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PALEOGEOGRAPHY AND PALEOTECTONIC EVOLUTION OF CUBA AND ADJOINING AREAS DURING THE JURASSIC-EARLY CRETACEOUS

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Abstract: An outline of paleogeography and paleotectonic development of Cuba during the Jurassic—Early Cretaceous is presented within the framework of the evolution of the Caribbean area. During the Middle Jurassic to Oxfordian, the sediments of the San Cayetano Formation in Cuba and clastics of the Caracas and Juan Griego(?) groups in Venezuela were deposited on two different continental margins. The Caribbean oceanic crust began to form in the Middle Jurassic. The connection between the Atlantic and the Gulf of Mexico through Cuba existed since Middle or Late Oxfordian time. The volcanic activity in the Greater Antilles (Cuba, Hispaniola) has started most likely in the earliest Cretaceous and was related to the oceanic crust subduction.

Key words: paleogeography, paleotectonic evolution, oceanic crust, subduction, Yucatán block, Cuba, Caribbean area, Jurassic, Early Cretaceous.

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INTRODUCTION

In this paper an outline of paleogeography and paleotectonic development of Cuba during the Jurassic-Early Cretaceous is presented within the framework of the paleotectonic evolution of the Caribbean area, mainly of its northwestern part (Fig. 1). Some aspects of the evolution of this area during the Mesozoic are still controversial in spite of a considerable progress of the geological studies in recent years.

It has been proposed (Le Pichon & Fox, 1971; Freeland & Dietz, 1971; Moore & Del Castillo, 1974) that the origin of the Caribbean plate was related to the divergent motion of the North and the South America during the Jurassic with generation *in situ* of a new oceanic crust. Other authors formulated the hypothesis of the Pacific origin of the Caribbean lithosphere (Edgar *et al.*, 1971; Malfait & Dinkelman, 1972). According to this idea the Caribbean plate was originally a part of the East Pacific plate and was wedged between the North and South American continents during the Late Cretaceous (Malfait & Dinkelman, 1972). The hypothesis of the East Pacific origin of the Caribbean plate is not contradictory with respect to the concept of *in situ* formation of the Caribbean (or proto-Caribbean) oceanic crust during the Jurassic—Early Cretaceous. This older crust could be subducted and partly obducted during Cretaceous and Paleogene times.

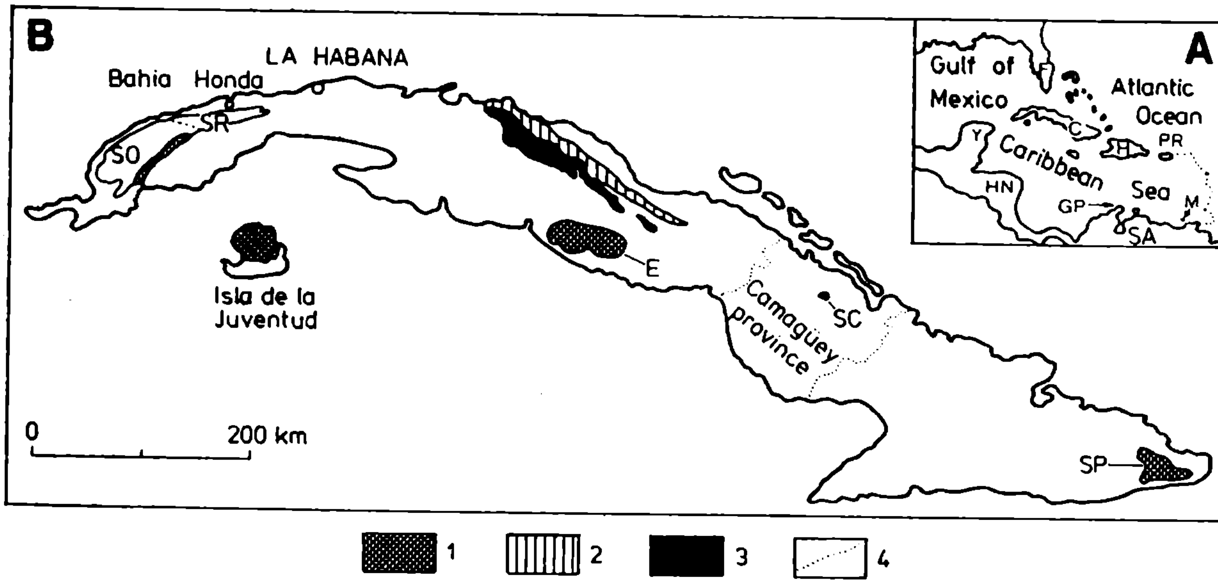

Fig. 1. Index map of the Caribbean and the Gulf of Mexcio (A) and Cuba (B): *1* — metamorphic massifs; *2* — Placetas subzone; *3* — Camajuaní subzone; *4* — limits of the Camagüey Province; *B* — Bahamas; *C* — Cuba; *E* — Escambray massif; *F* — Florida; *GP* — Guajíra Peninsula; *H* — Hispañola; *HN* — Honduras and Nicaragua; *M* — Margarita Island; *PR* — Puerto Rico; *SC* — Sierra de Camaján; *SO* — Sierra de los Organos (with Cangre metamorphic belt in the south-east); *SP* — Sierra del Purial; *SR* — Sierra del Rosario; *Y* — Yucatán

The Triassic fits of the continents around the Caribbean and Gulf of Mexico proposed by Dickinson and Coney (1980, fig. 1) and by Salvador and Green (1980, fig. 1) are accepted here as the most convenient basis for the paleogeographic and paleotectonic reconstructions in the Greater Antilles.

CALLOVIAN—MIDDLE OXFORDIAN

After the continental break-up, during the Middle and Late Jurassic the Cuban sedimentary basin (*SC* in Fig. 2) was connected with the Yucatan block (Salvador & Green, 1980), and was separated from the Florida-Bahamas platform by a tectonic discontinuity named the Florida transform fault by Moore and Del Castillo (1974). In Cuba, this fracture (*FT* in Fig. 2) may be correlated with the left-lateral strike--slip fault between the Bahamas platform and other Mesozoic-Tertiary facies-structural zones to the southwest (Rigassi, 1961).

In the opinion of some authors (Anderson & Schmidt, 1983; Klitgord *et al.*, 1984; Ryabukhin *et al.*, 1984) the clastic sediments of the San Cayetano Formation (?Lower Jurassic—middle Oxfordian) in Cuba were accumulated on the South American continental margin, directly north of the clastics of the Caracas and Juan Griego groups in Venezuela. According to this hypothesis the "Caracas—San Caye-

