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Artikel: Contribution to the geology and paleontology of the area of the city La Habana, Cuba, and its Surroundings

Autor: Brönnimann, Paul / Rigassi, Danilo

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group in the middle to eastern part of the Habana area with predominantly clastic calcareous sediments. The brown shales occasionally referred to by PALMER as "Dirty shale" member of the Habana formation, were regarded as an intermediate facies between the western "El Cano" and the eastern "Big Boulder Bed" lithologies. The diagram explains further that the Habana formation is lithologically heterogeneous. It shows correlations between sediments of different environments and from different areas, which at the time they were proposed could not be supported by fossil evidence (PALMER, 1934, p. 131). In 1945, PALMER (p. 12) changed his idea of the Habana formation and recognized in its eastern development only 3 members by dropping the Chalk member. In this paper he did not mention any longer the "Dirty shale" equivalent of the Big Boulder Bed member.

Where subsequently the name Habana formation was mentioned, it never meant a well-defined formation with definite lithologic features but rocks of late Upper Cretaceous, mainly Maastrichtian age. PALMER (1942, p. 629) used Habana formation in exactly this age sense when he wrote: "The Maastrichtian in Cuba has been named the Habana formation from its well developed occurrences in Habana Province." He actually identifies the Maastrichtian stage with the Habana formation. The Habana formation therefore was regarded by PALMER, and later by some of the Dutch geologists as a time concept and not as a lithologic unit. THIADENS (1937) called Habana formation the shallow-water orbitoidal and rudistid limestones of Maastrichtian age of the Cienfuegos area, and VERMUNT (1937) applied the term Habana formation to the flysch-type deep-water sediments of Maastrichtian age of Pinar del Río Province.

Because the Habana formation is 1) a complex lithologic unit of wide stratigraphic and lithologic spread and 2) has been generally employed in a local stage sense, it is recommended to suppress it and to establish in its place 3 new lithologic units, viz. the pre-Vía Blanca beds of Cenomanian (?) to Turonian age, the Vía Blanca formation of Campanian to Lower Maastrichtian age, and the Peñalver formation of Upper Maastrichtian age. The name Habana, however, will still be used in the designation Habana group of formations. In our stratigraphic concept PALMER's El Cano shales are part of the Lower Eocene Capdevila formation.

Stratigraphic Summary

Habana group

As shown by the detail lithologic and environmental descriptions of its formations, the Habana group represents a flysch series (TERCIER, 1947; SUJKOWSKY, 1957) characterized by sedimentary features such as listed below:

1. Rapid alternation of sharply defined marine pelitic and psammitic layers. Psammitic layers are usually graded bedded, the coarser grains being at the bottom and the finer grains at the top of the bed.
2. Thick series of monotonous aspect.
3. Occasional intercalations of thin limestones and of conglomerates.
4. Penecontemporaneous folds and faults and erosional features caused by submarine slumping and turbidity currents reflecting unstable tectonic conditions in the source area.

5. Rapid vertical changes in faunal elements. Deep-water assemblages indicate the depositional environment. Shallow-water assemblages are accidental interlopers transported from the shelf.
6. Occurrence in calcilutaceous limestones of ichnocoenoses, and at the bottom surfaces of psammitic beds of infillings of animal tracks and of other erosional surface markings, such as the so-called hieroglyphs.

The Habana group ranges in age from early Upper Cretaceous to Lower Eocene and is subdivided from bottom to top as follows:

Pre-Vía Blanca beds—Maximum thickness about 20 m.
Probably unconformable on ultramafics. Olive gray, brownish and grayish silicified limestones, indurated siliceous shales, radiolarites and interbedded graywacke silts, tuffaceous and flow rocks. Ophicalcites at the base.
Age: Cenomanian (?) to Turonian.
—Major unconformity—
Gap of Coniacian to Santonian (Emscherian) age.

