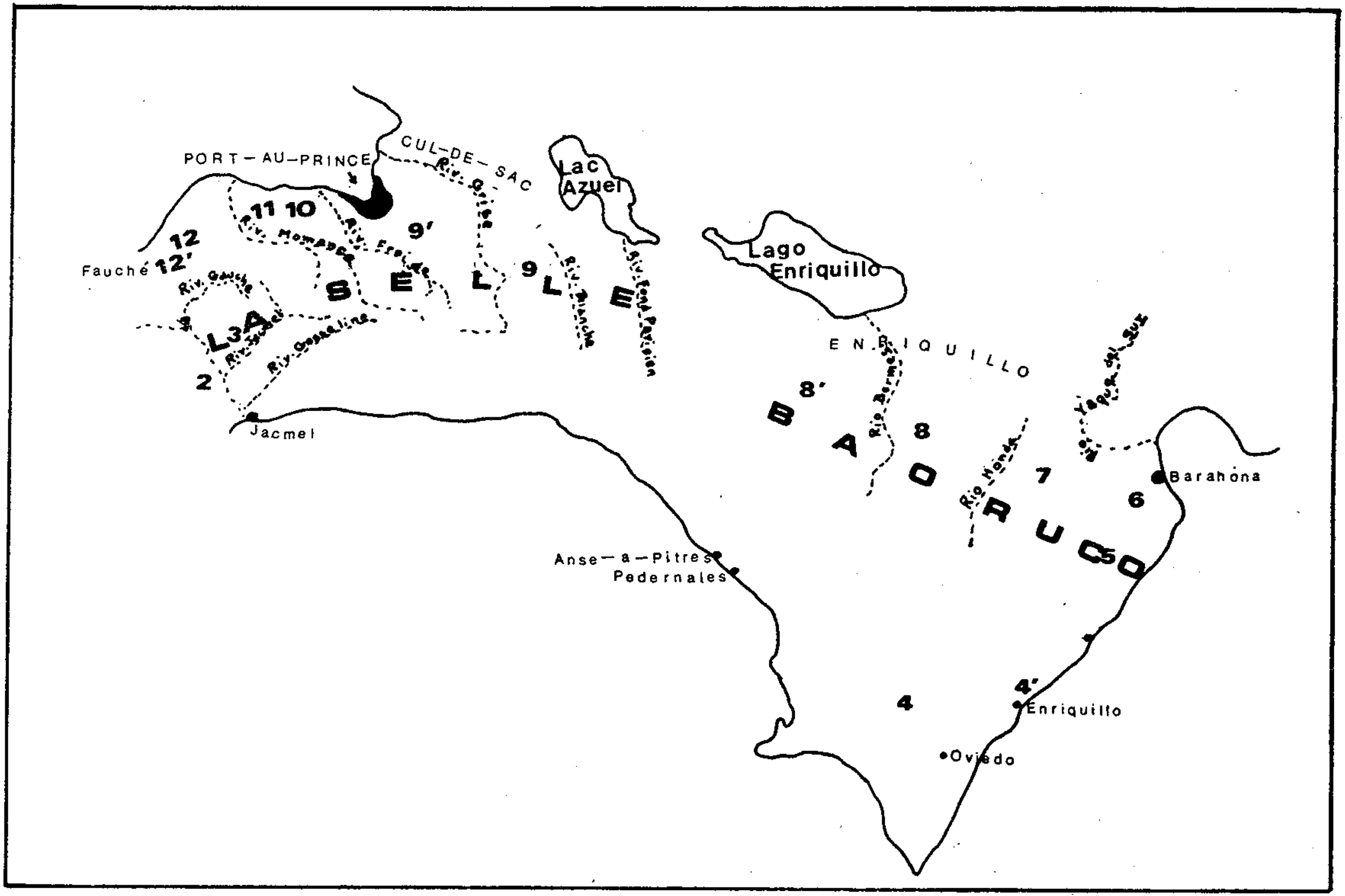

Figure 1. Map showing location of study sites (cf. to Figures 5 and 6), and main rivers which have been influential in Neogene clastic sedimentation in the area.

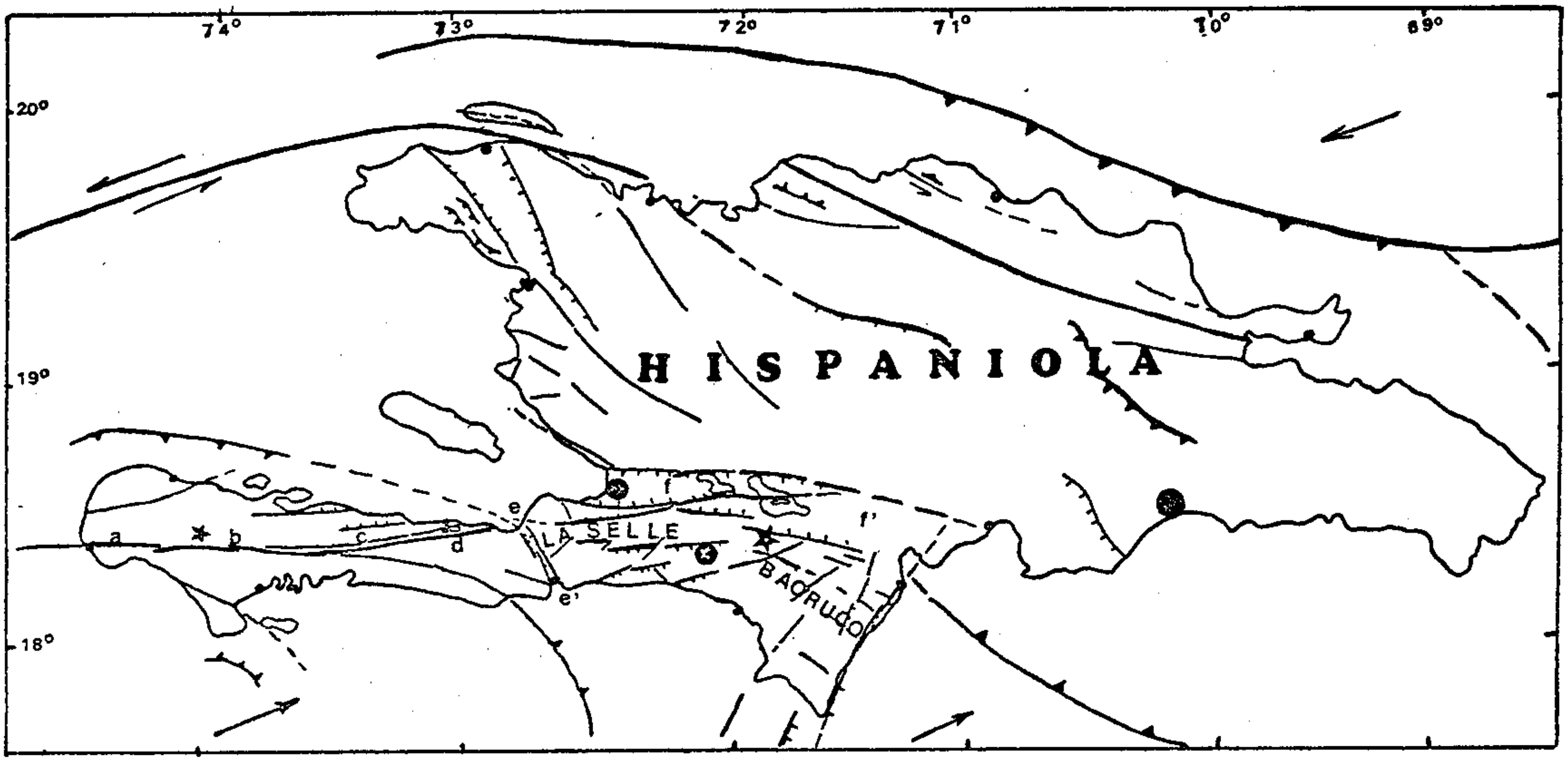

Figure 2. General structural setting of Hispaniola.