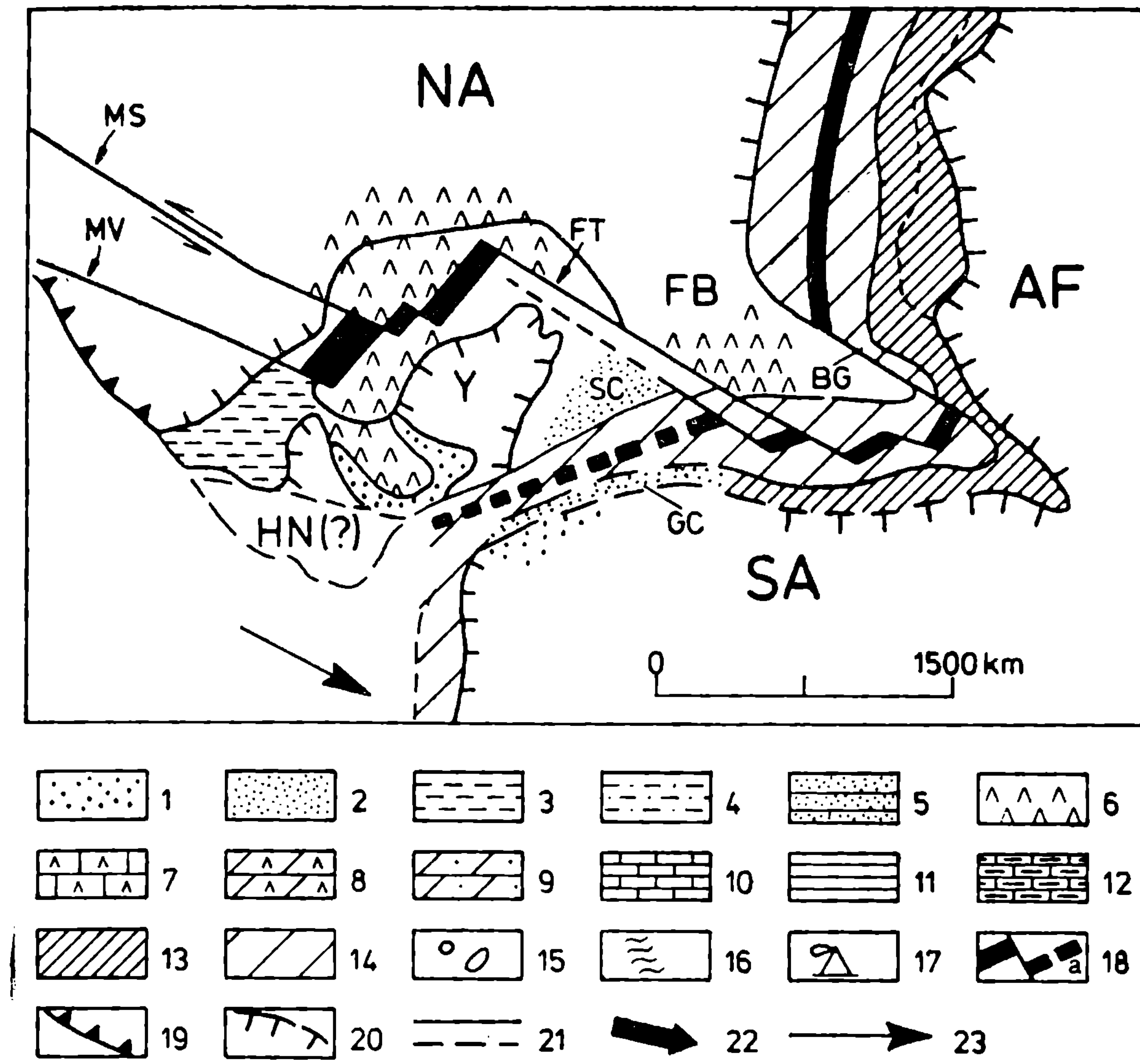

Fig. 2. Reconstruction of the Caribbean and adjacent areas for Callovian to Middle Oxfordian time (partly after: Viniegra-O., 1971; Geyer, 1973, Le Pichon *et al.*, 1977; Buffler *et al.*, 1980; Dickinson & Coney, 1980; Imlay, 1980; Salvador & Green, 1980; Jansa & Wiedmann, 1982; Anderson & Schmidt, 1983). Legend for Figures 2, 3 and 5: *1* — continental red beds; *2* — marine and continental clastic sediments (undivided); *3* — shallow-marine argillaceous sediments; *4* — clastics and calcareous clays; *5* — turbidites in the Lower Cretaceous pelagic sediments; *6* — evaporites, *7* — calcareous sediments and evaporites; *8* — dolomites and evaporites; *9* — dolomites with basal arkoses; *10* — shelf limestones; *11* — pelagic limestones; *12* — limestones and claystones; *13* — marine sediments of the South American and African continental shelf and slope; *14* — oceanic crust; *15* — probable shallow-water sediments in the Early Cretaceous; *16* — metamorphic and/or plutonic basement; *17* — active volcanic arc; *18* — spreading center; *19* — subduction zone; *20* — limits of land areas; *21* — active faults (continuous lines) and inactive fractures (dashed lines); *22* — transport direction of clastic material; *23* — direction of relative motion of South America with respect to North America after Ladd, 1976; *NA* — North America; *SA* — South America; *AF* — Africa; *FB* — Florida—Bahamas platform; *Y* — Yucatán block; *HN*(?) — Honduras—Nicaragua block, its position is uncertain; *SC* — San Cayetano Formation; *GC* — Caracas and Juan Griego(?) groups; *FT* — Florida transform fault; *MS* — Mojave—Sonora megashear; *MV* — Mexican volcanic belt megashear; *BG* — hypothetical strait between the Bahamas and Guinea in Middle to Late Oxfordian time; *G* — Guerrero (Portal del Balsas) strait

tano" sedimentary basin existed till the Callovian when parts of Cuba and Hispaniola separated from South America (Anderson & Schmidt, 1983). However, the stratigraphic correlation of the San Cayetano Formation and its metamorphic equivalents in Cuba (Millán & Myczyński, 1978; Somin & Millán, 1981) with metamorphosed terrigenous sediments of the Caracas and Juan Griego groups in Venezuela is uncertain. The last mentioned terrigenous sediments were laid down upon the South American continental margin, and perhaps partly above the mafic metavolcanics and other rocks of the La Rinconada Group on Margarita Island (Maresch, 1974, 1975). Nevertheless, Vignali (1979) considers these metavolcanics as a formation of the Lower Cretaceous age within the Juan Griego Group. The tentative age of this group (Late Jurassic—Early Cretaceous) may be younger than the bulk of the San Cayetano Formation in Cuba. North of the South American continental margin the oceanic crust has started to form already in the Middle Jurassic as it is proved by the Bajocian-Early Bathonian ammonites found in the allochthonous Siquisique ophiolite complex of northern Venezuela (Bartok *et al.*, 1985). In Cuba, Millán and Somin (1982) assume a probable Middle Jurassic age of the ophiolitic complex in the Camagüey province, on the basis of the radiometric age of 160 Ma from an anorthosite. However, according to Kent and Gradstein (1985) the age of 160 Ma corresponds to the Middle Oxfordian.

The deposition of the San Cayetano Formation in Cuba terminated in the Middle Oxfordian (Myczyński & Pszczółkowski, 1976; Pszczółkowski, 1978), nevertheless fine-grained clastic interbeds still occur in the limestones of the lower part of the Artemisa Formation (Upper Oxfordian—Lower Cretaceous) in the Sierra del Rosario, western Cuba (Fig. 1). These clastic interbeds do not differ from the San Cayetano Formation sediments. It is inferred that the connection between the sedimentary basin in Cuba and the source area of the terrigenous material persisted through the Late Oxfordian—?Early Kimmeridgian. By this time the Cuban area was located far from the South American continental margin (*cf.* Fig. 3, and Anderson & Schmidt, 1983; Salvador & Green, 1980).

The problem of provenance of the clastic material for the San Cayetano Formation and equivalent metasediments in Cuba was considered in a number of papers (Khudoley & Meyerhoff, 1971; Meyerhoff & Hatten, 1974; Haczewski, 1976; Pszczółkowski, 1978; Somin & Millán, 1981, 1982; Anderson & Schmidt, 1983). The predominance of the paleocurrent directions from the south or SSW (Haczewski, 1976) do not agree with the idea of the detritus supply from the North American continent (Somin & Millán, 1982). In contrast, the clastic material could have been transported from the area of Central America (Haczewski, 1976). Te basement in Yucatán was eroded during the Middle and Late Jurassic and continental red beds formed there (Lopez Ramos, 1975; Viniegra-O., 1971). The paleogeographic position of the Honduras—Nicaragua block during the Jurassic is controversial (*cf.* Freeland & Dietz, 1971; Malfait & Dinkelman, 1972; Gose *et al.*, 1980; Ryabukhin *et al.*, 1984) and its role as a potential source area is not clear.

