

*PRESENCE OF A NEOAUTOCHTHONOUS SUPERSTRUCTURE IN PART  
OF CENTRAL CUBA (CIEGO DE AVILA — CAMAGUEY)*

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Geological investigations (1979—1981) carried out in the central part of Cuba — the former Camaguey Province, yielded quantitatively new information on the lithostratigraphy and tectonic structure, including relations between structural-facies zones, structural plans, structure-building events, etc. The results of their complex interpretation extend beyond the boundaries of the territory studied. The present discussion is focused mainly on the general tectonic environment and the post-Lower Campanian development of the area of the former island arc (Zaza zone) and the former continental margin (Placetas, Camajuani, Remedios and Cayo Coco zones) on the north. From the end of the Upper Cretaceous new conditions, equalized in respect of the pre-existing basement, were superimposed in this area. They were more contrasting on the territory of the former island arc while north of the Camajuani-Cubitas fault, on the continental margin (the southern periphery of the Bahamian platform — Iturralde-Vinent, 1975; Aubouin & Tardy, 1980), the conditions were of a more transitional character.

The territory of Central Cuba exhibits a complex tectonic pattern. A large variety of structures — result of several intensive structure-building phases, have been established. The available data are still insufficient to prove which type of movements prevailed but undoubtedly the horizontal ones were of importance and may be of leading role. The information on the deep structure, irrespective of the existing deep boreholes, is still insufficient. The analysis of the gravimetric surveys (Soloviev et al., 1964; Сажина et al., 1965; Ипатенко et al., 1971) and of other tectonic and geophysical, interpretations (Furzola-Bermúdez et al., 1964, Meyerhoff & Hatten 1968; Левченко & Рябухин, 1971; Шапошникова, 1974; Mattson & Lewis 1980, etc.) leads to the conclusion that the larger part of the section of the volcano-genic-sedimentary and intrusive complexes of the island arc (Zaza zone) is already in allochthonous position after the Lower Campanian. This becomes evident when we examine also the chronologic relations between the island arc and the continental margin, and the located between them rocks of the ophiolitic association, extracted from depth along a thrust plane. As fragments of an ancient oceanic lithosphere, their contemporary position on the surface, directly north of Zaza zone, may be explained most logically likewise by allochthonous position. Apart from geophysical data (Шапошникова, 1974) the thrusting is confirmed also by a number of geological facts. Adjacent to and in the Camajuani-Cubitas fault zone, the present front of the thrusting, many structural features point out to an allochthonous position. There is an active tectonic reworking and incorporation of strongly dislocated sheet-like bodies mainly in the ophiolitic complex. Such are also the large fragments of the former Placetas structural-facies zone which were evidently tectonically assimilated during the thrusting. Directly north

of the thrust front (the former Remedios and Cayo Coco zones) the area shows a typically para-autochthonous structure — numerous imbrications, overthrusts, local nappes of small amplitude and isoclinal folds, all of northern vergence (Iturralde-Vinent & Roque Marrero, 1982).

After an intensive structure-building event, most probably after the Lower Campanian, the until then existing structural-facies zones lost their individuality. As a result of collision and obduction of the former volcanic island arc upon the continent on the north, they were welded together into a continental block of complex structure. A new sedimentation regime was superimposed from the Upper Campanian to present days. The distribution of the younger rock complexes does not coincide and is not confined within the existing first-order Mesozoic structural-facies zones. The boundaries of the latter, mainly faulted, were to a large extent deprived of their limiting until then role. The new, relatively quiet period was broken by several structure-building events as a result of which the dominating on the surface geologic structures were formed (Fig. 11-1).

