Alcuni stimolanti spunti per dedicarsi allo studio della Placca Caraibica.

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Da oltre venti anni la Placca Caraibica costituisce una delle più affascinanti palestre per lo studio dell'evoluzione di un relativamente piccolo settore litosferico sotto una più moderna visione della "tettonica a zolle".
Non a caso, superate una serie di difficoltà di ordine geografico, politico, culturale, bibliografico etc, un gruppo non particolarmente numeroso di geologi di varie nazionalità, talora riuniti sotto l'egida dell' IGCP- International Geological Correlation Program, hanno dedicato molto tempo alla comprensione della geologia di queste regioni, tentando ancora oggi di ricostruirne l'evoluzione tettonica e geodinamica attraverso la soluzione degli innumerevoli problemi che la Placca Caraibica presenta. Insieme ad alcuni colleghi italiani, minoritari numericamente, si è cercato di contribuire al miglioramento delle conoscenze nei vari settori di competenza.
La nota che segue, in verità un poco "individualista", pur nella sua brevità e senza la pretesa di fornire una sintesi completa della Placca Caraibica, vuole delineare uno stato del dibattito scientifico in atto nella regione, ed in particolare fornire ad una più vasta platea uno stimolo ad affrontare problematiche multidisciplinari. Ciò in una regione che, oltre a possedere un singolare fascino paesaggistico e umano, rappresenta uno dei migliori laboratori naturali al mondo per ricerche di base ed applicate (es. rischi naturali) nel campo delle Scienze della Terra, in particolare utilissime ad una nuova e più incisiva didattica nel nostro Paese.

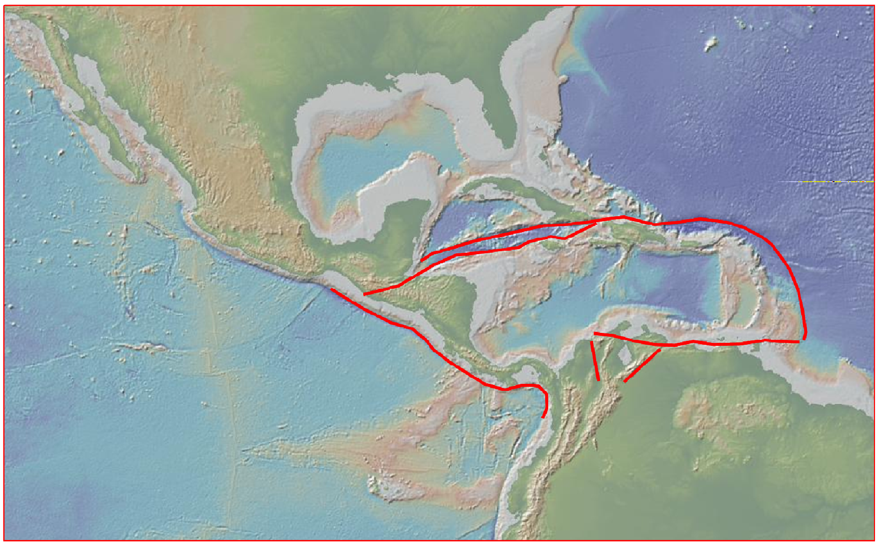

Fig.1 – The present day Caribbean Plate and its margins.

The Caribbean Plate: some informations.
The Caribbean Plate (fig. 1) is today an independent lithospheric element of more than 4 Mkm2, composed by the un-deformed or less deformed Cretaceous oceanic plateau of Colombia and Venezuela Basins (almost 1 Mkm2), and the Palaeozoic-Mesozoic Chortis continental block (about 700,000 km2) , both bounded by deformed marginal belts (about 2,3 Mkm2), resulting from the Mesozoic to Present interactions with the adjacent Nazca, Cocos, and Americas Plates. The northern (Guatemala and Greater Antilles) and southern

(northern Venezuela) plate margins mainly consist of collisional belts (shear zones), while the western (Central America Isthmus) and eastern (Lesser Antilles) ones are represented by convergent systems and related magmatic arcs, all involving ophiolitic terranes which represent about 40-50% of the belts.
The Caribbean lithosphere has been deformed and tectonically emplaced over the Pacific and Atlantic oceanic crusts producing the western and eastern arc systems of the Central American Isthmus and Lesser Antilles. It has also been squeezed against the North and South American continental crusts thereby originating suture zones in the Cordilleras of Guatemala, Greater Antilles and Venezuela.
The Caribbean Plate margins include several terranes, in particular Jurassic-Cretaceous ophiolitic complexes, exposed along suture zones or as accreted terranes on the northern, southern and western sectors of the plate, and subordinately in the eastern one (figg.2, 3).