Vía Blanca formation—Maximum thickness about 500 m.
Unconformable on pre-Vía Blanca beds and probably locally also on ultramafics. Mostly reddish, brownish and greenish graywacke silts and sands, shales, and thin beds of white calcilutites. Thick lenticular intercalations (Bacuranao "limestone") of mainly fine-grained yellowish gray calcarenites and calcilutites with "clay" pebbles at base derived from underlying Vía Blanca beds. Lower part of Vía Blanca formation with grayish yellow tuffs, brownish and greenish bentonitic clays and some andesitic and porphyritic volcanics. Conglomerates with elements derived from intermediate igneous rocks, graywackes, radiolarites, limestones and marls occur at different stratigraphic levels within the Vía Blanca formation.
Age: Campanian, *Globotruncana linneiana* zone, to Lower Maastrichtian, *Rugotruncana gansseri* zone.

Peñalver formation—Thickness from 20 to 150 m.
Disconformable contact with Vía Blanca formation. Single graded cycle of mostly calcareous clastics. Overall color whitish when weathered, bluish gray when fresh. Basal portion generally with abundant subangular "clay" inclusions derived from the underlying Vía Blanca formation. Grain size at base from 5 mm to a few centimeters. Top hard calcilutite the clastic nature of which can only be recognized with the handlens or in thin sections. Geomorphologically forming dominant ridges. Exploited in numerous quarries. Common oil seeps.
Age: Upper Maastrichtian, *Rugotruncana mayaroensis* zone.
—Major disconformity—
Gap of Danian age.

Apolo formation—Maximum thickness about 100 m.
Transgressive on Peñalver formation. Reddish to brownish clays and graywacke silts and sands, and occasional igneous derived conglomerates.
Age: Lower Eocene, *Globorotalia angulata* zone.

Alkázar formation—Thickness about 10 to 40 m.

Transitional on Apolo formation. Greenish marls and chalks interbedded with hard, occasionally silicified well-cemented light-colored calcareous clastics and fragmental limestones. Geomorphologically forming minor ridges between the relatively softer Apolo and Capdevila beds.

Age: Lower Eocene, *Globorotalia velascoensis-Globorotalia membranacea* zone.

It seems that the Alkázar lithology can go locally as high as the *Globorotalia rex-Globorotalia formosa* zone.

Capdevila formation—Thickness from about 300 to 400 m.

Disconformable to transitional on Alkázar formation. Well-bedded brownish to orange shales and graywacke silts and sands. Subdivided into 4 lithologic parts. In the lower part, shales and graywacke silts better developed than graywacke sands; in the type part, the amount of finer sediments about equal to that of the coarser ones. The upper part of the formation characterized by greater development of the coarser beds and by some conglomerates. In this upper part, the graywacke sandstones contain large indurated concretions. The uppermost part of the formation consists of cream to brownish shales, graywacke silts and sands and some marly beds forming the lithologic transition to the carbonate facies of the Universidad formation, Marianao group.

Age: Lower Eocene.

Lower part or Unit I:	*Globorotalia rex-Globorotalia formosa* zone.
Type part or Unit II:	*Globorotalia broedermanni-Globorotalia pseudoscitula* zone.
Unit III:	No diagnostic microfossils.
Uppermost part or Unit IV:	*Globorotalia palmerae* zone.

Marianao group

The younger series of formations, the Marianao group, consists mainly of carbonates ranging in age from Lower Eocene to Pleistocene. Post-Cojímar formations, which are not distinguished in the interpretive geological map (plate II) are restricted to the coastal belt and to the Vento syncline. These young beds were not studied in the same detail, but certain new formation names and type localities will be proposed. The new formations are mentioned in the stratigraphic chart to show our opinion on age and correlation (plate I). This presentation is tentative and probably subject to changes after completion of mapping, lithologic studies and identification of megafossils.

The oldest formation of the Marianao group, the Universidad formation, is resting either transitionally or unconformably on the Habana group. Most of the carbonate formations are separated by unconformities or disconformities corresponding sometimes to considerable time gaps. They are often difficult to recognize in the field because of the similar overall lithologies of some of the formations. This difficulty is increased by the possibility to confound discordant formation boundaries with intraformational breaks. The unconformity between the Universidad formation and younger beds for instance, indicates one of the most pronounced sedimentary gaps of the Marianao group. A distinct unconformity occurs also between the Pleistocene and older beds. South of Playa de Guanabo, a small coastal town about 17 km east of Cojímar, Pleistocene calcarenites are resting with a strong angular unconformity on Vía Blanca beds.