Normal faults
Thrust faults
Unspecified faults

Localized direction of strike-slip motion
Main direction of crustal displacement

★ Pic Macaya: 2347 m
✪ Pic de la Selle: 2674 m
☆ Loma del Toro: 2367 m

a) Rivière des Anglais et de Tiburon; b) Vallée de l'Asile; c) Vallée de Fond des Nègres; d) Etang de Miragoane; e–e') Jacmel-Fauché dépression; f–f') Cul-de-Sac – Enriquillo Graben.

co" in the Dominican Republic (Figures 1, 2). The present study has centered on the late Tertiary tectonic evolution of this eastern portion which will be referred to as the "La Selle-Baoruco block" hereinafter.

GENERAL STRUCTURAL AN GEOLOGIC SETTING

The general structural trends of the "La Selle-Baoruco block" have been discussed by Llinas, (1972), and Maurrasse *et al.*, (1979). As summarized in their works the predominant structural trend in the La Selle portion of the block is roughly east-west, whereas it is approximately northwest-southeast in the Baoruco portion. Major northeast-southwest trending faults also transect the prevalent former fault system (Figure 2), giving rise to an orthogonal fabric comparable to that of the adjacent Caribbean-Sea crust (Case and Holcombe, 1980). The most striking fault system which characterizes the "La Selle-Baoruco block" is along the northern edge of the "La Selle Mountain. It controls the flow patterns of "Riviere Momance and Riviere Froide" (Figure 1). This fault system appears to be slightly offset northward at its intersection with the Jacmel/Fauché structural system, and continues diagonally across the Presquile du Sud into the Caribbean Sea (Figures 2, 4). One of the tallest summits of the Peninsula, the Macaya Peak (2347 meters) is a horst related to uplifts associated with this fault system, whereas depressions such as "Rivières de Tiburon et des Anglais", "Vallée de l'Asile", "Vallée de Fond des Nègres", and the lowland of the "Etang de Miragoâne" are along the strike of the fault. Perhaps less striking than the former fault system, but equally important, is the "La Selle Fault" system (Maurrasse, 1981c; Maurrasse and Pierre-Louis, 1981), which is associated with the highest uplift in the "La Selle-Baoruco block" (Figure 2). The eastern extremity of the block is bounded by a prominent normal fault system, which seems to continue into the Beata Ridge (Figure 4). The structural setting of the "La Selle-Baoruco block" is indeed much reminiscent of the structures which characterize the Beata Ridge (Roemer *et al.*, 1976). Like the latter, its structural mode is compatible with theoretical models of probable fault attitudes developed by Hafner (1951), and Moody and Hill (1956) in areas of strike-slip tectonism. In Figure 3 we show a simplified theoretical model which is compatible with the major structures observed in the study area. It points to the evidence that the structural features of the "La Selle-Baoruco block" developed in a wrench-fault tectonic system related to the interactions between the Caribbean and the American plates (Figure 4). As it should have also been expected in such a system, body forces which developed within the system represented by the Hispaniola area led to some localized reorientation and the formation of second order features. The original segmentation of the crust has apparently been primarily affected by differential rotation between the American, European and African plates, as reported in the literature. Despite the varying stress patterns which affected the area, it appears, however, that the net shear pattern must have been consistent throughout the tectonic history of the block. Like the Beata Ridge, the "La Selle-Baoruco block" also shows a history of differential vertical uplift, suggesting that vertical stresses exceeded the net horizontal compressional stresses in the area. Thus, thrusting and all greater fold complexity are confined to subsidiary structural features between smaller blocks, and are related to gravity slide and secondary compression which developed during differential uplift of these blocks. Faulting has been the dominant mechanism which affected the igneous basement. Repeated dislocation has often also led to tectonic megabreccia both in basement rocks and the sedimentary cover (Maurrasse and Pierre-Louis, 1981). Extensive calcareous mylonites are particularly well developed within the fault zone of the northern side of the La Selle portion of the block.

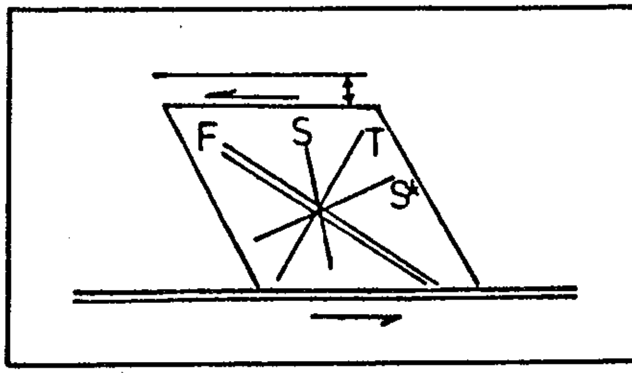

Figure 3. Theoretical model of rotational couple predicting main directions of structure in case of simple shear associated with compression in Southern Hispaniola.

F – Fold orientation and 1rst order shear.
T – Tension fracture or graben.
S – Shears.
S* – Shears and possible normal faults.

Geologically the "La Selle-Baoruco block" is characterized by a core of dislocated igneous complex of Cretaceous age (Llinas, 1972; Maurrasse *et al.*, 1979) recently described as the Dumisseau Formation. It is typically represented near Dumisseau in the La Selle Mountain (Maurrasse *et al.*, 1979). Field study (Maurrasse *et al.*, 1979) and gravity surveys in the area (Reblin, 1973; Bowin, 1976; Case. in press) suggest that igneous rocks of oceanic character probably underlie most of the block. Crustal thickness as estimated in the Baoruco Mountains (Reblin, 1973) could exceed 20 kilometers.