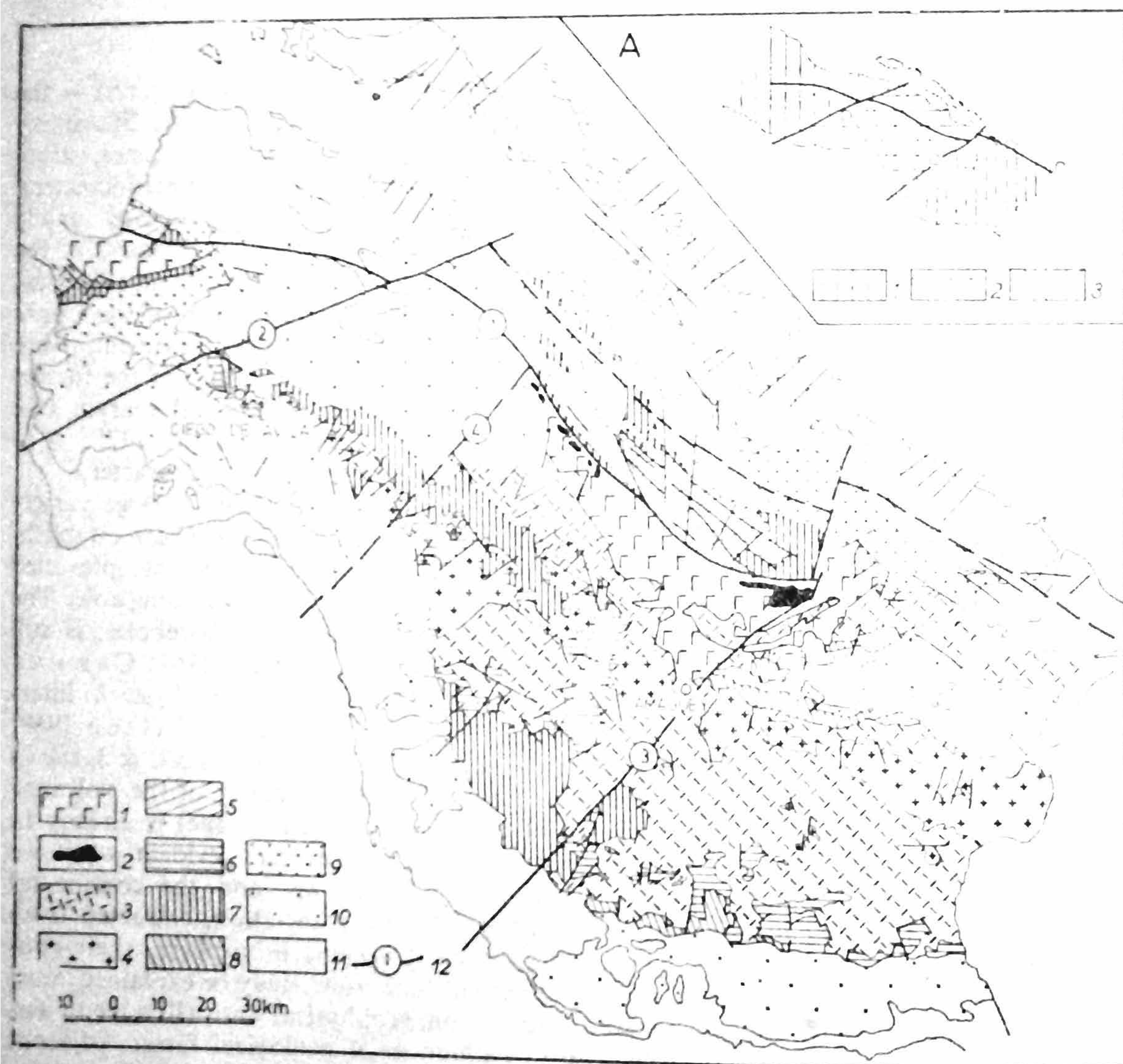


Fig. 11-1. Tectonic scheme of part of Central Cuba

Allochthon (former island arc): 1 — ophiolitic association; 2 — fragments of the former Placetas zone; 3 — volcanic-sedimentary complex; 4 — intrusive complex. Para-autochthon: 5 — former zones of Camajuaní; Remedios, Cayo Coco (Remedios Group). Early Neoautochthon — structural stages: 6 — Upper Campanian-Maastrichtian; 7 — Paleocene-Middle Eocene; 8 — Paleocene-Upper Eocene. Late Neoautochthon — structural stages: 9 — Upper Eocene-Oligocene; 10 — Early Miocene; 11 — Pliocene-Quaternary; 12 — faults. A. Scheme of megablocks: 1 — west of La Trocha; 2 — Florida; 3 — Sibanicu

The tectofacies environments created after the Upper Campanian, including particular lithostratigraphic units and tectonic structures, upon the Subhercynian allochthonous rocks of the former continental margin (Remedios and Cayo Coco zones) are of neoautochthonous character. Depending on the intensity of the later movements, on the created relationships, the character of structural parageneses and lithofacies features, an early and a late neoautochthon may be divided in the geochrone Upper Campanian — present days. On the background of the continental period they correspond to two development stages and structure-building events — transitional continental and continental (contemporary). The first covers the time from the Upper Campanian to the middle of the Eocene (and Upper Eocene only east of Camaguey zone) and the second — from the Upper Eocene (Oligocene) to the Quaternary inclusive.