In summary, existing data indicate that the sediments of the San Cayetano Formation and the Caracas and Juan Griego (?) groups were deposited on two different continental margins separated by a narrow zone of the new oceanic crust generated since the Middle Jurassic (Fig. 2). The direct paleogeographic connection between the San Cayetano sedimentary basin and the South American continental margin was possible in pre-Middle Jurassic (or pre-Bathonian) time. This problem is still open to discussion becausse the age of the lowermost part of the San Cayetano Formation is conjectural. The Yucatán block was most likely the main source of the clastic material for the Middle Jurassic and Oxfordian sediments of the San Cayetano Formation and its metamorphic equivalents in Cuba.

KIMMERIDGIAN—TITHONIAN

The horizontal motions of the Yucatán block terminated in pre-Cretaceous time (Schlager *et al.*, 1984), probably in the Oxfordian (Anderson & Schmidt, 1983). It may be assumed that the Cuban area located between the Yucatán and the Florida—Bahamas platform became also fixed during pre-Tithonian or pre-Kimmeridgian time. Farther to the south there existed a new oceanic crust (Fig. 3), created in the hypothetical Caribbean spreading center (Freeland & Dietz, 1971; Moore & Del Castillo, 1974; Saunders, 1980). This center was active untill Callovian time

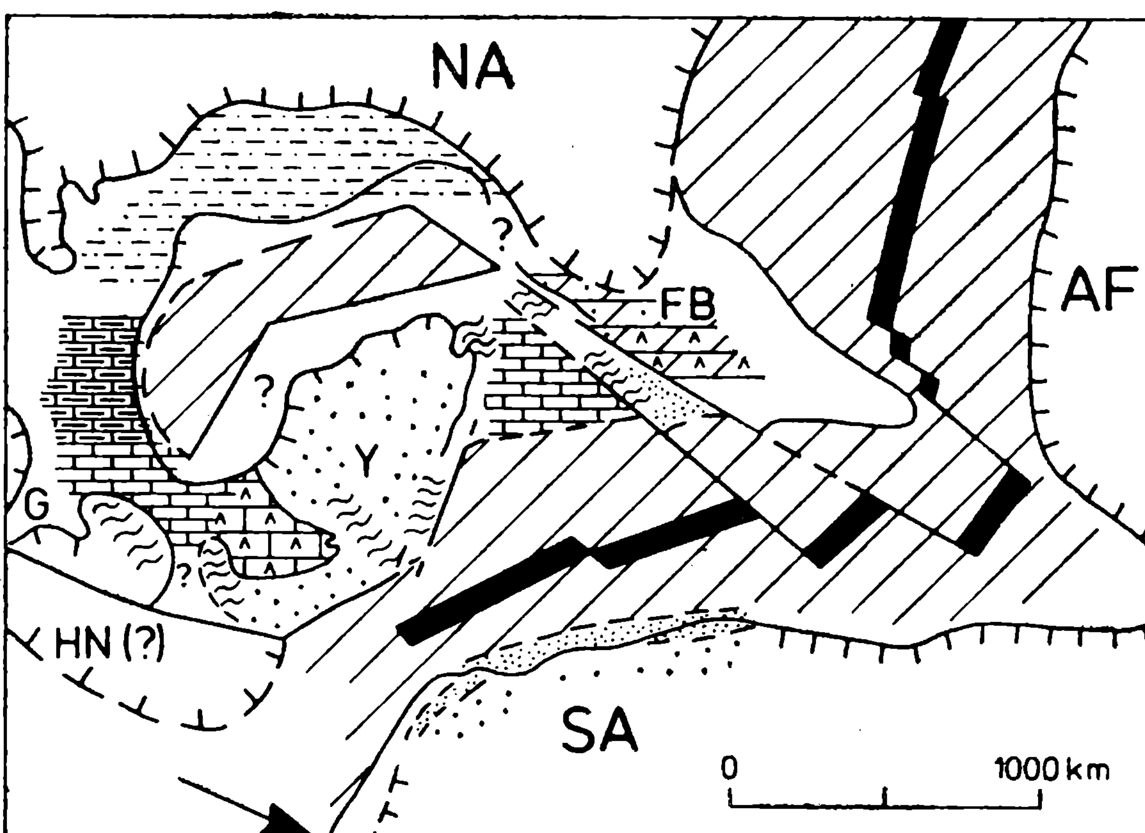

Fig. 3. Reconstruction of the Caribbean and adjacent areas for the Late Jurassic (Kimmeridgian—Tithonian), (partly after: Viniegra-O., 1971; Moore & Del Castillo, 1974; Le Pichon *et al.*, 1977; Buffler *et al.*, 1980; Dickinson & Coney, 1980; Imlay, 1980; Maresch, 1983; Schlager *et al.*, 1984). Legend as for Figure 2

when the main stage of the oceanic crust formation started in the Gulf of Mexico (Dickinson & Coney, 1980; Anderson & Schmidt, 1983). In the Oxfordian, the western part of the Caribbean spreading center could have been less active because of the Gulf of Mexico opening (Fig. 2). During the Kimmeridgian and Tithonian the oceanic crust was formed along the whole Caribbean spreading center (Fig. 3) as a result of the divergent motion of the South America—Africa and North America. In the northwestern part of the Placetas subzone (*3* in Fig. 1B) the Tithonian—Lower Cretaceous sediments were probably underlain by granitoids and metamorphic rocks (Pardo, 1975; Pszczółkowski, 1986). In contrast, the Tithonian (?) tholeiitic basalts were found at the base of the Placetas stratigraphic sequence in the Sierra de Camaján (*SC* in Fig. 1B), central Cuba (Iturralde-Vinent & Marí, 1984). These basalts could be related to the Kimmeridgian—Tithonian spreading episode in the Caribbean area. The mafic rocks of the Tithonian (?)—Early Cretaceous age drilled in the southwestern part of the La Esperanza zone (Cuban—Soviet mapping team pers. comm., 1984), located in the Pinar del Río province north of the Sierra de los Organos (Fig. 1B), may be interpreted as a result of a spreading center activity or as a marginal basin volcanics (Simón Méndez, 1986). However, more complete data are needed for any reliable evaluations of these rocks.

During the Kimmeridgian the shallow-water carbonate deposition persisted in western and central Cuba (Pszczółkowski, 1978; Millán & Myczyński, 1978). Extensive carbonate bank embraced the depositional realms of the Sierra de los Organos, Escambray and Isla de la Juventud (= Isle of Pines). During the Tithonian this area subsided and was covered by thin periplatform to pelagic carbonate sediments (Fig. 4). In northern part of central Cuba, the periplatform calcareous ooze and carbonate turbidites of total thickness of 300 m were accumulated in the Camajuaní basin. At the same time, terrigenous sediments were deposited above the granitoid-metamorphic basement in the northwestern part of the Placetas subzone (Pszczółkowski, 1986). The basement high in the Placetas subzone terminated probably along a fault (Fig. 3). This fracture and the Florida transform fault may correspond to the fracture zones between the Banco de Campeche and Florida as postulated by Klitgord *et al.*, (1984).