The younger sedimentary cover ranges from the late Cretaceous, Campanian stage, to the late Pleistocene. Until the Paleogene, sedimentary rocks of the study area are predominately limestones and chalks which can be assigened to the Plaisance (Vaughan *et. al.*, 1921) and the Neiba (Dohm, *in* Bermúdez, 1949) types of lithofacies. In certain areas these two facies are synchronous and therefore may represent contemporaneous lithotopes whereby the Plaisance type of facies would be shallower or developed adjacent to shallow banks, and the Neiba type of facies its deeper water equivalent. The latter is the land analog of chalks and limestones with cherts found in the submerged areas of the Caribbean Sea (Edgar *et al.*, 1973), which have been equated to Horizon A" (Edgar *et al.*, 1973; Maurrasse, 1973; Maurrasse *et al.*, 1979). Chalk equivalent of the Jeremie Formation (Maurrasse, 1981a) may also be a more eupelagic equivalent of the Neiba facies. Coeval shallow-water facies which occur in the area point to the uneven physiographic changes which took place in the area through time due to differential uplifts. Similarly, vertical and lateral distribution of

Neogene lithofacies in the area points to the effects of the same repetitive tectonic style.

NEOGENE LITHOFACIES IN THE "LA SELLE-BAORUCO BLOCK"

The Neogene facies to be discussed in the following paragraphs are exemplified in the synoptic Figures 5 and 6, and their geographic location given in Figure 1. In the latter, the major rivers which we believe to have played a major role in the sedimentation of the area are also presented. In the present physiographic setting these rivers are primarily structurally controlled. Although the late Pleistocene tectonic activities in the region affected these structures, their general trend which controls the drainage basin of these rivers remains the same as during the Neogene.

1.– Riviere Gauche

Woodring *et al.*, (1934), and Butterlin, (1954), studied the sequence of polygenic conglomerate associated with coralline biocalcirudite which crops out in the Jacmel-Fauché depression (Figure 1). These rocks were further described as the Rivière Gauche Formation (Butterlin, 1954) and assigned to the Pliocene, with their base possibly being upper Miocene.

It is possible also that the base intergrades with lower Miocene facies in the northern areas of the trough, as well as in the southern areas near Jacmel, where upper Oligocene chalk facies occur. Although the scarce planktonic foraminifera present in the Rivière Gauche sequence are not diagnostic of a precise stratigraphic position, the assemblage suggests a late Miocene age, *Globorotalia menardii* zone, for the oldest exposed rocks. The predominantly coralline beds are remarkably rich in delicate branching taxa (*Porites*, and possibly *Acropora cervicornis* in the younger levels). The absence of wave resistant *Acropora palmata* at these levels may also indicate an age older than latest Pliocene (Frost, 1972) for the top of the formation. This lithofacies was deposited in the trough bordered by fringing reefs growing along a narrow and steep shelf transected by fault-controlled river valleys (Figure 7). Intermittent tectonic disturbances may have been responsible for sporadic slumps of reef rubbles in the basin where clastic sedimentation prevailed.

Facies of the Riviére Gauche sequence are much reminiscent of the lithofacies which characterize the Arroyo Blanco Formation (Bermúdez, 1949) in the Azua Basin, near Fondo Negro, Dominican Republic.

2.– Bodin, near Jacmel

This locality is approximately 5 kilometers northwest of Jacmel, and on the old road which used to follow the river valley to Fauché (Figure 1). Outcrops in this area exhibit well preserved polygenic conglomerate with calcareous matrix. The main components of the matrix consist essentially of a rich assemblage of planktonic foraminifera. Among others, it yielded the following taxa: *Globorotalia pseudomiocenica, Gl. plesiotumida, Gl. acostaensis, Gl.* aff. *humerosa, Globigerina nepenthes, Globigerinoides haitiensis, Globoquadrina altispira, Gq. venezuelana, Sphaeroidinella subdehiscens, Sphaeroidinellopsis seminulina,* indicating a late Miocene age. This sequence most likely continues into the Pliocene. The predominance of the planktonic taxa contrasts sharply with the scarcity of benthonic forms of any kind. Benthonic foraminifera are mostly represented by taxa of the Rotaliform group. The biogenic components of this sequence thus indicate a bathypelagic environment for the original condition of sedimentation. The presence of boulders and other terrigenous elements in this deposit can be related to the nearby Rivière De Jacmel and/or Rivière La Gosseline (Figures 1, 7), which evidently existed since that time. Terrigenous components probably slumped periodically into the deep basin where normal pelagic sedimentation was taking place. The steepness of the basin edge at this location may have prevented the development of significant fringing reefs, unlike the areas farther north near Rivière Gauche. The present analog of such an environment can be found in the steep coastal regions at the eastern extremity of the La Selle-Baoruco block which is bounded by mayor high-angle faults (Figures 2,4).

These chalky polygenic conglomerates crop out essentially-within the Jacmel-Fauché depression, whereas coeval eupelagic chalk occurs farther inland to the northeast as is discussed in the following paragraph.

3.– Morne Castell (11–12 Kms north of Jacmel)

The mountain road going from Jacmel northward shows series of chalky lithofacies ranging in age from the late Eocene (*Porticulasphera mexicana* Zone) to the late Miocene and possibly early Pliocene. Owing to the structural complexity of the area, however, the sequence is extremely dislocated and stratigraphic continuity disturbed.

The Neogene rocks crop out at about? meters altitude and consist essentially of thinly bedded foraminiferal chalk and packed foraminiferal biocalcarenite. As at Locality 2 previously mentioned, the planktonic foraminiferal assemblage is well diversified, showing ages from the late Miocene to the early Pliocene. This facies evidently developed in a bathypelagic environment beyond the reach of terrigenous subaqueous flows which affected the areas farther to the southwest (Figure 7). This lithofacies is much the same as the one cropping out near the town of Enriquillo, locality 4 of the present study.

4.– Enriquillo

From Locality 3 to Locality 4 there is apparently no rock exposure of Neogene age. In the southeastern portions of Barahona, however, Neogene rocks may occasionally crop out in windows underneath the elevated reef terraces.

Rocks of Neogene age are particularly well exposed around the town of Enriquillo (Figure 1) where the sequence is at least 150 meters thick. This sequence is also extensively faulted, with fractures running in a northwest-southeast direction, dipping at high angles to the northeast. Beds exhibit various structural attitudes between the faults. As at Locality 3, chalk and packed foraminiferal biolcalcarenite occur in alternating beds throughout the sequence. Burrow mottling enhanced by partial differential and selective oxidation is also characteristic of this series, particularly in the Mid-Miocene portion (Figure 5). Biogenic components consist of planktonic foraminifera dominated by globigerine-shaped taxa which are of particularly large size in the older levels. The oldest sampled level yielded an assemblage of the late early Miocene *Globigerinatella insueta* Zone, including some reworked older taxa (*Chilogumbelina* sp., *Globorotalia* aff. *kugleri*). The younger levels lie within the latest middle Miocene *Globorotalia menardii* Zone. It is possible that the topmost part of the sequence has been removed by erosional processes as it is overlain by Holocene taluses. As at Locality 3, the chalk and limestone facies of this location are typically eupelagic; they are the land analog of similar facies cored on the adjacent Beata Ridge (Maurrasse, 1973; 1976a).

The landward occurrence of these rocks may be limited by the major northeast-southwest trending fault system which is superimposed on the preexisting structures. Their present altitude may not exceed 100 meters.

5, 6.— Northeastern Barahona Province (Roads to Los Hierros and to Santa Elena)

The sections on the roads to Los Hierros and to Santa Elena are grouped together because of their great similarity, even though significant differences may occur in the middle Miocene portions of the sequences (Figure 5). The lithology at both locations consists essentially of thinnly bedded buff chalk and limestone of pelagic character, as previously discussed for the preceding localities.