#### TRANSITIONAL CONTINENTAL STAGE (EARLY NEOAUTOCHTHON)

This stage is typical of the southern periphery of the Bahamian plate, i. e. of the southern and not yet stabilized part of the continental margin, considerably thicker after the Subhercynian movements. Here, the tectonic processes did not fade out and were still rather intensive. Compression and extension stages repeatedly changed. The basins, particularly during the Early Paleogene, were of marked linearity. The sedimentary complexes deposited in them were later intensively deformed. In that stage, both during the sedimentation and the structure-building processes, the transversal La Trocha and Camaguey faults, evidently of ancient origin, played important part. They are fault zones of different width and show complex structure, though not expressed on the surface in some places. They predestine the subdivision of this part of Central Cuba in three megablocks — west of La Trocha (the larger part being outside the region), Florida and Sibanicu. They show different behaviour during the individual stages of Paleogene development. Until now Florida and Sibanicu megablocks have been described as a single block structure — Camaguey horst block (Итурalde-Винент, 1979).

Along the transversal La Trocha and Camaguey cryptofaults repeated vertical movements and in some moments — horizontal displacements of small amplitude took place. The sign of movements changed and in this way the faults controlled the formation of lithostratigraphic units and structural stages. As a result of vertical movements along the transversal faults a nearly complete section of the Paleogene is exposed in the megablock west of La Trocha, only Middle Eocene and in parts Lower Eocene (north of Cubitas fault) sediments — in Florida megablock, and only Middle and Upper Eocene and isolated Oligocene occurrences — in Sibanicu megablock. The longitudinal Camajuaní - Cubitas fault also played a certain paleogeographic role during the Paleogene.

Depending on the represented lithostratigraphic units and the established sedimentation breaks and unconformities within the Early Neoautochthon, three structural stages are distinguished — Upper Campanian - Maastrichtian (Lower Paleocene?), Paleocene-Middle Eocene and Paleocene-Upper Eocene. Each of them shows specific features and a definite position in the general environment. They include a wide range of formations, are well spatially individualized and contain different though sharply contrasting structural parageneses. The latter result from the structure-building phases after the Upper Cretaceous, in the end of the Middle Eocene and after the Upper Eocene.

The chronostratigraphic range of the formations which form the Early Neoautochthon and the range of the respective structural stages is different in individual megablocks or parts of them. This is due to their different behaviour during the emersion periods after the respective folding phases. The duration of denudation was related to the dissection of the newly formed relief, as well as to the rate and amplitude of vertical movements along the transversal (La Trocha and Camaguey) and longitudinal (Camajuaní -

Cubitas) faults. On the other hand the lithologic variety was predestined by the sea floor relief of the respective basin which determined different hydrodynamic environments in individual parts of the basins. In most cases the basins were elongated in subequatorial direction and covered the shelf and eventually parts of the continental slope.

The Upper Campanian-Maastrichtian structural stage east of La Trocha fault and south of Cubitas fault includes Yaquimo and Duran Formations (Upper Campanian-Maastrichtian) and Jimaguayu Formation (Maastrichtian). At that time north of Cubitas fault the Remedios Group (in the southern part — Remedios zone) and Guanay Formation (to the north — Cayo Coco zone) continued to form and north of Camajuani fault — Lutgarda Formation (Maastrichtian) which is better developed to the west, in the former Las Villas Province. The structure-building event after the Maastrichtian created (west of Camaguey, around Florida, north of Arroyo Blanco del Norte, etc.) gentle, normal to slightly north vergent folds of not very high style. They were to a considerable degree erased by later foldings. Probably at that time a new slight northward thrusting of the ophiolitic association occurred along the Camajuani-Cubitas fault.

After the Upper Cretaceous a general uplift took place which continued west of La Trocha fault until the beginning of the Upper Paleocene, east of this fault and north of Cubitas fault — until the beginning of the Lower Eocene, and west of the same fault and in Sibanicu megablock — until the beginning of the Middle Eocene. The presence of a considerable hiatus after the Maastrichtian (or the Lower Paleocene) likewise confirms the occurrence of a structure-building event.