The Marianao group consists of the following formations listed below from bottom to top:

Universidad formation—Maximum thickness about 50 m.

Transitional or transgressive on older beds. The formation is divided into two members. The lower, here called Toledo member, consists of white to greenish chalks and silicified limestones. The upper, here called Príncipe member, is a whitish to yellowish chalk.

Age: Lower Eocene, *Globorotalia palmerae* zone and *Globorotalia bullbrooki-Globorotalia aragonensis* zone, to Middle Eocene, *Hantkenina mexicana-Globorotalia aragonensis* zone and *Hantkenina dumblei-Globigerinatheka barri* zone.

—Unconformity—

Urría beds—Residual thickness 2 to 3 m.

Unconformably on older formations. Thin-bedded yellowish dolomitized limestones. Restricted to channel-like depressions.

Age: Probably Middle Eocene.

—Unconformity—

Punta Brava formation—Thickness 23 m.

Unconformable on Capdevila formation. Brownish calcareous silts and yellowish limestones. Toward the top whitish chalks.

Age: Upper Eocene. Upper part of *Globigerapsis semiinvoluta* zone.

—Unconformity—

Gap coincides with *Globorotalia cerroazulensis* zone.

Consuelo formation—Maximum thickness about 20 m.

Unconformable on older formations. Massive whitish to yellowish chalks with few thin shaley layers. Basal beds often slumped with reworked pre-Consuelo elements. Barite concretions.

Age: Oligocene, *Globigerina ampliapertura* zone to *Globigerina ciperoensis-Globorotalia opima* zone.

—Unconformity—

Husillo formation—Maximum thickness less than 25 m.

Unconformable on older formations. Whitish, massive and fragmental limestones, reefal and reefal derived limestones, yellowish chalky marls and chalky limestones. Locally conglomeratic, with igneous and sedimentary components.

Age: Oligo-Miocene, *Globigerina ciperoensis-Globorotalia opima* zone to *Globigerinatella insueta* zone.

Cojímar formation—Maximum thickness up to 50 m.

Unconformable or conformable on older beds. Yellowish whitish powdery chalks with irregularly constricted chalky limestone beds and algal limestones.

Age: Miocene, *Globorotalia fohsi* zone.

Post-Cojímar beds.

The following post-Cojímar beds are distinguished:

Güines formation: Type locality has not been established for the whitish to yellowish, massive, hard, crystalline, cavernous, dolomitic limestones which

are weathering to a lateritic soil. Pseudoölitic textures, algae, shallow-water megafossils and common peneroplids, often embedded in a clear calcite groundmass suggest restricted environments. Limestones of this type were encountered in the Vento syncline, where they rest unconformably on Husillo beds.
Age: post-Cojímar, Miocene or younger.

Rosario formation: Type locality is in the large quarry west of Santa María del Rosario, coordinates 359.00 N and 369.80 E. Whitish, conglomeratic marly chalks and yellowish to pale yellowish orange chalks. Common megafossils. Unconformably on Husillo beds (type locality) or on Capdevila beds (Arroyo Naranjo).
Age: Late Miocene, *Globorotalia menardii* zone.

Cangrejeras formation: Type locality in the large quarry east of Cangrejeras, a small village between Punta Brava and Sante Fé. Lower part whitish massive chalky limestones, upper part thin-bedded chalky limestones separated by very thin chalk layers. Solution cavities filled with limonitic clay. Megafossils. *Operculinoides cojimarensis* (D. K. PALMER) near Baracoa. Possibly transitional on Cojímar beds.
Age: post-Cojímar, Miocene or younger (pre-Pleistocene).

Vedado formation: Type locality at the Hotel Nacional, forming the northern cliff toward the Malecon. Whitish reefal limestones with large corals and other megafossils. Also reefal limestone of rubbly appearance. Weathering to lateritic soil.
Age: post-Cojímar, Miocene or younger (pre-Pleistocene).