The middle Miocene portion at the Los Hierros section includes intercalations of chert stringers and intermittent coarse biocalcarenite beds composed predominantly of benthonic foraminifera. These foraminifera include taxa of shallow-water environments such as *Archaiis, Operculina,* and Miliolids, indicating the deeper water environment was periodically affected by basin edge turbidites. The sequence on the road to Santa Elena also shows sporadic extraneous interference within the middle Miocene, but in this case the components of clay at these levels clearly indicate extrabasinal provenance. The thin marl layers (2—3 cm thick) contain, however, essentially planktonic foraminifera. It is also worth noting that while globigerinids are remarkably well developed at these levels globorotalids are scarce or absent. Although the effects of paleoclimatic fluctuations (Maurrasse, 1973b; 1979) are apparent in these lithologic variations, they may have been enhanced by contemporaneous tectonic instabilities which seem to have begun at that time. Major physiographic changes appear indeed to have affected the whole Caribbean Basin, as it is also at that time that a major shift in facies occured in the Caribbean (Edgar *et al.*, 1973; Maurrasse, 1973b; 1979).

The combined section from the Northeastern Barahona Province ranges in age from the latest early Miocene *Praeorbulina glomerosa* Zone to the middle Miocene *Globorotalia fohsi lobata* Zone. The Miocene rocks crop out up to altitudes less than 100 meters on the road to Santa Elena, whereas they may exceed 300 meters on the road to Los Hierros. The tops of the sequences are truncated by recent or Pleistocene erosional processes, and overlain in places by taluses. The presence of Pliocene farther north, at Locality 7 (Figures 1, 6) may suggest that perhaps sedimentation was also continuous here until that time. Nonetheless, taking account of the extensive fracture systems in the area, it is also possible that differential tilting of the sub-blocks played a significant role in post middle Miocene sedimentation in the area. Incipient uplift may have affected the Southern Barahona areas as early as late Miocene as suggested by the absence of Pliocene farther south of Enriquillo, and the mature state of lateritic soil which developed on the elevated terraces.

Lithofacies of the Northeastern Barahona sections are similar to those of the Sombrerito Formation (Bermúdez, 1949). They can also be equated to the land analogs of the more eupelagic facies of Horizon "A".

7.— Cabral

The areas near Cabral, east of Rio Honda, are characterized by low reliefs which merge into the foothills of the Baoruco Mountains. Although most of the older rocks are blanketed by recent and sub-recent alluviums, road cuts often show a soft, light yellowish-gray (5Y7/2) marl which occurs intermittenly from the lowland areas to about 200 meters altitude on the road to Polo. These rocks yielded well diversified planktonic foraminiferal assemblages from the middle Miocene *Globorotalia fohsi* Zone to the earliest Pliocene *Globorotalia margaritae* Zone. Although these marls are much reminiscent of the chalky facies on the roads to Los Hierros and Santa Elena, benthonic foraminifera are significantly more abundant within the coarse components greater than 44 microns. *Bolivina* spp. predominate among the benthonic foraminiferal taxa. In addition, there are also rare gastropod fragments, and scarce ostracods. The faunal make up of this facies indicates a nerito-pelagic or upper bathypelagic environment which apparently existed in these areas until the onset of early Pliocene time. It is apparent that the fault system which controls the present Rio Honda separated the easternmost portion of the Baoruco Mountains, which remained under a sedimentologic regime much different from the adjacent areas to the west where clastic and/or restricted sedimentation prevailed, as will be discussed later. The thick fanglomerate deposit which extends along this structural feature is presently deeply cut upstream on the road to Polo. This suggests recent and rapid downcutting probably associated with ongoing differential uplift of the La Selle-Baoruco block.

8.— Las Salinas — Angostura Formations

In addition to our personal observations, most of the data pertaining to the study of these formations are from Vaughan *et al.*, 1921, Bermúdez, 1949, Llinas, 1972, and Llinas *et al.*, 1980. Both formations are characterized by the predominance of terrigenous clastics throughout. Both may reach thicknesses in excess of 3,000 meters (Llinas *et al.*, 1980), as has been found in exploratory wells in the Mella area. Like the lithofacies which acumulated in the Jacmel-Fauché depression, the lithofacies of these formations show extreme vertical and lateral variations due to the influence of the nearby rivers, most likely Rio Bermesi and Rio Honda (Figures 1, 7). The presence of benthonic foraminifera such as *Discorbis, Ammonia, Elphidum*, and a significant molluscan component in the coarse fraction indicate a much shallower environment of deposition than the former depression. Evaporites associated with the Angostura sequence point to the very shallow character of these deposits. These lithologies evidently developed in a subsiding basin margin of a complex physiographic setting controlled by shifting deltas and tectonic structures. Such environments probably developed along the edges of the Cul-de-Sac/Enriquillo seaway much in the same way as similar environments are developing in the Gulf of California, Mexico, for instance. Perhaps we could also appropriately compare the environment of deposition of the Angostura evaporites with Salina Omatepec on the western edge of the Colorado Delta tidal flats of the above mentioned gulf. In a similar manner, the Angostura Formation accumulated in a tidal flat of primarily halite-gypsum deposition. By analogy with Salina Omatepec (Vonder Haar and Gosline, 1975) we can also infer that the Angostura environment of deposition was characterized by erratic, nonseasonal flooding by marine waters. In the early stages, however, conditions were apparently those of a restricted neritopelagic basin, probably a structurally controlled marginal pool of the seaway. In the later stages, a sabka type of environment prevailed. These formations show some similarity with the lithologies of the Rivière Grise and Delmas Formations (Butterlin, 1950, 1954), which will be discussed below.

The Angostura and Las Salinas formations show that clastic terrigenous conditions prevailed prior to the middle Miocene and continued into the Pliocene in most of the eastern portions of the southern edges of the Cul-de-Sac/Enriquillo seaway. The La Selle-Baoruco landmass was therefore emergent at least since the late Oligocene. Incipient tectonic activities of the middle Miocene probably enhanced the preexisting reliefs through differential uplifts.

9.— Delmas — Rivière Grise Formations

Lithofacies of the western portions of the southern edges of the Cul-de-Sac/Enriquillo seaway are much similar to those of the eastern portions, although evaporites are absent. These "beds near Port-au-Prince" (Woodring *et al.*, 1924; Coryell and Rivero, 1940) or the Delmas and Riviere Grise formations (Butterlin, 1950, 1954) are also characterized by extreme vertical and lateral lithologic changes. Like their eastern counterpart they include interbeds of chalks, limestones, bluish gray to brownish marls, polygenic conglomerates, and fine grained low rank graywacke. Beds of coralline limestones rich in molluscs also occur intermittently within these sequences. Most of the terrigenous components include rocks similar to those being carried by the present Riviere Grise (Figure 1), thus indicating the dominant influence of this river in the sedimentation of this area since at least the Miocene. The bulk of the terrigenous load originated from the central regions of the La Selle Mountain. In addition, fine volcanogenic debris also makes up a variable amount of the clastics within most of this sequence, particularly within the levels corresponding to the latest Miocene. It is evident that the volcanic products were carried from the volcanoes north of the Cul-de-Sac/Enriquillo graben by the trade winds of that time.

