

SECCION / SECTION II

**SIMPOSIO GEOLOGIA
DEL CARIBE OCCIDENTAL**

**SIMPOSIUM GEOLOGY
OF WESTERN CARIBBEAN**

MODELO GEOFISICO Y ESTRUCTURAL (CONCEPTUAL) DE LA PARTE SEPTENTRIONAL DE LA REGION CARIBE-MEXICANA
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Basados en una serie de mapas esquemáticos confeccionados por los autores a escala 1:2 500 000, el isobatimétrico, el de las anomalías magnéticas y gravitacionales, el del relieve de la superficie de Mohorovicic y de otros, así como su ulterior elaboración con los métodos del modelaje matemático y su reducción geológica, se exponen los modelos gravitacional y de las heterogeneidades de la densidad y magnéticas de la parte septentrional de la región Caribe-Mexicana, que incluyen la parte oriental de la península de Yucatán, la parte occidental de la Española (Haití), de las islas de Cuba y Jamaica, de la península de la Florida y de los mares que las separan. El modelo estructural (conceptual) contiene los principales elementos geotectónicos de la región, que se formaron, según la opinión de los autores, como resultado de la destrucción inicial por procesos de riftogénesis de la parte central del continente mesoamericano prejurásico y por los procesos posteriores de compresión y distensión en su unidad geodinámica. Durante este proceso, las suturas hiperbasálticas en su etapa inicial de formación se entienden en calidad de fallas transcurrentes como dinamopares, ortogonalmente a los rifts que se separaban. Los bloques metamórficos y los cinturones de Yucatán oriental y Cuba meridional, se formaron en la zona de interacción de las estructuras continentales y suboceánicas, que consisten en sí en los llamados prismas "seudoacrecionales". El magmatismo básico es característico para las etapas de la destrucción por riftogénesis y el andesítico-basáltico, para las etapas de compresión-distensión y de la subducción parcial sincrónica con el metamorfismo de los prismas pseudoacrecionales. El territorio de Cuba se considera como un margen continental con la dirección primaria nororiental de las estructuras premesozoicas, destruida y transformada por los procesos de la apertura de los rifts del Triásico y posteriores al Triásico, la sedimentación, la subducción parcial, el diapirismo del manto y de los fenómenos magmáticos y tectónicos que lo acompañan.

GRAVITY FIELD OF THE CARIBBEAN REVISITED

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In the intervening 12 years since the publication of my Geologic Society of America Special Paper 169: CARIBBEAN GRAVITY FIELD AND PLATE TECTONICS, much new gravity data has been obtained. A new compilation of these data is presented, and aspects of the geoid, gravity, and gravity gradient anomalies of the Caribbean region are discussed. In addition, the gravity field of the Caribbean is compared and contrasted with patterns of gravity anomalies observed over the whole of the earth.

GEOLOGICAL POSITION OF CUBA IN CARIBBEAN REGION

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Cuba, except its northern part, is situated in the limits of folded belt of Great Antilles. Here where Jurassic, Cretaceous, Paleogene and Neogene deposits are spread and, except Neogene, are variously dislocated. From west to east along geosynclinal troughs the age zonation is well indicated. It is reflected in display of metamorphism -- from Jurassic in the west to Cretaceous in the east. The location of intrusives from Cretaceous in the west to Eocene in the east. In volcanic activity -- from Cretaceous to Neogene and on Small Antilles being in volcanic activity the present time. In the south-western direction the folded belt continues to the eastern shore of the Central America where it is connected with the Pacific structures of Peten belt. Westward and northward of the belt there are the following structures: Yucatan platform formed by horizontally laying Cretaceous, Paleogene and Neogene deposits having the thickness up to 2,5 km and represented by

limestones and dolomites which probably overlie Paleozoic. The Eastern part of Mexico Gulf is formed by limestones of Cretaceous (up to 564 m), Paleogene and Neogene (up to 280 m). They disconformably overlie old gneisses (500 m.y.) and diabases (160-190 m.y.). Bahamas platform is entirely formed by limestones, dolomites and bands of anhydrites of Cretaceous (up to 4,5 km), Paleogene and Neogene (up to 1,2 km) ages probably overlaying terrigenous Jurassic deposits. We may judge about the geological structures southward of the belt only by morphology of the bottom of the Caribbean sea and geophysical investigations. Geophysical data on Yucatan basin suggest its structure to be similar to Venezuela basin. Probably Caiman ridge is the continuation of Sierra Maestra in Cuba, and it has analogous structure. A part of Caiman through adjacent to Cuba, is formed by sedimentary, volcanic and igneous rocks both of ultrabasic and acid composition of Cretaceous, Paleogene and Neogene ages.