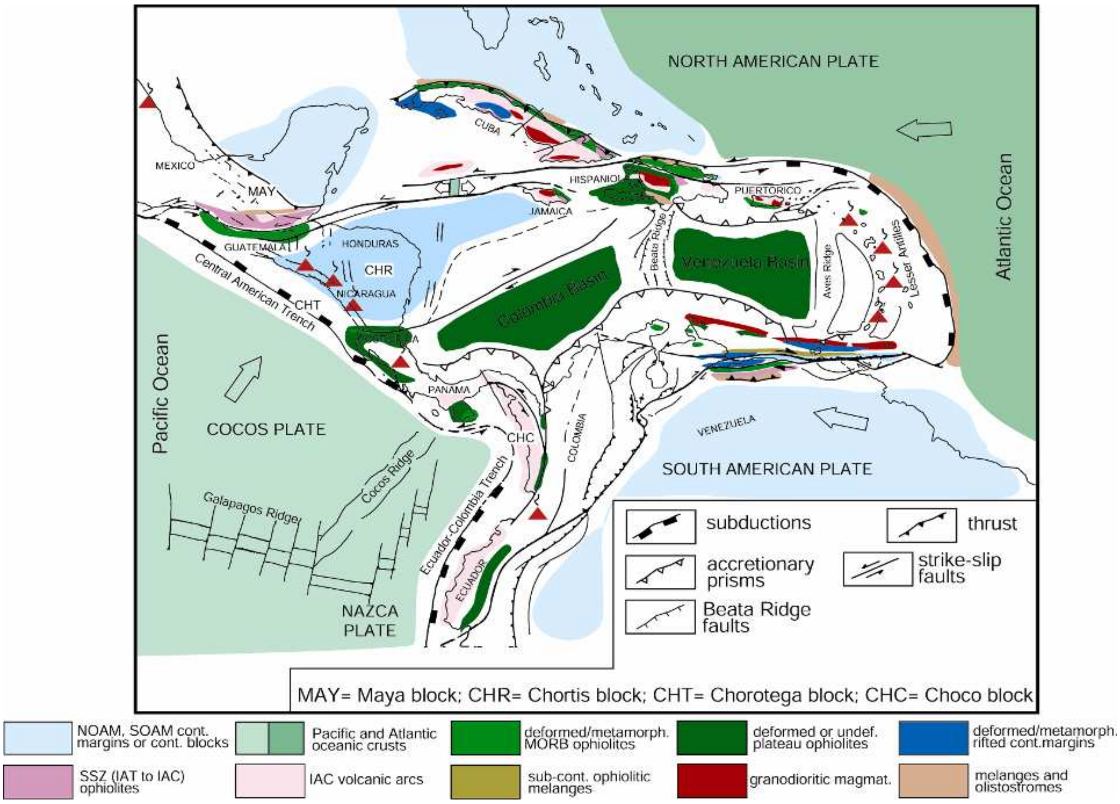

Fig.2 – The main elements characterizing the Caribbean Plate.

From the Jurassic-Early Cretaceous until the Present times, the Plate evolution was realized through spreading or plume, accretionary and collisional tectonics, dominated by a strongly oblique tectonic regime, constraining seafloor spreading, subduction, crustal exhumation, emplacement, and dismembering processes, the evidence of which has been recorded in the oceanic remnants of a lost Large Igneous Province (LIP).
At the moment, even if the acquired facts can be considered enough for an evolution outline, a lot of different order problems remain open or insufficiently explained, so that the related models seem to be far too speculative.