The oldest foraminiferal assemblages from the Rivière Grise Formation yielded taxa indicative of the late middle Miocene *Globorotalia siakensis* Zone. Low diversity observed in these assemblages indicates stressed condition of a neritic environment close to the shelf edge. The younger planktonic foraminiferal assemblages characteristic of the Delmas Formation belong in the midlle Pliocene *Globorotalia altispira* Zone, and possible the *Globorotalia tosaensis* Zone. The younger facies are also more neritic, suggesting gradual shallowing related to the combined effects of progradation and accentuated uplift toward the close of the Miocene and the early Pliocene. Conditions were such that the sediments were deposited in a basin in which fluviatile fans along the margins graded into deeper neritic environments away from the deltas (Figure 7). Thus, upper bathyal to neritopelagic hemipelagic facies intertongued with coarser components as a result of intermittent subaqueous mud flows and basin edge slumps, because of the effects of the paleo-Rivière Grise and tectonic instability associated with differential uplifts to the south and volcanic activities to the north.

10.— Mer Frappée

From the Port-au-Prince to until about 8.5 kilometers west of Carrefour Bizoton (Sites 10, Figure 1) the area is virtually capped with a thick Pleistocene to recent fanglomerate developed at the base of the fault zone which delimits the southern boundary of the "Cul-de-Sac/Enriquillo graben" (Figure 2). From Mer Frappée westward there are good exposures of Neogene rocks which occur as thinly bedded partly indurated chalk and foraminiferal biocalcilutite. At this locality the exposure is about 75 meters thick, and is contorted and fractured. The lower part of the sequence yielded a rich planktonic foraminiferal fauna of the middle Miocene *Globorotalia mayeri* Zone, including few reworked Oligocene taxa. The youngest levels also contain essentially planktonic foraminifera as coarse components. The assemblages indicate a late Miocene age, possibly in the *Globorotalia acostaensis* Zone. The predominance of planktonic foraminifera within the mid-Miocene portion of the sequence is indicative of a pelagic environment over this site until that time. Conditions appear to have changed significantly within the late Miocene time as the limestone beds also include a large proportion of benthonic foraminifera. Benthonic organisms, including some ostracods and echinoid debris, became gradually predominant, although a few planktonic foraminifera are also present. The absence of coral fragments suggests shallowing to a neritic depth beyond the reach of coral growth. The top of the exposure is truncated and capped with slope taluses. Because of the apparent rapid change in depth which took place at this location within the late Miocene, we infer that total emergence may have occured by the close of the Miocene or at the onset of Pliocene time.

Lithofacies of the Mer Frappée area are much similar to those of the Neiba Formation, they also grade into facies comparable to the Florentino Formation (Bermúdez, 1949).

11.— Morne a Bateau

This locality is only about 5.3 kilometers, from the preceding one, but their facies are distinctly different. Although the sequences at the two locations are not contemporaneous, the difference in facies appears to reflect conditions of sedimentation in dissimilar lithotopes. In fact, the presence of terrigenous components in the Morne a Bateau sequence (Figure 6) points to the influence of the paleo-Momance River in this area, while the Mer Frappée area was apparently not affected by terrigenous supplies from this river. As at localities farther eastward terrigenous supplies were sporadic, but only the distal parts seem to have reached the Morne a Bateau area. As pointed out by Woodring *et al.*, 1924, this locality shows an alternation of soft, dark yellowish sandy and clayey beds with conglomeratic beds composed predominately of lumpy aggregates of coral and mollusk fragments. In addition, benthonic foraminifera and a well diversified ostracod fauna predominate at certain levels. Few bryozoan and echinoid fragments also make up part of the components.

Beds composed of finer constituents include well diversified planktonic foraminiferal assemblages, although most specimens are remarkably small. Planktonic foraminifera indicate an age ranging from the latest Miocene *Globorotalia dutertrei* Zone to the early Pliocene *Globoquadrina altispira* Zone. A few reworked Eocene and Oligocene specimens also occur mixed within the younger levels. It is apparent that this sequence accumulated on or near the slope in a bathypelagic to neritic environment which was intermittenly affected by terrigenous and bioclastic subaqueous flows, in the same manner as seen in previous areas. This area had a remarkable development of coral reefs as suggest by the great abundance of coralline fragments.

It appears that the corals probably developed only fringing reefs along a high energy coast as the highly fragmented state of most of the benthonic components implies.

12.– Fauché – Dufort

This section is a composite of outcrops immediately south of Dufort and about 3 kilometers south of Fauché (Figure 1). Both areas include a relatively well developed sequence of bedded limestone and chalk very much reminiscent of the facies found along the eastern side of the La Selle–Baoruco block, but here they include a large amount of coral fragments within the younger levels. In the Fauché sequence, which includes the oldest portion of the composite section, limestone layers consist of packed foraminiferal biomicrite including about 5 to 50 percent benthonic foraminifera. The benthonic forms are well diversified and comprise taxa of at least 30 genera such as *Discorbina, Rosalina, Eponides, Ammonia, Planulina, Globulina, Sphaeroidina, Amphistegina, Robulus, Bolivina*, etc. Ostracods are also relatively common, although not exceeding 1 percent of the total coarse fraction greather than 44 microns. Echinoid and coral fragments are virtually absent in the older portion of the section, but become very abundant in certain levels near Dufort (Locality 12 in Figure 1). Planktonic foraminifera indicate that the section spans the latest Miocene *Globorotalia dutertrei* Zone to the Pliocene *Globorotalia tosaensis* Zone.

This composite section indicates that a neritopelagic environment prevailed in this northwest portion of the La Selle–Baoruco block at least until the onset of Pliocene time. During the Pliocene extensive fringing reefs developed along the edge of the basin supplying extensive amounts of coral rubble through intermittent subaqueous debris flows. The youngest levels of these coral rubble deposits comprise large fragments of *Acropora palmata*, indicating the development of reefs similar to modern analogs in the present offshore environments adjacent to these localities. The presence of abundant *Potamides* spp. and *Ostrea* spp. in the section equivalent to about middle Pliocene also indicates significant shallowing by that time. Furthermore, the increase in abundance of certain taxa of the genus-groups *Nonion* and *Cibicides* at these levels is indicative of the development of an environment that was probably characterized by shallow-water grass-beds. Such an environment may have been protected by an outer main reef. It is apparent that this area became emergent either during the latest Pliocene or the Pleistocene. At present these rocks crop out at a maximum elevation of about 75 meters above sea level.