A GEODYNAMIC STUDY OF THE CARIBBEAN REGION

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A modern understanding of the plate tectonics simultaneously with global reconstructions urgently requires a regional geodynamic study. An objective of such investigations is to interpret geodynamic and paleogeographic conditions of formation of concrete structural elements of the Earth's crust in different regions, to substantiate theoretically a mineral specialization of lithologo-structural complexes with different geodynamic nature, to identify on this basis regularities of mineral distribution and to work out predictive recommendations. For the last years methods of compilation of geodynamic maps of 1:2 500 000 to 1:500 000 scale have been developed in the USSR. The methods are based on complex formational-paleogeographic, structural-geological, spacegeological, geophysical, geochemical and paleomagnetic investigations, on model computer calculations and man-machine predictions. At present specimens of legends and compiled geodynamic maps are shown. A geodynamic mapping of the Caribbean regions promises new data valuable in theoretical, regional-geological and applied aspects. In conclusion examples of geodynamic compilation done in the Caribbean regions are demonstrated. The compilations show the interaction of Pacific, North and South American lithosphere plates. A complex accretion structure of the Antilles arc and Central American isthmus is conditioned mainly by processes which accompany subduction of the oceanic crust and accretion of fragments of island arcs and terrains of other nature over a subduction zone.

IGNEOUS HISTORY OF THE CARIBBEAN

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The oldest igneous rocks of the Caribbean are basalts and mafic intrusive rocks. Jurassic basaltic rocks of Venezuela and Costa Rica, probably Cuba and possibly northern Hispaniola and Puerto Rico, belong to the spreading phase following the separation of North America from South America -- Africa in the early Jurassic. Basaltic rocks drilled in the Venezuelan and Colombian basins during Leg 15, DSDP, and found virtually everywhere around the Caribbean are dominantly Aptian -- Santonian (younger in the west) and belong to the Cretaceous Caribbean basalt event, which is a major oceanic-plateau or flood-basalt event. This event formed during a time when North and South America were diverging but the Farallon plate was converging from the west. A major problem is to determine which, if any, basaltic rocks of Guatemala, Belize (subsurface), Cuba, and northern Hispaniola belong to this association. The earliest island-arc association of the Caribbean is approximately coeval (Aptian -Coniacian) with the basalt event and evidently formed as an island arc bordering the Caribbean basalt province; its trend became the proto-Antillean arc. This arc was

characterized by submarine activity in the absence of major compressive stresses. Only limited sediment was subducted and the island-arcs are dominantly chemically primitive with low contents of radiogenic lead and other characteristically sedimentary minor elements. This association is well known from Hispaniola to the Virgin Islands, and on Tobago and Bonaire, which represents the southern end of the proto-Antillean arc. The cessation of north-south inter-American divergence in approximately the Santonian caused a major change in igneous geology. At this time compression, resulting largely from the convergence of the Farallon plate, caused active subduction. Subducted sediments were chemically involved in later Cretaceous normal calc-alkaline volcanism; associated sediments were thick and coarse. The Caribbean plate moved eastward, and the proto-Antillean arc was severed, with the smaller southern part partly obducted on to South America and the northern part becoming the Greater Antilles. Eastward movement of the Caribbean plate during the Paleogene was accompanied by diminished north-south stress, cessation of compressive subduction and calc-alkalic volcanism, and the occurrence of numerous rift-associated sub-alkaline to alkaline volcanic occurrences. Although the Wagwater volcanics of Jamaica are the best known of these, there are numerous additional examples from Central America, Venezuela, and the Greater Antilles. Neogene volcanic activity is dominantly calc-alkaline associated with compressive subduction in the Lesser Antilles and Central America, and is similar to the Cretaceous volcanism of the proto-Antillean arc. During the Neogene there was widespread igneous activity associated with local spreading of the northwestern Caribbean, dominantly the Chortis block and nearby Caribbean plate. The early and middle Miocene was a time of extensive ignimbrite eruption in Honduras. Later Miocene to Pleistocene alkaline volcanism occurred on Hispaniola, Jamaica, Honduras and Costa Rica and is associated with local spreading. The Cayman Trough spreading is a longer lived example of this spreading which has occurred on purely oceanic crust and produced igneous products very similar to MORB.