Schlager *et al.*, (1984) suggested a Jurassic—Neocomian deep-sea connection between the Gulf of Mexico and the Atlantic through the Cuban area, although the Jurassic sediments were not reached in the SE Gulf drilling sites. This connection was established already in the middle to late Oxfordian time, probably via the Bahamas—Guinea strait (Fig. 2). This conclusion is supported by paleogeographic evidence (Imlay, 1980) and faunistic data (Myczyński, in press). In the Early Kimmeridgian the deep-water connection between the Caribbean basin and the Gulf of Mexico probably did not exist because the sediments with ammonites of this age are not known in Cuba. The Mexican character of the Lower Kimmeridgian ammonites from the Guajíra Peninsula in Colombia (Geyer, 1973) may be explained by the existence of a more distant connection through the Pacific shelf and the Guerrero (or Portal del Balsas) strait in central Mexico (Imlay, 1980; Lopez Ramos,

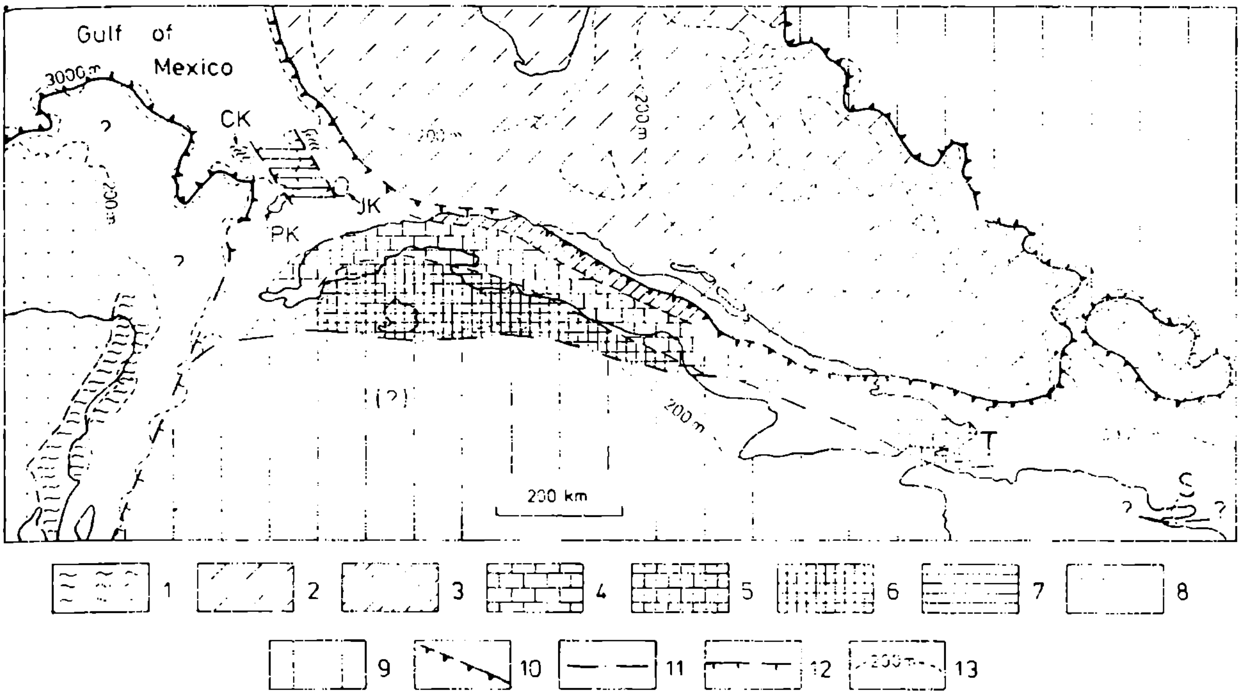

Fig. 4. Paleogeography of the northwestern part of the Caribbean and adjacent areas in Tithonian time (partly after: Viniegra-O., 1971; Meyerhoff & Hatten, 1974; Lopez Ramos, 1975; Sheridan *et al.*, 1981; Cobiella, 1984; Millán *et al.*, 1984; Schlager *et al.*, 1984). *1* — pre-Mesozoic basement; 2 — carbonate sediments and evaporites of the Florida—Bahamas platform; *3* — peri--platform calcareous oozes and carbonate turbidites of the Camajuaní sequence; *4* — carbonate -pelagic sediments; *5* — marine terrigenous and terrigenous-carbonate sediments; *6* — Upper Oxfordian—Tithonian succession of the shallow-water carbonates and periplatform oozes; *7* — -probable deep-water carbonate sediments; *8* — continental red beds; *9* — oceanic crust and its deep-water sedimentary cover; *10* — margins of the Yucatán and Florida—Bahamas platforms; *11* — hypothetical boundary of the North American continental margin in the Greater Antilles area; *12* — probable faults; *13* — present-day isobaths; *T* — Tortue Island; *S* — Samaná Peninsula of Hispaniola; *CK* — Catoche Knoll; *JK* — Jordan Knoll; *PK* — Pinar del Río Knoll (these knolls could be connected with the Jurassic platforms); subdivisions *4*—*6* are presented in their pre-tectonic position in western and central Cuba

1984). The Caribbean basin and the Gulf of Mexico could have been directly connected during the Tithonian as inferred from the Cuban carbonate sediments containing ammonites and planktonic microfossils.

LOWER CRETACEOUS (PRE-APTIAN)

During the Early Cretaceous pelagic sediments and turbidites were deposited in western and central Cuba (Pardo, 1975; Pszczółkowski, 1978, 1982). The clastic material was transported from the Yucatán block (Fig. 5). Northwest of Cuba, in the southeastern Gulf of Mexico there existed a deep-water seaway approximately 100 km wide (Schlager *et al.*, 1984). In eastern Cuba the Tithonian—Lower Cretaceous sediments are known from the Sierra del Purial, where metamorphosed terrigenous and carbonate formations were related by Millán *et al.*, (1984) to the "miogeosynclinal paleostructure" of the North American continental margin.

Metamorphic rocks exposed in the Tortue Island and in the Samaná Peninsula of Hispaniola may include sediments of a continental margin (Nagle, 1974) of Jurassic—Early Cretaceous age; however, at least a part of these rocks is younger (Vila *et al.*, 1982).