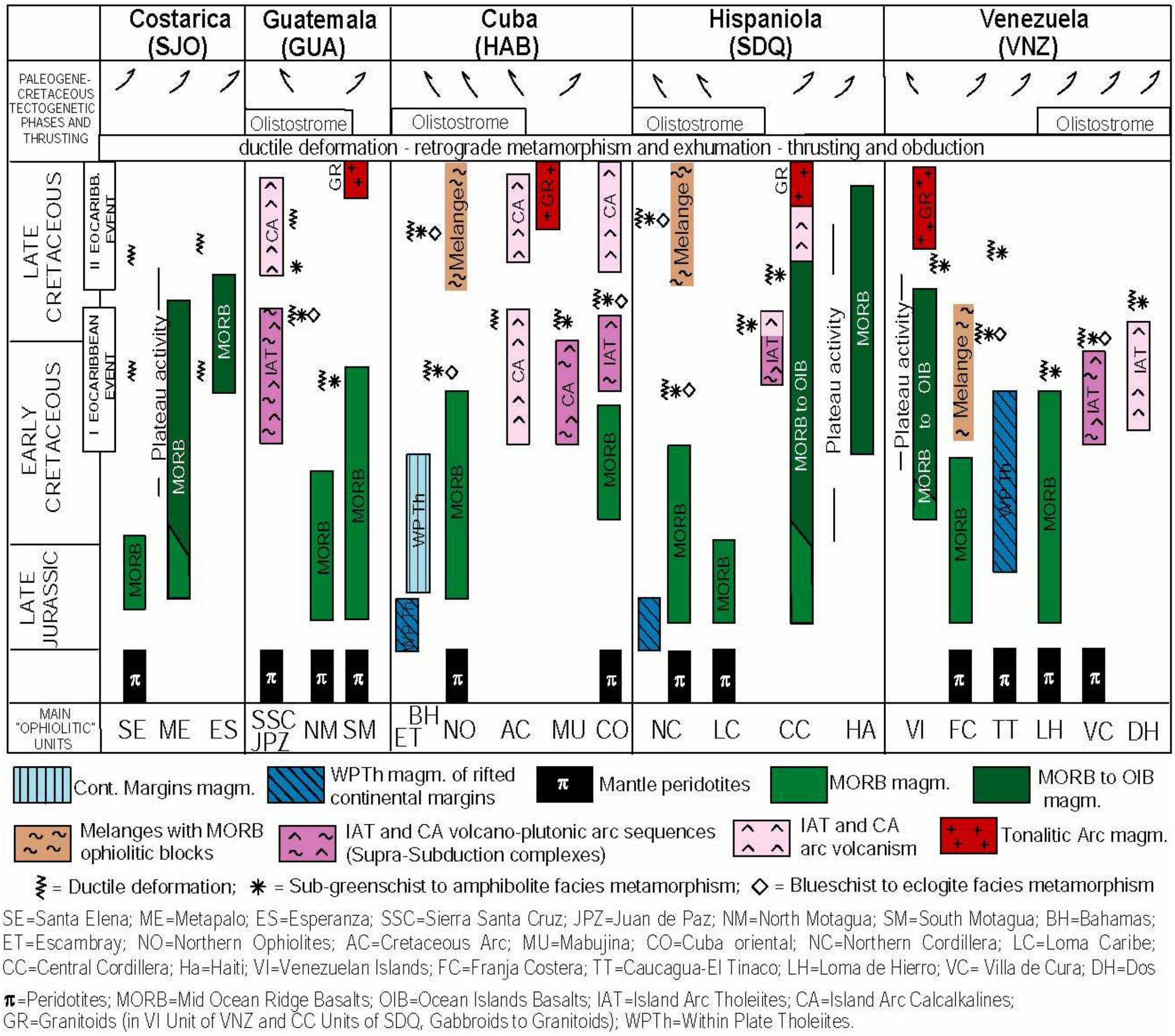

Fig.3 – Regional correlations between the main tectonic units outcropping in the plate margins.

Oceanic crust was generated at multiple spreading centres during the Jurassic and Early Cretaceous, forming the “proto-Caribbean” ocean. During the Cretaceous, part of that crustal domain thickened into an oceanic plateau, of petrologic Mid-Ocean Ridge (MOR) to Ocean Island Basalt (OIB) affinity. Simultaneously, the South and North American continental plates developed rifting and tholeiitic magmatism, which created space for the “proto-Caribbean” oceanic domain. These facts should demonstrate a “near mid-American” original location of the “proto-Caribbean” ocean, even if their growth steps and size are poorly known, differently from the “Pacific” origin model.

Petrological and tectonic regional correlations suggest that the “proto-Caribbean” crust was involved into two main stages of subduction, referred to as first and second “eo-Caribbean” stages of Giunta (1993).

Starting from the Early Cretaceous, the South Atlantic opening and related westward and north-westward motion of the American plates led to ocean-ocean and ocean-continent plate convergences (1^ “eo-Caribbean” stage), producing several SSZ and magmatic arcs (fig. 4).