The Paleocene-Middle Eocene structural stage is developed only west of Camaguey fault. In this area, however, block structures of higher order were formed at that time as a result of movements along some second-order faults. Therefore, the range of formations in this structural stage is different in individual megablocks and blocks. Thus, for instance, in the megablock west of La Trocha fault, in the block south of Camajuani fault, Taguasco (Paleocene-Middle Eocene), Husillo and Loma Iguara (Lower Eocene) and Vertientes (Middle Eocene) Formations were deposited, and in the northern block — only one formation — Vega (Paleocene-Middle Eocene) which differs from Taguasco only in the pebble composition of the psphytic sediments. In Florida megablock likewise two blocks are distinguished — north and south of Cubitas fault. In the northern block the sedimentation began as early as in the Lower Eocene (Iturralde-Vinent & Roque Marrero, 1982). It includes Embarcadero (Lower Eocene), Senado and Lesca Formations (Middle Eocene) which overlay the former Remedios zone and further north — the Cayo Coco zone — Paso Abierto (Lower Eocene), Venero and Feliz (Middle Eocene) Formations. In the southern block, however, the sedimentation began as late as in the Middle Eocene and Florida and Vertientes Formations (Middle Eocene) were formed. Most probably during the deposition of Vertientes Formation the deleveling in the southern part of La Trocha fault was insignificant and this structure did not play any essential limiting role. During the Middle Eocene the synsedimentary thrusting along Cubitas fault continued. This is witnessed by the olistostrome character of Senado Formation which includes also olistolites of the ophiolitic association.

In the end of the Middle Eocene, in the megablocks west of Camaguey fault, an intensive structure-building took place (Cuban phase=Illyrian). As a result the first-order structures, today dominating on the surface, were formed — the anticlines of Vega Alta-San Felipe, Jarahueca, Jucaro, Corojo, Florida, Cubitas and the synclines Dagamal, Tinima as well as other positive and negative folds of second and higher order. They are well expressed linear or brachy-folds amongst which anticlines predominate. Their structure was probably more complex but due to the deep erosion it cannot be reconstructed. The folds are of northern vergence, persistent in linear direction and trend northwest-southeast. The ratio between length and width varies in a wide range — from 2:1 to 10:1 and in the folds which continue outside the area studied this ratio may be even larger.

In the end of the Middle Eocene a new northward thrusting along Camajuani-Cubitas fault occurred as a final response to the collision between the former volcanic island arc and fragments of the oceanic crust, and the continental margin on the north. This is the second in importance and intensity activation of the line dividing them. The amplitude of this last thrusting cannot be accurately evaluated due to lack of borehole data. Directly in front of the thrust a number of narrow, subparallel folds formed in the Upper Cretaceous rock complexes of Remedios Group (Iturralde-Vinent & Roque Marrero, 1982). Narrow bands of Lower and Middle Eocene sediments are also preserved in the synforms. In most cases they are semi-grabens with southern monoclinal dips bound by northvergent overthrusts and thrusts of small amplitude. In northern direction, with increasing distance from the frontal zone, the intensity of folding and thrusting gradually decreases.

In the end of the Middle Eocene there was also northvergent overthrusting along Los Perejiles fault north of Arroyo Blanco. A number of transversal to oblique faults of small length are synkinematic to the folds. At that time a left-lateral displacement along Camaguey fault zone took place as a result of which a number of high-order folds originated (east of Vertientes). The shortening of the crust during that structure-building phase was not large. The direction of maximum horizontal compression was northeast-southwest to submeridional. Later, the area west of Camaguey fault uplifted. The duration of the emersion period was different in individual parts of the region studied. It must be pointed out that Florida megablock, after the active movements in the end of the Middle Eocene, emerged almost entirely from the waters until the Miocene.

The Paleocene-Upper Eocene structural stage is developed only in Sibanicu megablock, east of Camaguey fault zone. It includes Maraguan (Middle Eocene) and Saramaguan Formation (Middle-Upper Eocene) in the northern, and Guaicanamar Formation (Middle-Upper Eocene) — in the southern part of the megablock. Nearly over the whole area of the megablock the sedimentary environment, existing during the Middle Eocene, was preserved also during the Upper Eocene. Neither breaks in the sections nor considerable changes in facies have been established. This shows that the folding phase after the Middle Eocene did not affect this area. The main structure-building event in this megablock occurred in the end of the Upper Eocene and corresponds to the Pyrenean phase. Mainly fold structures of considerable size were formed — Najasa and San Miguel de Baga anticlines and Redencion syncline. They are of normal to northern vergence and submeridional direction. Their western parts are cut by Camaguey fault. These structures evidently continue to the east, in Las Tunas Province. The direction of the maximum horizontal compression was north-south. In the southern part of the megablock between Jagua and Arroyo Blanco del Norte, on the background of the subequatorial band of Guaicanamar Formation, folds of second-order are developed which show the character of hemianticlines and hemisynclines. They are of meridional direction and with hinges, pitching steeply to the south. They may result from right-lateral strike-slip along Camaguey fault zone. Some transversal to oblique faults of not very large dimensions are synkinematic to the folding. After the folding in the end of the Upper Eocene the Sibanicu megablock (without the area around Nuevitas) was uplifted and subjected to denudation until the beginning of the Miocene.