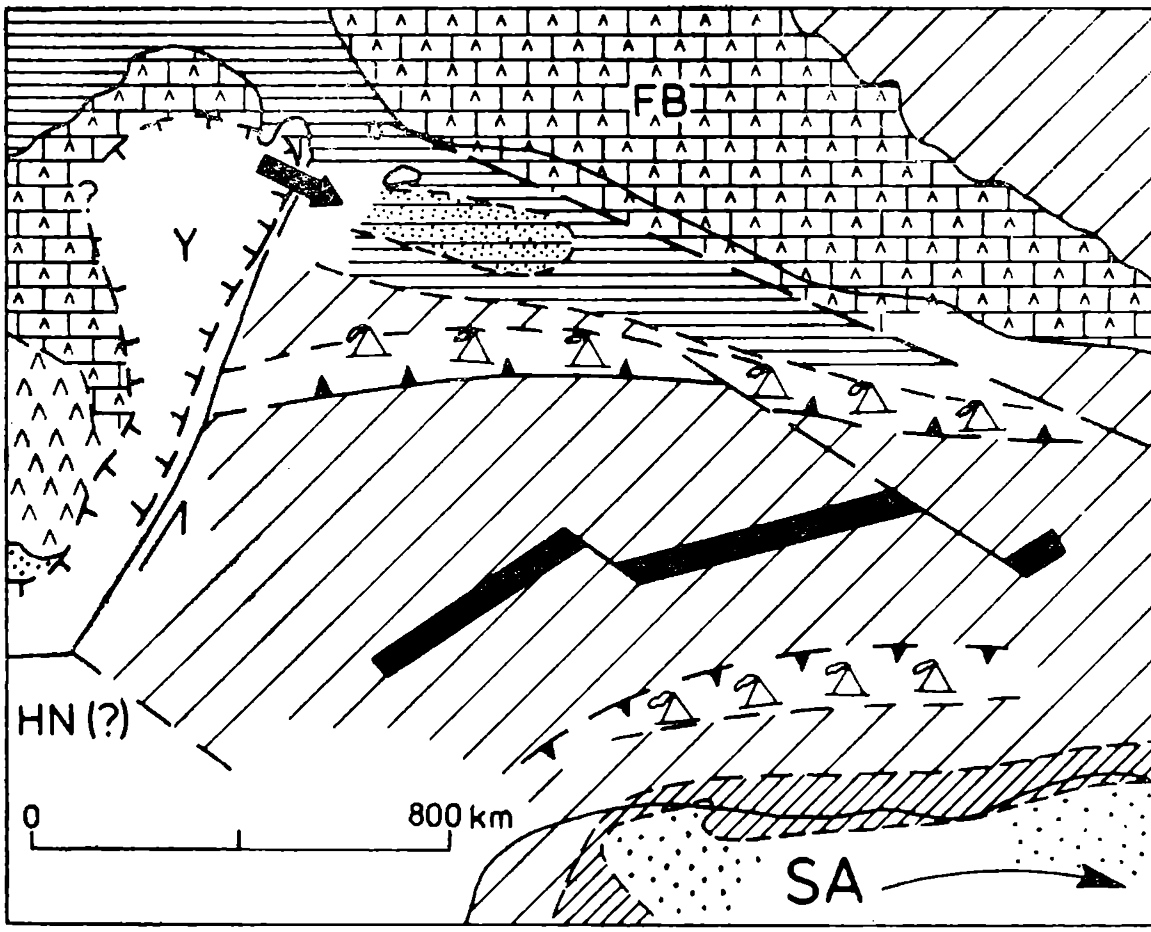

Fig. 5. Paleogeographic scheme of the Caribbean in Early Cretaceous (pre-Aptian) time (partly after: Khudoley & Meyerhoff, 1971; Viniegra-O., 1971; Malfait & Dinkelman, 1972; Maresch, 1974, 1983; Lopez Ramos, 1975; Walper, 1980; Schlager *et al.*, 1984). Legend as for Figure 2

In Cuba and Hispaniola the oldest rocks of the Cretaceous volcanic arc are paleontologically dated as Aptian—Albian (Khudoley & Meyerhoff, 1971; Bowin, 1975). Nevertheless, in central Cuba, a thick pre-Cenomanian volcanic succession is barren of fossils in its lower part (Pardo, 1975). Even the Late Jurassic age of these oldest island-arc volcanics in Cuba was suggested (Meyerhoff in: Khudoley & Meyerhoff, 1971; Iturralde-Vinent, 1975; Mattson, 1979), but this opinion was not supported by any clear evidence. Therefore in this paper the Early Cretaceous initiation of the volcanic arc activity in Cuba is assumed as a less speculative possibility. This volcanic activity has developed in the Zaza facies-structural zone, located south of the Placetas subzone in central Cuba, but aso north of the Sierra del Rosario (in the Bahía Honda area) in the western part of the island (Fig. 1 B).

The onset of subduction in the Greater Antilles was correlated with the important change in the relative motion of the South America with respect to North America in the Valanginian (Ladd, 1976; Anderson & Schmidt, 1983). The controversial problem of the location and dip of the subduction zone in Cuba during Mesozoic time was considered by various authors (Malfait & Dinkelman, 1972; Nagy, 1972; Mattson, 1973, 1979; Iturralde-Vinent, 1975; Dickinson & Coney, 1980; Haydoutov, 1984; Millán & Somin, 1984). According to Malfait and Dinkelman (1972) a northward-dipping subduction zone and the associated volcanic arc were established as a result of the Caribbean plate consumption in the Late Cretaceous, but this paleotectonic situation probably occurred earlier, in Early Cretaceous time (Fig. 5). The alternative hypothesis is that the subduction zone dipped southward and the associated volcanic arc was situated far to the south or southwest of the North American continental margin during the Early Cretaceous (Ryabukhin *et al.*, 1984; Leclere-Vanhoeve & Stephan, 1985). However, the real position of this subduction zone and the Zaza volcanic arc in pre-Aptian time is difficult to restore. During the Early Cretaceous the Zaza volcanic arc was growing up in a deep marine environment which persisted in places through the Late Cretaceous (Tchounev *et al.*, 1984).

Various elements of the geological structure of Cuba were interpreted in favour either of the first or of the second hypothesis and it would be difficult to eliminate one of them at the moment. The mafic rocks in the Jurassic—Cretaceous sequences of the Escambray metamorphic massif may be interpreted as an indication of transition between the Mesozoic continental margin to the north and the oceanic crust and/or volcanic arc to the south (Millán & Somin, 1984). This paleotectonic situation would provide a supporting argument for the location of the subduction zone south of the Escambray Mesozoic sequences. The model of two successive Mesozoic episodes of northward-dipping and southward-dipping subduction (Mattson, 1979) is difficult to accept in the Cuban area. The terrigenous-carbonate sequences of Escambray and Sierra del Purial were metamorphosed in Late Cretaceous time (Somin & Millán, 1981; Millán *et al.*, 1984), while in the southern part of the Sierra de los Organos (Fig. 1 B) the metamorphic event occurred in the Paleogene (Pszczółkowski, 1984). Therefore the Late Cretaceous to Paleogene metamorphism of these sedimentary sequences could not be related to the northward-dipping subduction zone active before 119 Ma.

On other islands of the Greater Antilles the problem of the Mesozoic subduction episodes was also alternatively considered (Nagle, 1974, Bowin, 1975; Kesler *et al.*, 1977; Mattson, 1979). Nevertheless, it is assumed that the subduction started during the Early Cretaceous is Hispaniola and probably in Puerto Rico.

PROBABLE OCEANIC CRUST FORMATION IN THE APTIAN—?CENOMANIAN

In the Early Cretaceous the rate of the oceanic crust formation in the Caribbean area was probably reduced as a result of the change in the relative motion between North and South America (Ladd, 1976). However, in the northwestern part of the Caribbean the oceanic crust generation might have continued until the Cenomanian (?). Such a possibility is indicated by numerous tholeiitic basalt occurrences in the Encrucijada Formation in the Bahía Honda area of western Cuba (Fonseca & Zelepugin, 1981; Zelepugin *et al.*, 1982). This formation of the Aptian—?Cenomanian age is considered as the basaltic member of the ophiolitic association (Fonseca *et al.*, 1984). The Encrucijada Formation rocks, likewise the allochthonous volcano--sedimentary sequence in the Sierra del Rosario (Pszczółkowski & Albear, 1983), resemble the Dumisseau Formation of Cretaceous age in southern Haiti (Maurrasse *et al.*, 1979). The latter formation is considered to be an emerged analogue of the Caribbean crust. The above mentioned mafic rocks of western Cuba could have been formed in a back-arc basin north of the Zaza volcanic pile (Fig. 5), but an alternative interpretation as the partial equivalent of the lithologic succession beneath the seismic reflector B" in the Caribbean Sea (Edgar *et al.*, 1971; Maurrasse *et al.*, 1979; Saunders, 1980) is also possible.

CONCLUSIONS

1. The clastic sediments of the Jurassic San Cayetano Formation in Cuba and the Caracas and Juan Griego groups in Venezuela were deposited on two different continental margins, at least since the Bajocian-Early Bathonian.
2. The Yucatán block was most likely the main source of the terrigenous material for the San Cayetano Formation and its metamorphic equivalents in Cuba.
3. The Caribbean oceanic crust started to form already during Middle Jurassic time.
4. The connection between the Gulf of Mexico and the Atlantic through Cuba was established in the Middle to Late Oxfordian time. The Caribbean basin and the Gulf of Mexico were directly connected by a deep-water seaway during Tithonian time.
5. In the Greater Antilles, the subduction of the oceanic crust started probably in the earliest Cretaceous. So far there is no clear evidence in support for a Jurassic subduction episode.
6. In the northwestern part of the Caribbean area the oceanic crust generation might have continue through the Aptian—?Cenomanian.

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REFERENCES

Anderson, T. H. & Schmidt, V. A., 1983. The evolution of Middle America and the Gulf of Mexico—Caribbean Sea region during Mesozoic time. *Geol. Soc. Am. Bull.*, 94: 941—966.

Bartok, P. E. Renz, O. & Westermann, G. E. G., 1985. The Siquisique ophiolites, northern Lara state, Venezuela: A discussion on their Middle Jurassic ammonites and tectonic implications. *Geol. Soc. Am. Bull.*, 96: 1050—1055.