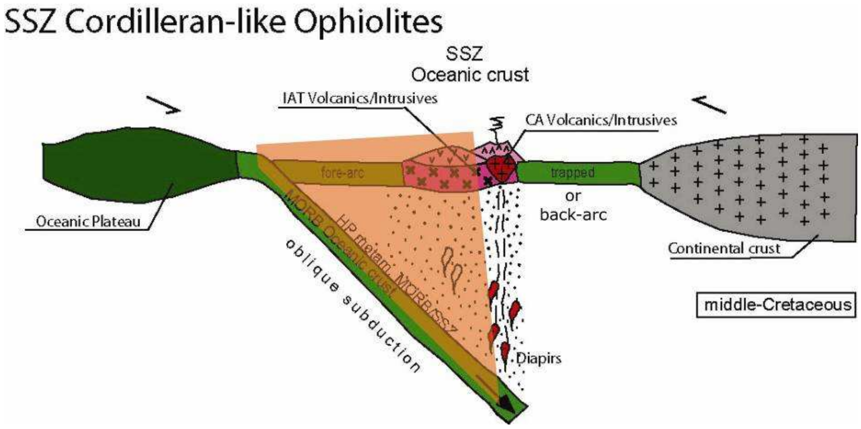

Fig.4 – Schematic cross-section across the intra-oceanic subduction zones of the 1^ eo-Caribbean stage (middle-Cretaceous).

Evidence of involvement of the proto-Caribbean oceanic lithosphere in subduction zones is also represented by the HP/LT metamorphosed units, outcropping in the peri-Caribbean terranes, related to an ocean-ocean subduction or subordinately to an ocean-continent subduction. Moreover, portions of the previously rifted continental margins were also involved in the subduction zones, reaching in places the eclogite facies. This oldest intra-oceanic convergence can be supposed to affect the eastern sector of the proto-Caribbean domain, where the thinner portions of the oceanic lithosphere were in more favourable conditions to be subducted, while at the same time the western sector was undergoing progressive crustal thickening, ultimately (Late Cretaceous) leading to a well defined oceanic plateau structure.

Some important problems should be resolved, as : (1) the ocean floor or back-arc pertinence of the MOR-type ophiolitic units, (2) the mid-Cretaceous location and the subduction directions of either ocean-ocean or ocean-continent convergences, and subordinately (3) both the volcanic arc complexes and thinned continental crusts involvement in subduction zones.

The whole geological data confirm that the first “eo-Caribbean” accretionary stage ends in the Late Cretaceous, when the un-thickened oceanic crust was involved in subduction below the thicker oceanic plateau, with a likely westward sinking of the lithospheric slab (2^ “eo-Caribbean” stage).

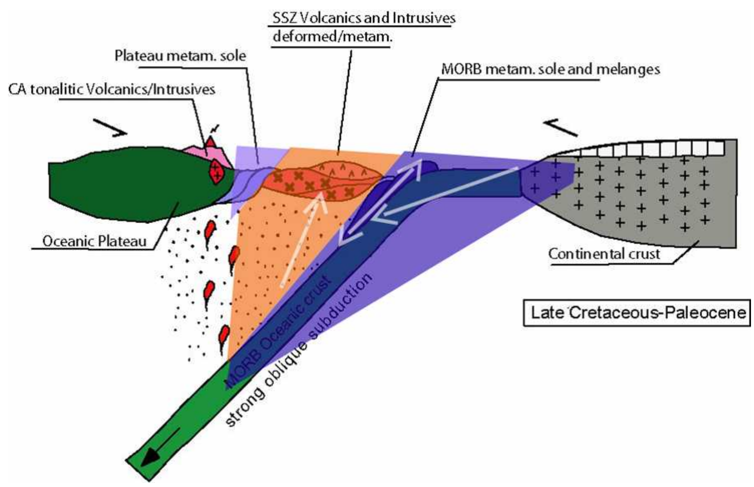

Fig.5 – Schematic cross-section across the northern Caribbean accretionary sistem of the 2^ eo-Caribbean stage (Late Cretaceous), also showing metamorphism and deformation in a strike-slip tectonic regime.

This implies a flip of the intraoceanic subduction direction or a continuous westward subduction, depending from the previos subduction direction in different models (fig. 5). At that time, the kinematics of the Caribbean plate is closely related to the eastward drifting of the “proto-Caribbean” oceanic plateau (Colombia and Venezuela Basins) that produced both a diachronous tonalitic magmatism (onset of the Aves - Lesser Antilles arc system), and an opposite dismembering of subduction complexes of different ages along an E-W trend (north and south Caribbean margins).