CARACTERISTICAS GENERALES DEL MAGMATISMO DE MARGEN CONTINENTAL DE CUBA

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En el territorio de Cuba se encuentran secuencias sedimentarias propias de márgenes continentales riftogénicos del mesozoico, a las cuales se le asocian magmatitas efusivas e intrusivas. Las rocas magmáticas están representadas por diques de gabros, diabasas, granitos y otras rocas, así como flujos de lava y sills de basaltos, diabasas y rocas vulcanógeno-sedimentarias de distintos tipos. Se pueden distinguir tres eventos magmáticos principales, uno del Triásico tardío al Oxfordiano, uno del Oxfordiano Medio a Superior, y otro del Tithoniano al Cretácico Inferior. En el pasado estas magmatitas habían sido interpretadas de distinto modo, pero a la luz de los conocimientos actuales pueden interpretarse como el magmatismo relacionado a los procesos de fracturación y dispersión de Pangea.

INVESTIGACIONES PALEOMAGNETICAS EN CUBA. IMPLICACIONES TECTONICAS

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Se investigaron rocas desde el punto de vista paleomagnético del período Cretácico hasta el Cuaternario. Se estudiaron las formaciones Santo Domingo, Mícará, Gran Tierra Sabaneta, El Cobre, Puerto Boniato, San Luis y Maya en las provincias orientales. En la parte occidental de Cuba se investigaron las Formaciones Countine, Universidad, Güines, Cojímar, Vedado, Guana y Jaimanitas, entre otras. Fueron procesadas un total de 2338 muestras, de las cuales a un 9 % se le realizó limpieza magnética paulatina para la selección del campo óptimo, que estuvo entre 12 y 20 Ka/M para la limpieza

por campo alterno y entre 150° y 250°C por temperatura. Como resultado del tratamiento paleomagnético se da la trayectoria polar aparente para Cuba desde el Cretácico inferior hasta el Cuaternario. Se ofrecen criterios sobre la paleolatitud de Cuba en los diferentes períodos, las características magnetoestratigráficas de algunas formaciones y se obtienen resultados sobre las características de la Neotectónica y la posible influencia de eventos glaciales en el área.

MAIN METALLOGENIC FEATURES OF THE WESTERN PART OF THE CARIBBEAN REGION

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The author considers the whole of the Central America (from the Motagua zone in Guatemala to the Daryen bay) and the western part of the Greater Antilles to be a part of the Western Caribbean Region. The Central American volcanic arc is developed in its northern part on the ancient metamorphic basement (Honduras-Nicaraguan massif) and its southern part is underlain by the crust of the transitional or oceanic types in Costa Rica and Panama. Medium-acid intrusions of 50-120 mln years in age, which are commonly not associated with volcanites, are known for its northern part. In the southern part of the Central America the effusive activity, which commenced in the Oligocene, was much intensive. Medium-temperature metasomatic and veined polymetallic deposits, associated with hypabyssal granitoid bodies were commonly developed in the northern part of the Central America. Silicate-nickel, nickel-cobalt and chromite or deposits are associated with serpentized ultrabasic rocks developed along the Motagua deep zone. Tin-tungsten deposits with molybdenum are known within the Paleozoic granitoids of the Honduras-Nicaragua massif. Numerous gold-silver and lead-zinc deposits are associated with the Late Cretaceous-Eocene subvolcanic bodies. The Cenozoic belt limiting the Honduras-Nicaragua massif from the south and south-west appear to be the area of development for low and medium-temperature gold, copper-porphyry and manganese deposits. On the whole, when moving to the north-east across the strike of the Central America isthmus, the age of Meso-Cenozoic volcanites becomes older and the amount of chalcophile elements in ores of the deposits increases. The Cenozoic veined deposits of the northern part of the Central America are reported to have bigger silver reserves than similar deposits of the southern part: lead, zinc, tungsten, arsenic and mercury deposits are also predominantly developed in the northern part of the Central America. The crystalline metamorphic basement of the area appears to be responsible for metallogenic peculiarities of the latter. In the Greater Antilles arc, developed on the continental crust, the Upper Jurassic and Lower Cretaceous volcanic rocks of the homodromous series, volcanogenic-sedimentary and sedimentary formations are very common. The intrusive activity (diorites, granitoids) was accomplished in the Earlier Cenozoic time. The metallogenic evolution of the Greater Antilles and Central American island arcs has a number of common features, they are: development of manganese and pyrite deposits prior to the commencement of the arc formation; development of the laterite deposits within the blocks uplifted in the Cenozoic era. There are a number of essential differences as well. Thus, pyrite deposits, commonly developed within the Greater Antilles arcs, are rare in the Central America. Quite a different picture with the deposits of precious metals. At the last stages of the Cenozoic volcanism manganese deposits are developed in the Greater Antilles arc, while in the Central American arc, gold veined deposits are formed. These peculiarities are related with the character of tectonic evolution and the Earth's crust composition of the two arcs.