Bowin, C., 1975. The geology of Hispaniola. In: A. E. M. Nairn & Stehl, F. G. (eds.), *The Ocean Basins and Margins*, Vol. 3 – *The Gulf of Mexico and Caribbean*. Plenum Press, New York, pp. 501–552.

Buffler, R. T., Watkins, J. S., Shaub, F. J. & Worzel, J. L., 1980. Structure and early geologic history of the deep central Gulf of Mexico basin. In: Pilger, R. H., jr. (ed.), The origin of the Gulf of Mexico and the early opening of the central North Atlantic Ocean. *Proc. of a Symposium at Luisiana State Univ.*, Baton Rouge, pp. 3–16.

Cobiella, J. L., 1984. *Sobre el origen del extremo oriental de la fosa de Bartlett.* Editoral Oriente, Santiago de Cuba, 43 pp.

Dickinson, W. R. & Coney, P. J., 1980. Plate tectonic constraints on the origin of the Gulf of Mexico. In: Pilger, R. H., jr. (ed.), The origin of the Gulf of Mexico and the early opening of the central North Altantic Ocean. *Proc. of a Symposium at Luisiana State Univ.*, Baton Rouge, pp. 27–36.

Edgar, N. T., Ewing, J. L. & Hennion, J., 1971. Seismic refraction and reflection in the Caribbean Sea. *Am. Assoc. Petrol. Geol. Bull.*, 55: 833–870.

Fonseca, E. & Zelepugin, V., 1981. Asociación de basaltos sódicos en la región occidental de Cuba (Provincia de Pinar del Río), In: *Resumenes. Primer Simposio Soc. Cub. Geol.*, 1981, La Habana, p. 77.

Fonseca, E., Zelepugin, V. & Heredia, M., 1984. Particularidades de la estructura de la asociación ofiolitica de Cuba. *Ciencias de la Tierra y del Espacio*, 9: 31–46.

Freeland, G. L. & Dietz, R. S., 1971. Plate tectonic evolution of Caribbean–Gulf of Mexico region. *Nature*, 232: 20–23.

Geyer, O. F., 1973. Das präkretazische Mesozoikum von Kolumbien. *Geol. Jb.*, B, 5: 1–142.

Gose, W. A., Scott, G. R. & Swartz, D. K., 1980. The aggregation of Mesoamerica: paleomagnetic evidence. In: Pilger, R. H., jr. (ed.), The origin of the Gulf of Mexico and the early opening of the central North Atlantic Ocean. *Proc. of a Symposium at Luisiana State Univ.*, Baton Rouge, 51–54.

Haczewski, G., 1976. Sedimentological reconnaissance of the San Cayetano Formation: an accumulative continental margin in the Jurassic of Western Cuba, *Acta Geol. Polon.*, 26: 331–353.

Haydoutov, I., 1984. Model for the Cretaceous geotectonic evolution of central Cuba. In: *27 Inter. Geol. Congress, Abstracts*, vol. III, Moscow, pp. 223–224.

Imlay, R. W., 1980. Jurassic paleobiogeography of the conterminous United States in its continental setting. *U. S. Geol. Surv. Prof. Paper*, 1062: 134 pp.

Iturralde-Vinent, M. A., 1975. Problems in application of modern tectonic hypotheses to Cuba and Caribbean region. *Am. Assoc. Petrol. Geol. Bull.*, 59: 838–855.

Iturralde-Vinent, M. A. & Mari, T., 1984. Basaltos toleíticos del Titoniano de la Sierra de Camaján (zona de Placetas), Camagüey. In: *X Jorn. Cient. Inst. Geol. Paleont. ACC.* La Habana, p. 57.

Jansa, L. F. & Wiedmann, J., 1982. Mesozoic–Cenozoic development of the eastern North American and northwest African continental margins: a comparison. In: Rad, U., von, Hinz, K., Sarnthein, M. & Seibold, E. (eds.), *Geology of the Northwest African Continental Margin.* Springer–Verlag, Berlin, pp. 215–269.

Kent, D. V. & Gradstein, F. M., 1985. A Cretaceous and Jurassic geochronology. *Geol. Soc. Am. Bull.*, 96: 1419–1427.

Kesler, S. E., Sutter, J. F., Jones, L. M. & Walker, R. L., 1977. Early Cretaceous basement rocks in Hispaniola, *Geology*, 5: 245–247.

Khudoley, K. M. & Meyerhoff, A. A., 1971. Paleogeography and geological history of Greater Antilles. *Geol. Soc. Am. Mem.* 129: 1–199.

Klitgord, K. D., Popenoe, P. & Schouten, H., 1984. Florida: a Jurassic transform plate boundary. *J. Geophys. Res.*, 89 (B9): 7753–7772.

Ladd, J. W., 1976. Relative motion of South America with respect to North America and Caribbean tectonics. *Geol. Soc. Am. Bull.*, 87: 969–976.

Leclere-Vanhoeve, A. & Stephan, J. P., 1985. Évolution géodynamique des Caraïbes dans la systéme points chauds, In: *Géodynamique des Caraïbes, Symposium Paris.* Ed. Technip, Paris, pp. 21–34.

Le Pichon, X. & Fox, P. J., 1971. Marginal offsets, fracture zones, and the early opening of the North Atlantic. *J. Geophys. Res.*, 76 (26): 6294–6308.

Le Pichon, X., Sibuet, J.-C. & Francheteau, J., 1977. The fit of the continents around the North Atlantic Ocean. *Tectonophysics*, 38: 169–209.

Lopez Ramos, E., 1975. Geological summary of the Yucatán Peninsula. In: Nairn A. E. M., & Steghli F. G., (eds.), *The Ocean Basins and Margins.* Vol. 3 — *The Gulf of Mexico and the Caribbean.* Plenum Press, New York, pp. 257–282.

Lopez Ramos, E., 1984. Paleogeografía y tectónica del Mesozoico en México. *Rev. Inst. Geol. Univ. Nac. Aut. de México*, 5 (2): 158–177.

Malfait, B. & Dinkelman, M., 1972. Circum–Caribbean tectonic and igneous activity and the evolution of the Caribbean plate, *Geol. Soc. Am. Bull.*, 83: 251–272.

Maresch, W. V., 1974. Plate tectonics origin of the Caribbean Mountain System of northern South America: Discussion and proposal. *Geol. Soc. Am. Bull.*, 85: 669–682.

Maresch, W. V., 1975. The geology of northeastern Margarita Island, Venezuela: A contribution to the study of Caribbean margins. *Geol. Rundsch.*, 64: 846–883.

Maresch, W. V., 1983. The northern Andes. In: Moullade, M. & Nairn, A. E. M. (eds.), *The Phanerozoic Geology of the World; The Mesozoic*, B. Elsevier, Amsterdam, pp. 121–149.

Mattson, P. H., 1973. Middle Cretaceous nappe structures in Puerto Rican ophiolites and their relation to the tectonic history of Greater Antilles. *Geol. Soc. Am. Bull.*, 84: 21–38.

Mattson, P. H., 1979. Subduction, buoyant braking, flipping, and strike-slip faulting in the northern Caribbean. *J. Geol.*, 87: 293–304.

Maurrasse, F., Hustler, J., Georges, G., Schmitt, R. & Damond, P., 1979. Upraised Caribbean sea floor below acoustic reflector B" at the Southern Peninsula of Haiti. *Geol. Mijnb.*, 58: 71–83.

Meyerhoff, A. A. & Hatten, C. W., 1974. Bahamas salient of North America: Tectonic framework, stratigraphy, and petroleum potential. *Am. Assoc. Petrol. Geol. Bull.*, 58: 1201–1239.

Millán, G. & Myczyński, R., 1978. Fauna jurásica y consideraciones sobre la edad de las secuencias metamórficas del Escambray. *Inf. Cient.-Técn. Ac. Cien. Cuba.*, 80: 1–14.