The Late Cretaceous-to-Present geodynamics of the Caribbean plate has been mainly driven by the eastward drift of the Caribbean plateau with respect to the North and South America plates, with the consequence that it has been trapped in the Colombia and Venezuela basins by the intervening Atlantic and Pacific subductions and related volcanic arcs, producing eastward the Aves-Lesser Antilles arc, and westward the Central American Isthmus as a mosaic of different blocks reciprocally juxtaposed and facing the Middle American Trench (fig. 6).
This seems to be the consequence of the eastward shifting of two triple junctions, allowing to the progressive bending of the Aves- Lesser Antilles arc. Westward, the Caribbean oceanic plateau was trapped by different rotation rates of the Chortis, Chorotega and Choco blocks during the construction of the western plate margin (Central American Isthmus).

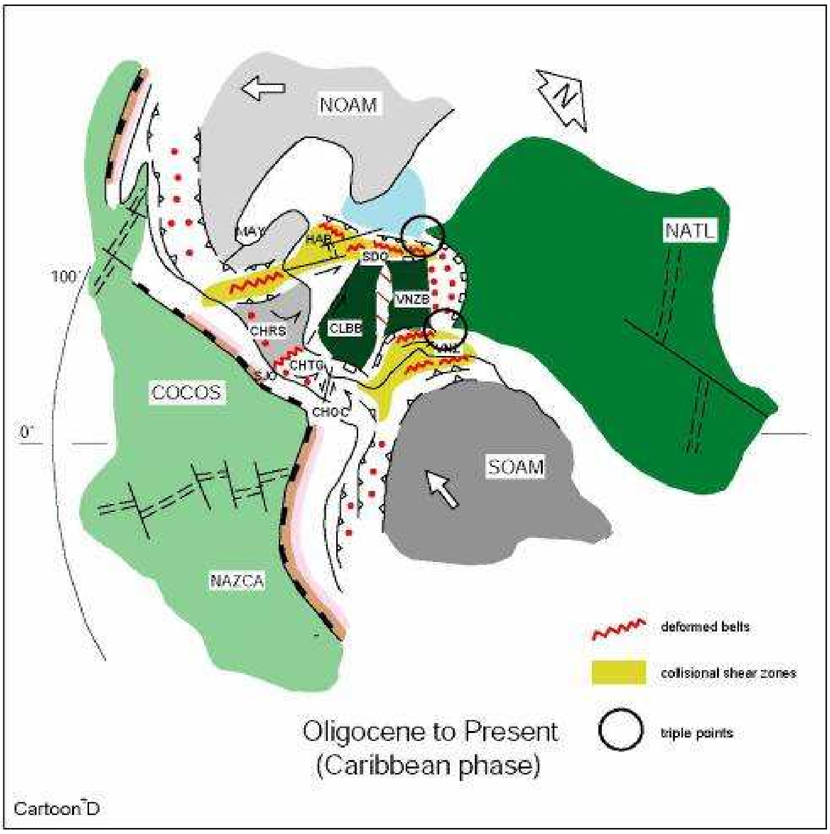

Fig.6 – Cartoon showing the Caribbean Plate evolution from the Oligocene.

As a result, both the northern and southern boundaries of the Caribbean correspond, since the Late Cretaceous, to two wide shear zones, where, during Late Cretaceous-Tertiary, large-scale tear faulting, still extensively active (e.g., Motagua fault in Guatemala, El Pilar fault in Venezuela), favoured eastward dispersion and uplifting of the previous subductionaccretion systems. During the collisional events the main structural elements (terranes) of the present-day Caribbean were essentially established in the Paleocene onwards. Fore- or back-arc and piggy-back basins, on the deforming plate borders, were filled by clastic sediments and volcanoclastics. On the northern and southern continental margins, thrust belt-foredeep couples began to develop, involving previously deformed terranes along north- or south-verging fronts (Sepur Basin in Mexico-Guatemala; Foreland Basin in Cuba; Piemontine Basin in Venezuela).

The proposed kinematic models seem to be based much more on unresolved problems than on recognized facts. In particular, the major disagreements currently concern: (1) the original location of the “proto-Caribbean” oceanic realm, if “Pacific” or “near mid.American”; (2) the Early Cretaceous paleogeography and morphology of the margins of the North and South American continents and minor blocks; (3) the polarity of the Cretaceous subduction zones; (4) the locations of and relationships between simultaneous intra-oceanic and sub-continental subduction zones, as well as (5) the progressive insertion (by tectonic erosion ?) of both rifted continental portions and supra-subduction complexes in the subduction slab; (6) the possibility of a subduction polarity reversal; (7) the number of magmatic arcs.
A number of these open-problems need continuous researches and discussions in a multi-disciplinary point of view in the aim to improve the knowledge of the Caribbean Plate geology.