DISCUSSION AND CONCLUSION

The lithostratigraphic record of Neogene rocks exposed in the "La Selle-Baoruco block" shows that eupelagic and neritopelagic conditions prevailed around most of the block until the beginning of middle Miocene. Deeper facies appear particularly in the meridional areas, whereas terrigenous clastics pervaded the northern areas in various degrees. Environments analogous to those in which the eupelagic facies developed presently occur in the Beata Ridge area (Figures 2, 4) as sediments recovered from cores taken over this ridge, (RC9–56, RC9–57, RC9–58) (Maurrasse, 1976b; 1979; Maurrasse and Glass, 1976) show the same continuous facies until the present. The eupelagic depositional regime of the southern areas had their equivalent to the north under neritopelagic sedimentological conditions. A remarkable change occurred about the start of middle Miocene when different portions of the "La Selle-Baoruco block" appear to have been affected by differential shallowing through the Pliocene. Superimposed on the changing facies, due to vertical movements at the depositional sites, periodic allochthonous subaqueous flows became progressively more important in the younger levels. Coral debris flows also became gradually prevalent in areas adjacent to the shelf edge, which is inferred to have been narrow and fault controlled. The block seems to have been tilted to the south where the deeper facies occur. It seems that high-angle subsidiary faults controlled differential movements of the subblocks, and also the paleo-drainage system. Deformation was thus contemporaneous with deposition particularly the graben areas of the Jacmel-Fauché depression and the Cul-de-Sac/Enriquillo basin edges.

Broad deltas developed along the northern regions of the block as most of the major rivers (Figure 1) supplied increasing terrigenous materials from the middle Miocene onward. True deltas did not develop at the mouths of rivers draining into the Jacmel-Fauché depression which was evidently a deep precipitous trough. Terrigenous input from the rivers all around the La Selle–Baoruco block was characteristically intermittent, as all these lithofacies show remarkable rhythmicity throughout. Although the dramatic increase in terrigenous clastics which occured by the middle Miocene may have been related to generalised tectonic activities in this area, we believe that climatic changes of that time (Vail *et al.*, 1977) played the most important role. As pointed out earlier, not only were terrigenous clastics supplied to the northern areas of the block prior to the middle Miocene, but their rhythmic character changed very little, except in relative abundance. Furthermore, variations in the terrigenous supply in the area can be related to varying hydrologic regimes of rivers whose loads increased within the middle Miocene and subsequent times. Thus, a combination of tectonic factors superimposed on the enhanced preexisting climatic factors contributed to the changes in lithofacies observed in the La Selle-Baoruco sedimentologic provinces during Neogene time. It is apparent that shifting river mouths and resulting variations in shelf conditions in the northern areas of the block also led to much greater diversity of lithofacies in these areas. Sediment accumulation in the "Cul-de-Sac/Enriquillo graben" also reached greater thicknesses than elsewhere around the block during Noegene time. Perhaps the most important physiographic feature of Neogene sedimentological basins around the "La Selle-Baoruco block" is their relatively narrow and steep shelves which were bounded by high-angle faults. Taphrogeosynclines (Kay, 1963) developed along the northern and western boundaries of the block which must have been an isolated island until at least the early late Pliocene. By that time continuous compressional forces, built up through wrench-fault mechanisms, led to further tectonic activity which, despite being differential through the sub-blocks, led to virtual linkage of the La Selle-Baoruco block with the adjoining parts of the island of Hispaniola. Further erosion of the emerging land and late Pleistocene uplifts (Maurrasse and Pierre-Louis, 1981) brought about the present configuration. Elevated Pleistocene reef terraces in the southern regions immediately adjacent to the Beata Ridge point to a steady history of uplift throughout that time, whereas uplifts in the northern regions seem to have been more erratic and probably faster as implied by higher elevations of Neogene rocks there. Based on this fact and modern seismic history of the northern regions, it is apparent that differential tectonic uplift is still active within the La Selle-Baoruco block. The eastern end of the block underwent, and may still be undergoing, more deformation than the adjacent areas to the west because of its structural relationship to main stress directions in the region (Figure 4). This inference is compatible with field observation relative to the present state of river downcutting in the area, as mentioned earlier in this study. Other areas have, however, also experienced significant differential uplift, notably the outcrops at Morne Castel (Figures 1, 5) and the northeastern portion of the Baoruco area as discussed for Site 7.

In conclusion, the lithostratigraphic record of the "La Selle-Baoruco block" provides evidence of a Neogene history punctuated by progressive and differential uplifts of sub-blocks bounded by high-angle faults associated with the mechanisms of deformation in a wrench-fault tectonic system (Hafner, 1951; Moody and Hill, 1956). Like the Beata Ridge system (Roemer *et al.*, 1976) the predominant tectonic style which characterizes the geologic evolution of the La Selle area (Maurrasse *et al.*, 1979) and the Baoruco Mountain (Llinas, 1972, Llinas *et al.*, 1980) has been dominated by differential vertical uplifts. Thrusting and other fold complexities developed as subsidiary structural features in between the sub-blocks.

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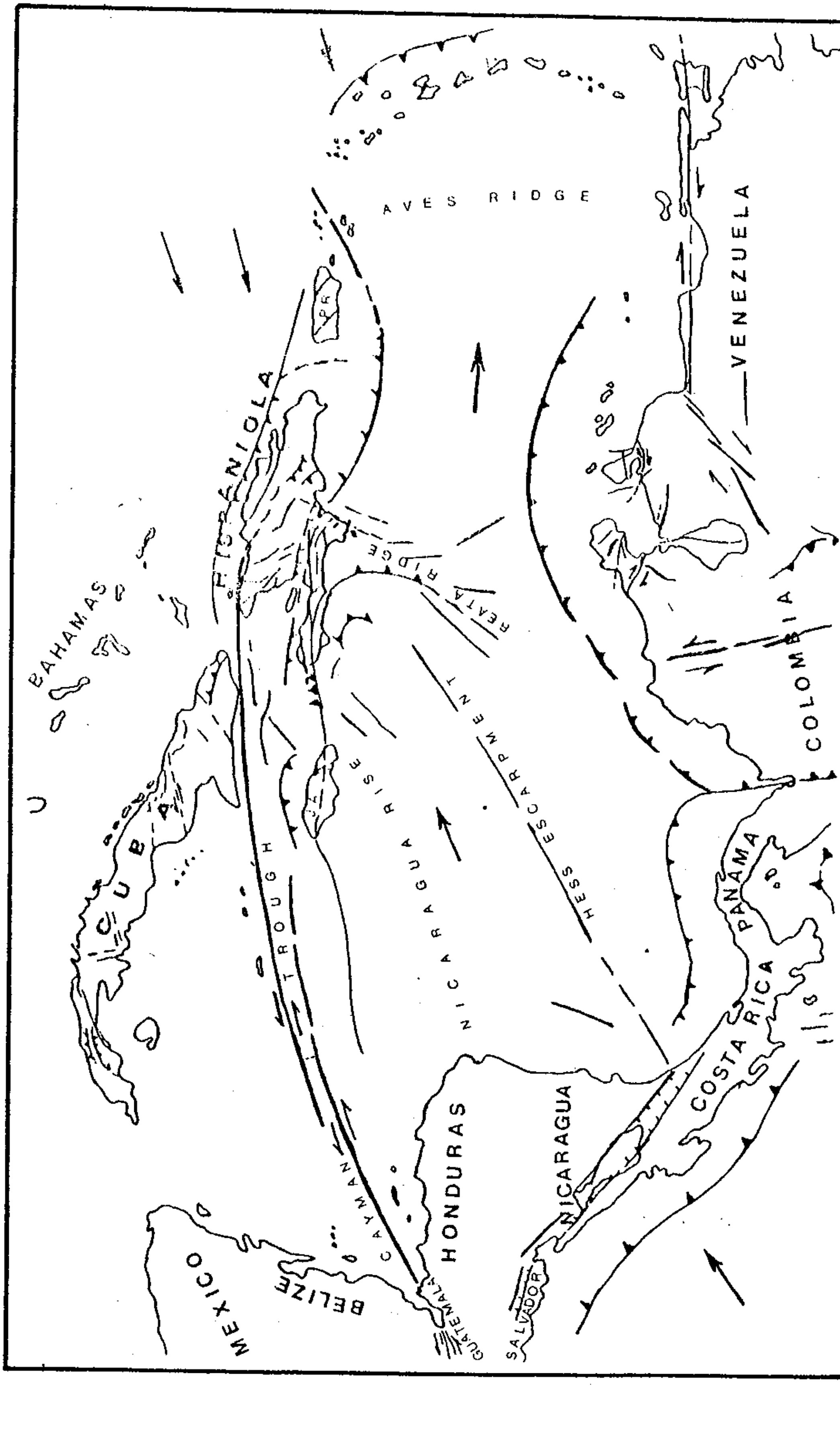