CENOZOIC TECTONIC ASSEMBLY OF THE GREATER ANTILLES, 2: HISPANIOLA

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We have completed a major map compilation of Cenozoic sedimentary basins in south-central and northern Hispaniola (Dominican Republic) at scale of 1:100 000. This compilation integrates the results of 1:25 000 scale mapping of two areas which total about 1000 km² in size. The purpose of this talk is to summarize the main tectonic results of this compilation using maps and cross sections from critical areas. The structure of Paleocene to Pliocene sedimentary rocks in the Dominican Republic indicates two deformational events: 1. Short-lived, dip-slip imbrication of early Cenozoic-Cretaceous arc-related clastic facies in Eocene time and 2. Long-lived, strike-slip imbrication of this deformed substrate by Eocene (?) to present, strike-slip faults of the North American-Caribbean boundary. A slight angular unconformity of middle Eocene age records uplift associated with WNW to NW- striking folds and thrust along the eastern edge of the Sierra el Numero in southern Hispaniola and in the central Cordillera Septentrional in northern Hispaniola. Mapping above and below the unconformity at both localities indicates a major change from fine-grained, pelagic sedimentation to coarser-grained turbiditic and olistostromal sedimentation. This folding and uplift event is interpreted as the tectonic response of the northeastward-facing Hispaniola arc to attempted subduction of the Bahamas Platform. Post-Eocene deformation in Hispaniola is marked by several unconformities in Eocene to Miocene clastic sedimentary basins. The most pronounced unconformity occurs in southern Hispaniola where late Miocene shallow marine clastic and carbonate rocks unconformably overlie a SE verging thrust belt affecting rocks as young as early Miocene. We interpret this deformation as middle Miocene oblique-slip "docking" or accretion of southeastern Hispaniola to a NW-striking restraining bend in central Hispaniola which formed in the EW- striking, strike-slip plate boundary. Mapping in northern Hispaniola indicates at least one other oblique-slip accretion event marked by an early Miocene unconformity. These oblique-slip accretion events appear to account for the present compositional diversity of Cretaceous-Eocene arc basement terranes in Hispaniola.

SIQUIRRES, COSTA RICA: SEDIMENTACION Y VOLCANISMO. TRAS - ARCO PLIO - CUATERNARIOS

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La cuenca tras-arco de Limón-Bocas del Toro ubicada a lo largo del litoral Caribe de Costa Rica y NW de Panamá, posee una historia litoestructural compleja, consecuencia del ambiente geotectónico donde se ha desarrollado. La sedimentación se inicia en el Cretácico Terminal con depósitos hemipelágicos, que progradan a sedimentos de talud de edad Paleógena. En el Neógeno la cuenca se colmata progresivamente donde predominan los depósitos neríticos, con Facies estuarinas y litorales en la parte cuspidal; la secuencia es coronada por espesos depósitos de piedemonte. En la zona de Siquirres, específicamente en la parte media de la cuenca de los ríos Pacuare y Barbilla, se ubica un evento volcánico de edad Plioceno Temprano con 700 m de espesor y de naturaleza alcalina, que afecta la sedimentación somera. Estas volcanitas afloran con un patrón que se orienta SW-NE y han sido denominadas como basanitas, además, están acompañadas por importantes intrusiones tescheníticas.

Los sedimentos tanto inferiores como superiores son depósitos de "fans deltas", pertenecientes a la Formación Río Banano de un espesor de 250 m. Estas volcanitas se interpretan como producto de un volcanismo fisural de fuente mantélica; su emplazamiento interrumpe la sedimentación somera en el Plioceno Temprano, sin embargo, cuando este evento cesa, continúan estos depósitos que colmatan la cuenca y determinan la formación del istmo en el Plioceno Tardío. Se distinguen en la zona dos eventos tectónicos; el primero, de tipo compresivo que afectó a las unidades sedimentarias del Eoceno Medio al Mioceno Superior; y el segundo, distensivo deformando toda la secuencia, el cual contrasta con las compresivas descritas en la parte sur de la cuenca.