Millán, G. & Somin, M. L., 1982. Los complejos metamórficos de Cuba, In: *IX Jorn. Cient. Inst. Geol. Paleont. ACC*, La Habana, pp. 28–33.

Millán, G. & Somin, M. L., 1984. Contribución a la geologia de las metamorfitas y al desarrollo paleotectónico del sur de Cuba central. *In: X Jorn. Cient. Inst. Geol. Paleont. ACC*, La Habana, p. 60.

Millán, G., Somin, M. L., & Díaz, C., 1984. Geología del macizo montañoso de la Sierra del Purial (extremo oriental de Cuba). In: X *Jorn. Cient. Inst. Geol. Paleont. ACC*, La Habana, p. 61.

Moore, G. W. & Del Castillo, L., 1974. Tectonic evolution of the Southern Gulf of Mexico. *Geol. Soc. Am. Bull.*, 85: 607–618.

Myczyński, R., (in press). Sobre las correlaciones paleobiogeográficas del conjunto de los ammonites del Jurásico Superior y del Cretácico Inferior de Cuba. In: *Contribución a la Geologia de la Provincia de Pinar del Rio.*

Myczyński, R. & Pszczółkowski, A., 1976. The ammonites and age of the San Cayetano Formation from the Sierra del Rosario, western Cuba. *Acta Geol. Polon.*, 26: 321–329.

Nagle, F., 1974. Blueschist, eclogite, paired metamorphic belts and early tectonic history of Hispaniola, *Geol. Soc. Am. Bull.*, 85: 1461–1466.

Nagy, E., 1972. Perfil transversal esquematico de Oriente desde el punto de vista de la tectónica de placas. *Acta Ac. Cien. Cuba, Inst. Geol.*, 2: 63–66.

Pardo, G., 1975. Geology of Cuba. In: Nairn, A. E. M. & Stehli, F. G. (eds.), *The Ocean Basins and Margins*, Vol. 3 — *The Gulf of Mexico and the Caribbean.* Plenum Press, New York, pp. 553–615.

Pszczółkowski, A., 1978. Geosynclinal sequences of the Cordillera de Guaniguanico in western

Cuba; their lithostratigraphy, facies development, and paleogeography. *Acta Geol. Polon.*, 28: 1–96.

Pszczółkowski, A., 1982. Cretaceous sediments and paleogeography in the western part of the Cuban miogeosyncline. *Acta Geol. Polon.*, 32: 135–161.

Pszczółkowski, A., 1984. Sobre la edad del metamorfismo y la estructura tectónica de la faja Cangre, provincia de Pinar del Río. *In: X Jorn. Cient. Inst. Geol. Paleont. ACC*, 66, La Habana, p. 66.

Pszczółkowski, A., 1986. Secuencia estratigráfica de Placetas en el área limitrofe de las provincias de Matanzas y Villa Clara (Cuba). *Bull. Pol. Ac. Sci., Earth Sci.*, 34: 67–79.

Pszczółkowski, A. & Albear, J. F. de, 1983. La secuencia vulcanógeno-sedimentaria de la Sierra del Rosario, provincia de Pinar del Río, Cuba. *Ciencias de la Tierra y del Espacio*, 6: 41–52.

Rigassi, D., 1961. Quelques vues nouvelles sur la géologie cubaine. *Chron. Mines et de la Rech. Min.*, 29 (302): 3–7. English translation in: *Benchmark Papers in Geology*, v. 33 (1977) *West Indies Island Arcs*. Dowden, Hutchinson and Ross, Inc., Stroundsburg, Pennsylvania, pp. 134–140.

Ryabukhin, A. G., Tchekhovich, V. D., Zonenshain, L. P. & Khain, V. E., 1984. Development of the Caribbean basin and the western part of the Tethys. In: *27 Inter. Geol. Congress, Coll. 03-Palaeoceanography, Repts.*, vol. 3. Moscow, pp. 104–113.

Salvador, A. & Green, A. R., 1980. Opening of the Caribbean Tethys (origin and development of the Caribbean and the Gulf of Mexico). In: Géoiogie des chaînes alpines issues de la Téthys. *Mém. B. R. G. M.*, 115: 224–229.

Saunders, J. B., 1980. The development of the Caribbean with special reference to the southern margin and the Venezuela basin. In: Géologie des chaînes issues de la Téthys. *Mém. B. R. G. M.*, 115: 237–243.

Schlager, W., Buffler, R. T., Angstadt, D. & Phair, R., 1984. Geologic history of the southeastern Gulf of Mexico. In: Buffler, R. T. & Schlager, W. *et al.*, *Init. Rept. DSDP*, vol. LXXVII. U. S. Govt. Printing Office, Washington, pp. 715–738.

Sheridan, R. E., Crosby, J. T., Bryan, G. M. & Stoffa, P. L., 1981. Stratigraphy and structure of southern Blake Plateau, northern Florida Straits, and northern Bahama Platform from multichannel seismic reflection data. *Am. Assoc. Petrol. Geol. Bull.*, 65: 2571–2593.

Simón Méndez, A., 1986. *Algunas ideas sobre la evolución geológica del archipiélago cubano.* (Unpublished). Empresa Geológica de Pinar del Río. Santa Lucía, Cuba, p. 39.

Somin, M. L. & Millán, G., 1981. *Geologija metamorficheskikh kompleksov Kuby.* (In Russian). Nauka, Moskwa, pp. 1–219.

Somin, M. L. & Millán, G., 1982. Algunos aspectos de la paleotectónica de Cuba fundamentados en el estudio de sus rocas metamórficas. In: *IX Jorn. Cient. Inst. Geol. Paleont. ACC*, La Habana, pp. 51–59.

Tchounev, D., Tzankov, T. & Yanev, S., 1984. A model of the Cretaceous island arc in central Cuba. In: *24 Inter. Geol. Congress, Abstracts*, vol. III. Moscow, pp. 432–433.

Vignali, M., 1979. Estratigrafía y estructura de las cordilleras metamórficas de Venezuela oriental (Peninsula de Araya–Paria e Isla de Margarita). *Geos*, 25: 19–66.

Vila, J.-M., Butterlin, J., Labesse, B. & Mercier de Lepinay, B., 1982. Donneés nouvelles sur les roches métamorphiques de l'ile de la Tortue (Hispaniola, Grandes Antilles). *C. R. Ac. Sci.* Paris, 294 (Sér. II): 1103–1106.

Viniegra-O., F., 1971. Age and evolution of salt basins of southeastern Mexico. *Am. Assoc. Petrol. Geol. Bull.*, 55: 478–494.

Walper, J. L., 1980. The tectono-sedimentary history of Caribbean basins and their hydrocarbon potential. In: Miall, A. D. (ed.), Facts and principles of world petroleum occurrence. *Canadian Soc. Petrol. Geol. Mem.*, 6: 887–911.

Zelepugin, V., Fonseca, E. & Diaz Villalvilla, L., 1982. Asociaciones vulcanógenas de Cuba occidental (provincia de Pinar del Río). *In: IX Jorn. Cient. Inst. Geol. Paleont. ACC*, La Habana, pp. 98–101.

Resumen

PALEOGEOGRAFÍA Y EVOLUCIÓN PALEOTECTÓNICA DE CUBA Y DE LOS ÁREAS ADYACENTES EN EL JURÁSICO—CRETÁCICO TEMPRANO

Andrzej Pszczółkowski

Extracto: En el trabajo se presentan los rasgos generales de paleogeografia y paleotectónica de Cuba durante el Jurásico—Cretácico Temprano, en el fondo de la evolución del área del Caribe. Se plantea que la Formación San Cayetano en Cuba y los sedimentos jurásicos de los grupos Caracas y Juan Griego en Venezuela se depositaron en distintos margenes continentales. La formación de la corteza oceánica en el área del Caribe empezó ya en el Jurásico Medio. La conexión entre el Atlántico y el Golfo de México, a través del área de Cuba, existía desde el Oxfordiano Medio a Tardío. La actividad volcánica en las Antillas Mayores (Cuba, La Española) fue relacionada con el proceso de subducción de la corteza oceánica iniciado en el Cretácico Temprano, Pre—Aptiano mas probable.