Figure 4. General structural setting and main directions of crustal displacement in the Caribbean Region (Adapted from various publications, particularly from Case and Holcome, 1980; Dengo, 1973).

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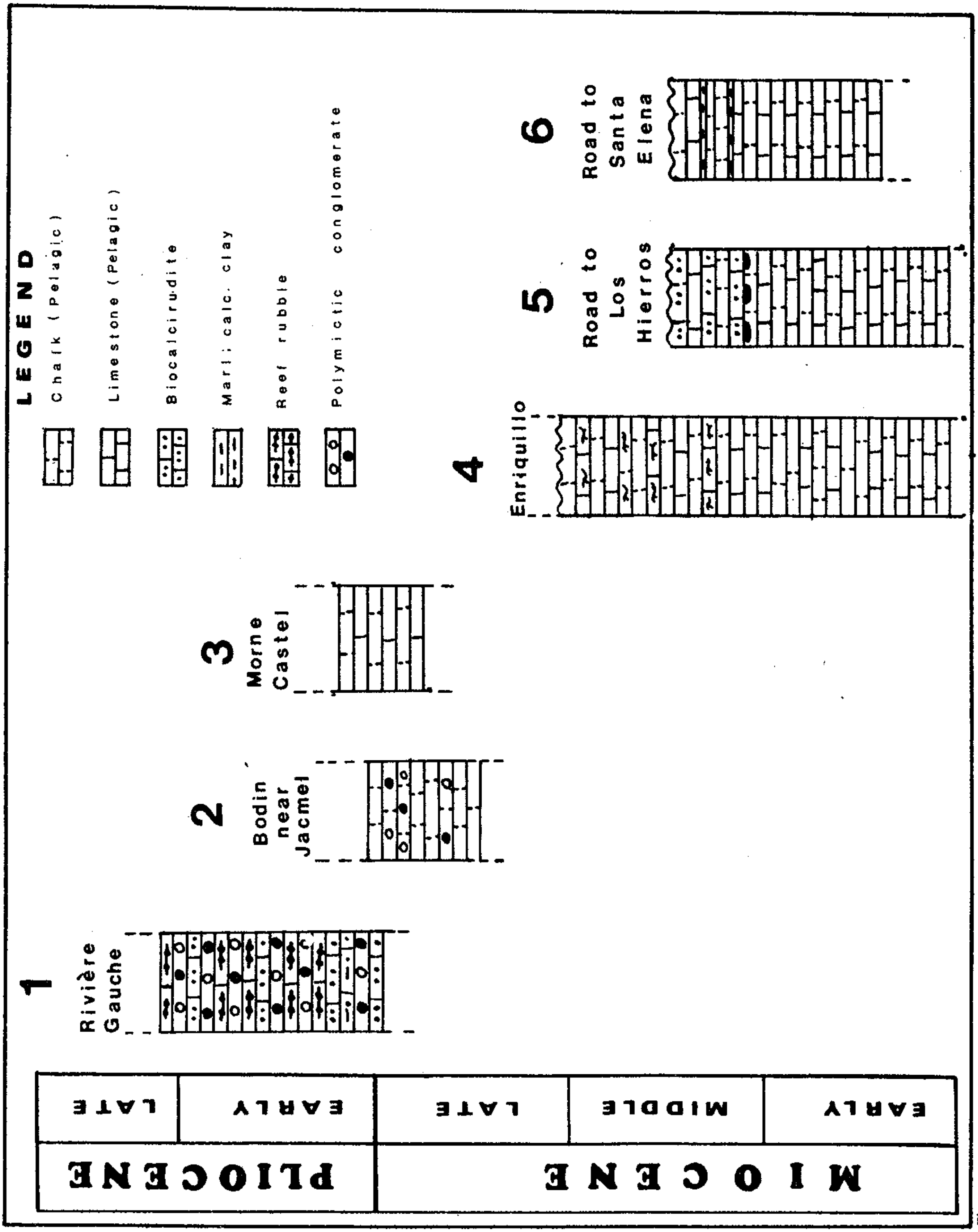
LEGEND
Chalk (Pelagic)
Limestone (Pelagic)
Biocalcirudite
Marl; calc. clay
Reef rubble
Polymictic conglomerate
1 Rivière Gauche
2 Bodin near Jacmel
3 Morne Castel
4 Enriquillo
5 Road to Los Hierros
6 Road to Santa Elena
PLIOCENE
LATE
EARLY
MIOCENE
LATE
MIDDLE
EARLY

Figure 5.