#### CONTINENTAL STAGE (LATE NEOAUTOCHTHONE)

After the main longitudinal (with respect to the island) fold structures were formed in this part of Central Cuba, the region was already a relatively monolithic and stable continental block (platform — Iturralde-Vinent, 1971, 1981). A relatively quiet period followed which is characterized only by differentiated oscillatory movements of different sign. The formation of superimposed depressions of irregular orientation,

different lithology and age of the sedimentary filling are the most typical features of this stage. In places they began to form in the beginning of the Upper Eocene, in others — during the Oligocene or (over wider areas) — during the Miocene. Depending on the traces of several well marked events of regional character three structural stages may be distinguished in the Late Neautochthone — Upper Eocene-Oligocene, Early Miocene and Pliocene-Quaternary.

The Upper Eocene-Oligocene structural stage in the area west of La Trocha fault includes Marroqui and Ferrer Formation (Upper Eocene) and Tamarindo and Chambas Formation (Oligocene). In the northeastern parts of the region, around Nuevitas, it is made up mainly of Nuevitas (Upper Eocene) and in parts Pastelillo Formation (Oligocene).

The transgressive position of Tamarindo Formation upon the Upper Eocene Marroqui and Ferrer Formations, as well as the presence of a basal conglomerate in its base northwest of Siego de Avilla, indicate the effects of the Pyrenean phase. Its intensity in this area, however, is weak — only local short uplift, followed by a new subsidence and change in facies.

The main structures of this structural stage are the three superimposed depressions — Jatibonico, Nuevitas and Ana Maria — which originated and developed as consedimentary structures. They show different orientation and dimensions. Jatibonico trends northeast-southwest, this direction being predestined by flexuring and step-like subsidence to the west, along La Trocha zone; Nuevitas is of northwest-southeast direction and is superimposed on the northern parts of Florida and Sibanicu megablocks while the depression Ana Maria has the same direction and its larger part remains in the aquatory of the Caribbean Sea (Furrazola-Bermudez et al., 1964).

In the end of the Oligocene a new orogenic phase lead to a regression of the waters and a general uplift of the whole territory. At the same time certain faults were formed, mainly of normal-fault character — the normal faults of Arroyo Blanco and Tuinico on the west as well as a number of smaller faults to the south and southeast of Tamarindo. The movements along La Trocha zone were revived — along the faults southwest of Nuevitas, those south of Minas and Redencion, etc. At the same time left-lateral strike-slip of small amplitude occurred along La Trocha as a result of which small folds of equatorial direction southeast of Tamarindo and northwest of Siego de Avila were formed. After the Oligocene the whole region was a not very high dry land.

The time from the Miocene to present — the following substage in the development of the Late Neautochthone, will be briefly characterized by some more important features.

The Early Miocene structural stage includes the following formations: Arroyo Palmas (Lower-Middle Miocene in the western part of the region and Middle Miocene south of Vertientes), Guines (Middle Miocene) and Magantilla (Lower-Middle Miocene — only east of Camaguey). At that time three new depressions originated: Moron, of northwest-southeast direction, Saramaguacan — east of Camaguey, of subequatorial direction, and Meridional — in the southern coastal part. The latter is of considerable size but of not accurately traced contours and a large part of it lies in the aquatory of the Caribbean Sea. This depression, in the area of Baragua, is complicated by a structural step which divides the structure into two parts — northern and southern. The areas dividing the depressions had different configuration and dimensions. In the depressions, positive and negative forms were formed synsedimentary. They are flat, of irregular oval contours. On the background of Moron depression, in the northern parts, several diapiric structures were established (Iturralde-Vinent & Roque Marrero, 1982).

After the Middle Miocene there was a general uplift. It was accompanied by normal faults, not numerous, relatively short and of small amplitude.

The time of the Pliocene and the Quaternary is marked by the occurrence of weak,

mainly vertical positive tectonic movements. The Quaternary deposits are diverse, widespread and according to genesis correspond to marine, transitional and continental formations. During the Pliocene the whole area was a dry land and intensive peneplainization took place.

During the Quaternary the present morphological pattern of the area was shaped. At present, in individual large areas near the coastal lines, a tendency to subsidence is evident as a result of which large swamps and lagoons on the land and deepening of the adjacent marine basins takes place.

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