Morro formation: Type locality in the western corner of the artificial basin made for the construction of the road tunnel under the Bahía de la Habana, on the north side of the entrance to the Bahía de La Habana, between Morro castle and the Fortaleza de la Cabaña. Yellowish to whitish indurated algal limestones and recrystallized chalks with calcite crusts. Common pelecypods. Resting transgressively on Cojímar beds. Dr. WOODRING (letter Jan. 4, 1961) reported *Lyropecten* (*Nodipecten*) aff. *L. colinensis* (F. and H. HODSON) from outcrops west of Casa Blanca and at foot of southern wall of the Fortaleza de la Cabaña. This pelecypod suggests a Pliocene age for the Morro formation.
Age: Probably Pliocene.

Jaimanitas formation: Type locality abandoned quarry near La Areca, Biltmore area, just north of the Biltmore Golf Club. Cotype locality lower calcarenite of road cut of the Habana–Mariel highway west of Santa Fé. Whitish to yellowish indurated calcarenite with abundant peneroplids and algal fragments. Thin-bedded, occasionally cross-bedded. Also shell beds, conglomerates and reefal deposits associated with calcarenites in the Jaimanitas–Biltmore–Miramar area, and coral formations forming the actual dog tooth-weathered beach terraces.
Age: Pleistocene, *Archaias angulatus* zone.
Santa Fé formation: Type locality upper calcarenite at the above mentioned road cut at the Habana–Mariel highway just west of Santa Fé. Whitish to

yellowish thin-bedded and cross-bedded calcarenite, separated from the underlying Jaimanitas calcarenite by a fossil soil horizon and calcite crusts indicating emersion period. Separated from recent lateritic soil by calcite crusts. Less indurated than the Jaimanitas calcarenite, with abundant algal fragments and peneroplids. Forming dune-like hills parallel to the shore.
Age: Pleistocene, *Archaias angulatus* zone.

Casa Blanca formation: Type locality at the post office of Casa Blanca, a small town on the north coast of the Bahía de la Habana, opposite the old part of La Habana. "Nodular" weathering whitish, chalky calcarenite with abundant peneroplids and megafossils, in particular echinids and pelecypods. The conglomeratic deposits with a reddish calcarenaceous matrix apparently resting unconformably on the Morro formation to the west of the type locality form part of the Casa Blanca formation.

Dr. WOODRING (letter Jan. 4, 1961) identified the following typically Pleistocene gastropods and pelecypods from the type locality of the Casa Blanca formation:

Modulus modulus (LINNÉ)
Strombus sp., fragment
Natica (*Naticarius*) *canrena* (LINNÉ)
Polinices lacteus (GUILDING)
Vasum muricatum (BORN), immature
Bulla occidentalis A. ADAMS ?
Pecten laurentii (GMELIN) ?
Aequipecten gibbus (LINNÉ)
Aequipecten gibbus nucleus (BORN)
Ostrea equestris SAY ?
Chama macerophylla GMELIN
Trachycardium muricatum (LINNÉ)
Trigoniocardia (*Americardia*) *medium* (LINNÉ)
Lirophora paphia (LINNÉ)
Age: Pleistocene, *Archaias angulatus* zone.

Serpentinites, diorites and associated igneous rocks

The only significant outcrops of serpentinites in the Habana area are along the east–west striking ridge from Regla, east of the Bahía de la Habana, to Guanabacoa and to Residencial Guanabacoa and extending farther east (plate II). Sections across this serpentinite body about 1 km west of Residencial Guanabacoa at the continuation of the Avenida Monumental are shown in fig. 1. Small east–west trending serpentinite bodies occur north of San Francisco de Paula and southwest of Santa María del Rosario. The main part of these rocks is formed by peridotite (harzburgite) which underwent medium to strong serpentinization which mostly affected the olivine. The bronzite and enstatite are usually fairly well preserved. The centers of many of the subangular to subrounded serpentinite "boulders", preformed through the original diaclasic fracture system of the peridotite mass, consist of peridotite. In good outcrops, 5 to 50 cm large "boulders" of relatively