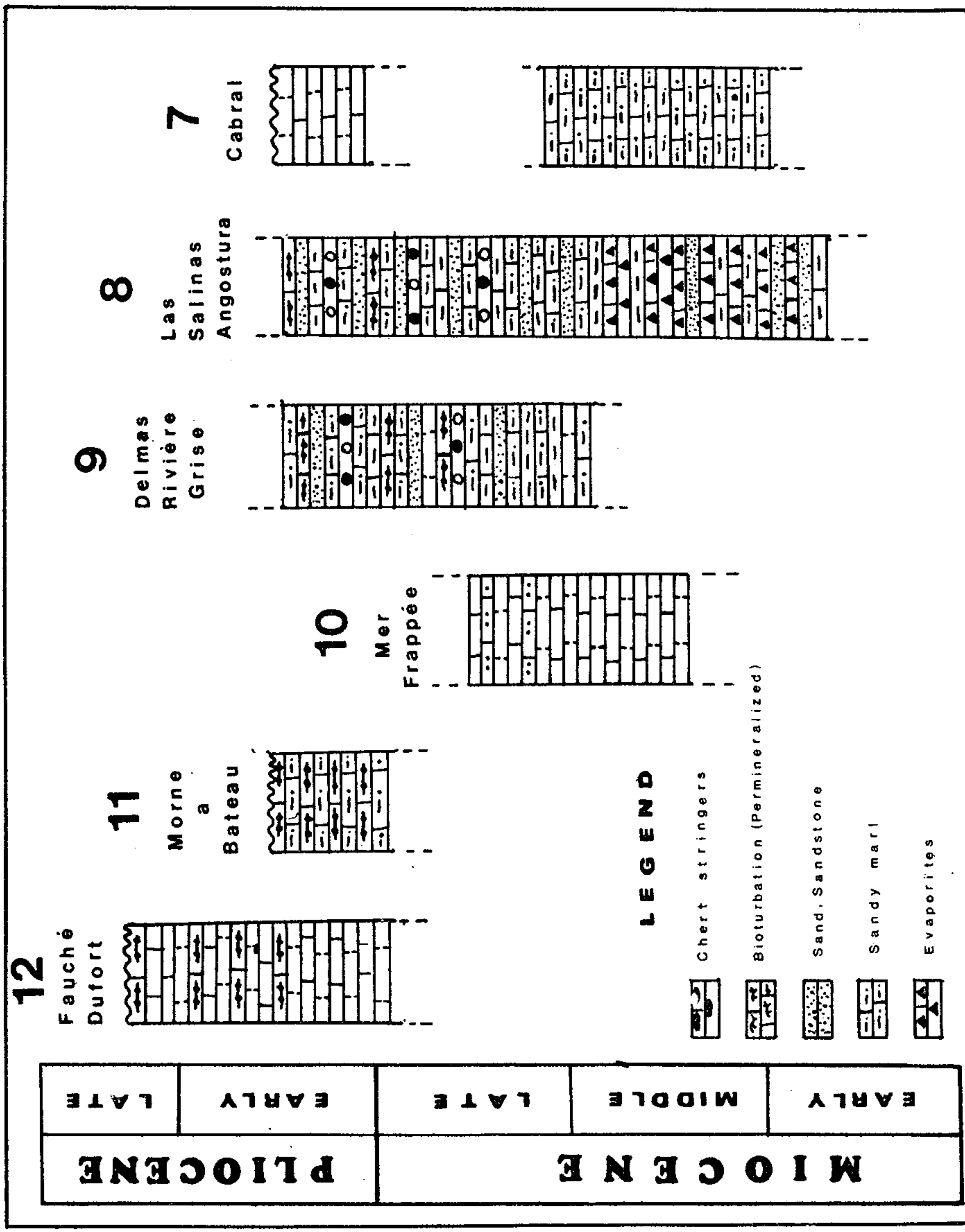
7
Cabral
8
Las
Salinas
Angostura
9
Delmas
Rivière
Grise
10
Mer
Frappée
11
Morne
a
Bateau
12
Fauché
Dufort
LEGEND
Chert stringers
Bioturbation (Permineralized)
Sand, Sandstone
Sandy marl
Evaporites
LATE
EARLY
PLIOCENE
LATE
MIDDLE
EARLY
MIOCENE

Figure 6.

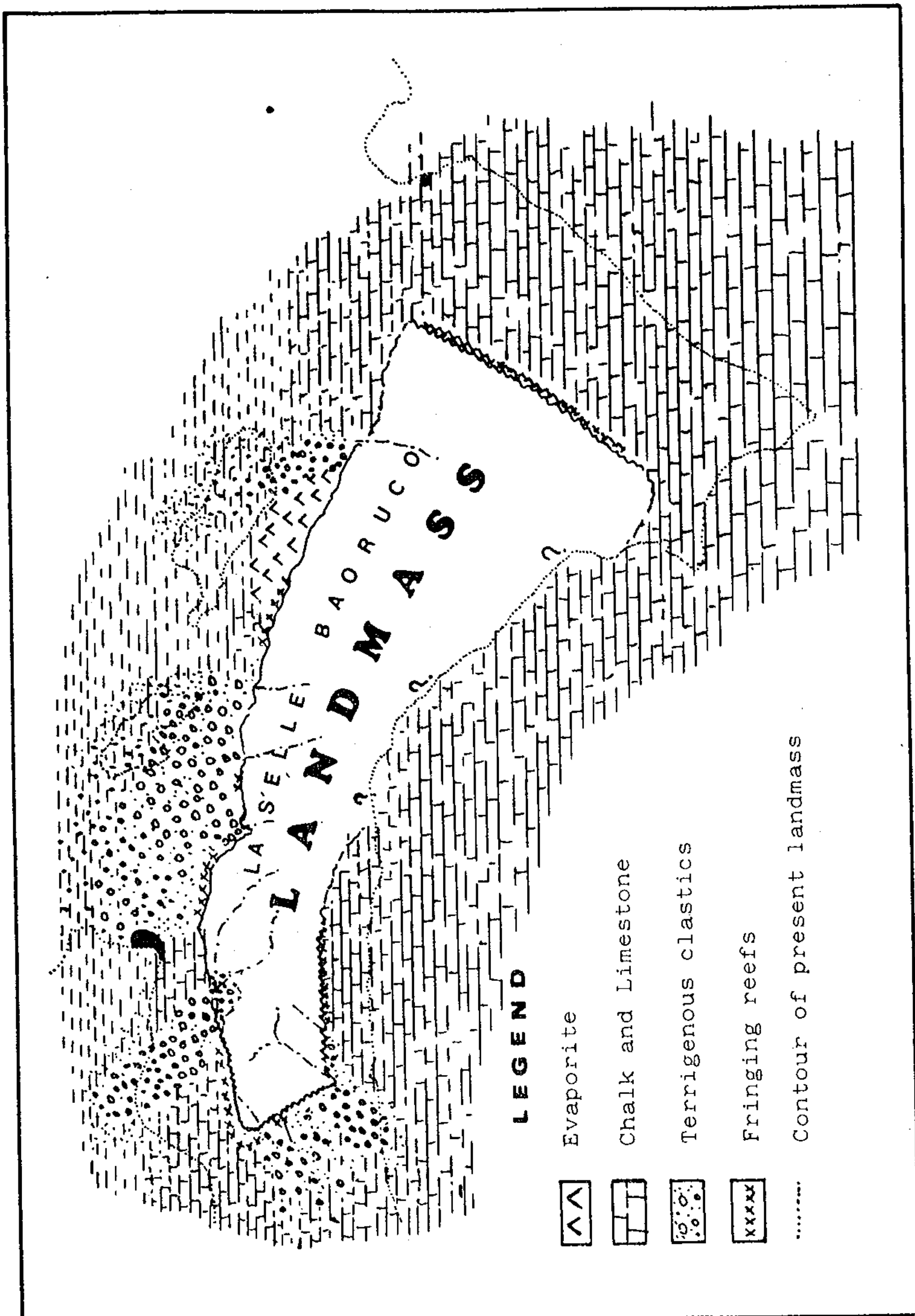

Figure 7. Paleogeography and lithofacies distribution of the La Selle-Baoruco block during Middle and Late Miocene.