En el trabajo se presentan los rasgos generales del desarrollo paleogeográfico y paleotectónico de Cuba durante el Jurásico—Cretácico Inferior, en el fondo de la evolución del área del Caribe, en particular de su parte noroccidental. Las configuraciones de los continentes en el Triásico, propuestas por Dickinson y Coney (1980) y por Salvador y Green (1980) se aceptan aquí como la basis para las reconstrucciones paleogeográficas y paleotectónicas de las Antillas Mayores. En el Jurásico, el área de Cuba (Fig. 1) fue vinculado estructuralmente con el bloque de Yucatán, mientras que con la plataforma de Florida-Bahamas contactaba a lo largo de una fractura nombrada "falla transformante de Florida" (Moore & Del Castillo, 1974). La posición paleogeográfica de los sedimentos de la Formación San Cayetano (Jurásico ?Inferior—Oxfordiano Medio) y de sus equivalentes metamorfizados en Cuba, señalada aquí (Fig. 2) se diferencia de la asumida en algunos trabajos recientes (Anderson & Schmidt, 1983; Klitgord *et al.*, 1984; Ryabukhin *et al.*, 1984). En estos trabajos los sedimentos clásticos de la Formación San Cayetano se ubicaron a lo largo del margen septentrional del continente de la América del Sur. No obstante, la correlación de la Formación San Cayetano con los sedimentos clásticos metamorfizados de los grupos Caracas y Juan Griego en Venezuela no es cierta. La formación de la corteza oceánica en el área del Caribe fue iniciada ya en el Jurásico Medio, lo que se sustenta por el hallazgo de los ammonites del Bajociano—Bathoniano Inferior en el complejo ofiolítico de Siquisique en Venezuela (Bartok *et al.*, 1985). Algunas rocas del complejo ofiolítico en Cuba central estan datadas como 160 millones de años (Millán & Somin, 1982). Del análisis de los datos existentes resulta que la Formación San Cayetano en Cuba y los sedimentos clásticos de los grupos Caracas y Juan Griego en Venezuela se depositaron en distintos margenes continentales (Fig. 2).

Los movimientos horizontales del bloque de Yucatán se terminaron antes del Cretácico (Schlager *et al.*, 1984), probablemente en el Oxfordiano (Anderson & Schmidt, 1983). Una parte del área de Cuba también pudo estabilizar su posición paleotectónica antes del Kimmeridgiano. Al sur del margen continental de la América del Norte se extendía la nueva corteza oceánica creada a lo largo de una hipotética zona de expansión oceánica del Caribe (Moore & Del Castillo, 1974; Sanders, 1980). En el Kimmeridgiano, en Cuba occidental y central se depositaban los sedimentos carbonatados de facies somera (Fig. 3). En el Tithoniano este extenso banco carbonatado fue hundido y cubierto por los depósitos carbonatados periplatafórmicos y pelágicos de poco espesor. En la cuenca de Camajuaní se formaron los sedimentos periplatafórmicos de un espesor hasta de 300 m (Fig. 4). El material resedimentado en las calcarenitas provenía probablemente de la plataforma de Bahamas. En la secuencia de Placetas los sedimentos terrígenos y terrígeno-carbonatados del Tithoniano se formaron sobre el supuesto basamento granitoide-metamórfico (Pszczółkowski, 1986). En la Sierra de Camaján (Fig. 1) las calizas tithonianas(?) de la secuencia de Placetas sobreyacen a los basaltos toleíticos (Iturralde & Marí, 1984).

Schlager *et al.*, (1984) plantearon una conexión marina profunda entre el Golfo de México y el Atlántico durane el Jurásico—Neocomiano a través de Cuba. Esta conexión fue establecida ya en el Oxfordiano Medio o Tardío, pero durante el Kimmeridgiano no funcionaba, pues los sedimentos con ammonites de esta edad no se conocen en Cuba. La cuenca del Caribe comunicaba directamente con el Golfo de México durante el Tithoniano, porque en Cuba occidental y central existen los sedimentos carbonatados de esta edad, con ammonites y tintínidos (Kantchev *et al.*, 1978; Pszczółkowski, 1978, 1982).

En el Cretácico Inferior (Pre-Aptiano), al sur de la plataforma de Florida—Bahamas y al este de Yucatán se depositaban los sedimentos pelágicos con intercalaciones de turbiditas (Fig. 5). El material clástico fue transportado desde NW, es decir, del bloque de Yucatán. En Cuba oriental los sedimentos metamorfizados de la edad tithoniana-infracretácica se conocen en la Sierra del Purial (Millán *et al.*, 1984). Las rocas más antiguas del arco volcánico en Cuba y La Española fueron datadas paleontológicamente como el Aptiano—Albiano; no obstante, en Cuba central la parte inferior de la potente secuencia volcánica pre-cenomaniana no contiene fósiles. Algunos autores han sugerido incluso la edad Jurásico Superior de estas rocas volcánicas más antiguas en Cuba, sin embargo, no se presentaron datos concretos al respecto. Aquí se acepta la idea de que la actividad del arco volcánico Zaza fue iniciada en el Cretácico Temprano. Se expresaron diversas opiniones sobre la supuesta posición de zona de subducción en Cuba durante el Mesozoico (Malfait & Dinkelman, 1972; Iturralde-Vinent, 1975; Mattson, 1979; Haydoutov, 1984). Varios elementos de la estructura geológica de Cuba apoyan una u otra de las hipóteses contradictorias sobre el buzamiento de la antigua zona de subducción y por el momento sería difícil eliminar una de ellas. Sin embargo, los datos existentes sobre la edad del metamorfismo de las secuencias sedimentarias en Cuba (Somin & Millán, 1981; Millán *et al.*, 1984; Pszczółkowski, 1984) no son compatibles con el concepto de dos zonas de subducción sucesivas y con buzamientos opuestos entre el Jurásico Superior y el Cretácico Inferior (Mattson, 1979).

El proceso de generación de la nueva corteza oceánica en la parte noroccidental del Caribe pudo continuar hasta el Cenomaniano(?). Dicha posibilidad se basa en la presencia de los basaltos toleíticos en el área de Bahía Honda, en Cuba occidental (Fonseca & Zelepugin, 1981; Zelepugin *et al.*, 1982). Las secuencias vulcanógeno-sedimentarias con basaltos toleíticos de Cuba occidental tienen algunos rasgos comunes con la Formación Dumisseau en Haití, considerada como el fondo del Mar Caribe emergido en el Terciario (Maurrasse *et al.*, 1979).

Streszczenie

PALEOGEOGRAFIA I EWOLUCJA PALEOTEKTONICZNA KUBY I OBSZARÓW SĄSIEDNICH W JURZE I WCZESNEJ KREDZIE

Andrzej Pszczółkowski

W pracy są przedstawione główne rysy paleogeografii i paleotektoniki Kuby w jurze i wczesnej kredzie na tle ewolucji obszaru karaibskiego. W jurze środkowej i w oksfordzie utwory formacji San Cayetano na Kubie i osady klastyczne grup Caracas i Juan Griego w Wenezueli osadziły się na różnych brzegach kontynentalnych. Skorupa oceaniczna zaczęła powstawać w basenie karaibskim już w jurze środkowej. Połączenie między Atlantykiem i Zatoką Meksykańską przez obszar Kuby istniało od oksfordu środkowego lub późnego. Działalność wulkaniczna w rejonie Wielkich Antyli (Kuba, La Española) była związana z subdukcją skorupy oceanicznej, której początek można określić na wczesną kredę (przed aptem).