PETROLOGICAL AND THERMAL EVOLUTION OF THE TINAQUILLO PERIDOTITE (VENEZUELA)

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The Tinaquillo peridotite complex is a layered and veined ultramafic-mafic body cropping out in the Cordillera de la Costa in northern Venezuela. Whole rock compositions, textures, and mineral chemistry of the peridotite and associated mafic rocks suggest that the complex underwent two major events before being emplaced into the Cordillera de la Costa. The peridotite first rose adiabatically within the upper mantle, at about 1350°C and 15-21 kb pressure. This rise caused a small to medium degree of partial melting, resulting in the formation of a stratified complex of clinopyroxene-rich spinell thersolites grading to harzburgites, interlayered with pyroxenite. The stratified complex then cooled and re-equilibrated at about 800-1000°C. A second upward movement of the peridotite brought it, still hot, from the upper mantle into lower crustal rocks (now called the Tinaco complex), at an estimated 7 kb pressure, then cooling to 600-700°C. Amphibolitization of the peridotite is associated with metasomatism. Pargasite forms small amounts (2-5%) distributed homogeneously, as well as local concentrations in amphibole veins grading into orthopyroxene and spinel-hornblende layers. The metasomatic enrichment seems greatest in the most depleted peridotites. The Tinaquillo peridotite shares many characteristics with Alpine spinel thersolites that are believed to be derived from the subcontinental upper mantle and are emplaced within a continental rift, or at the margin of an ocean rift. These characteristics are: low degree of depletion, highly aluminous spinels, abundance of metasomatic facies, and early high-pressure equilibration followed by re-equilibration with mafic-silicic continental-type rocks within the intermediate pressure granulite facies. (Tinaquillo, Venezuela, Caribbean, peridotite, amphibole metasomatism, continental crust, granulite facies.)

LA ZONA DE INFRACORRIMIENTO SANTIAGO DE CUBA: NUEVOS DATOS SOBRE EL BORDE NOROESTE DE LA PLACA CARIBE

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El borde norte de la placa Caribe es una zona de gran complejidad geológica que ha sido objeto de numerosos estudios, especialmente en los últimos años. Uno de los segmentos más polémicos de dicho borde lo constituye el situado entre las islas de Cuba, Jamaica y la Española (Haití), donde no está claro todavía el origen, estructura y evolución del extremo oriental de la Fosa Caimán, ni el papel concreto que ella juega en el proceso geodinámico de la región. El estudio combinado de las regiones emergidas colindantes y las partes sumergidas, parece ser la única vía adecuada para poder resolver los difíciles problemas planteados. Esto es especialmente válido para la parte suroriental de Cuba, donde la cordillera montañosa de la Sierra Maestra, se considera la continuación de la cresta de los Caimanes. Los resultados de la interpretación de cuatro nuevos perfiles gravimétricos combinada con un perfil sísmico del método "Zemlia", indican que la estructura geológica profunda de la Sierra Maestra es análoga a la de Puerto Rico, con una corteza de tipo de transición con una potencia

del orden de los 20 km. Reinterpretando según un perfil paralelo a la costa sur de la isla de Cuba, los datos de 10 sondeos sísmicos profundos norteamericanos realizados en el mar, se pudo determinar una zona de hundimiento de la frontera de Moho hacia el este, entre los meridianos 76° y 77° de longitud oeste. La característica general del corte sísmico del fondo de la Fosa Caimán cambia, a partir del meridiano 76°30' longitud oeste, de un tipo de corteza puramente oceánica (parte más profunda de la fosa), a otra del tipo de transición situada hacia el este. Los eventos sísmológicos registrados en los últimos diez años por la red situada en la parte oriental de Cuba, de estaciones sísmológicas confirman la existencia en la franja cercana a la costa, de una zona sísmofocal principal de terremotos instrumentales someros, cuyos focos más profundos van hundiéndose hacia el este-noroeste, entre los meridianos 75° y 77° longitud O, bajo un ángulo suave de unos 15 - 20°. Por encontrarse frente a la ciudad de Santiago de Cuba, le denominamos con dicho nombre a esta zona de infracorrimiento que por los datos actuales sólo alcanza con seguridad hasta la profundidad de 50 km. Este hecho puede explicarse geológicamente si consideramos que la corteza oceánica surgida en el centro del spreading situado en la Fosa Caimán, entre los 82° y 83° de longitud oeste, avanza hacia el este-noreste, provocando mayores movimientos sísmicos en las zonas de colisión situadas al sur de Cuba. Por datos batimétricos, pueden delimitarse bloques costeros sumergidos, medianos y grandes (40 x 15 km), algunos deslizados, en dichas zonas. La zona de infracorrimiento se extiende por su rumbo a través de la Sierra Maestra, pasando muy próximo a la ciudad de Bayamo por el oeste, dividiendo al Horst anticlinal en dos megabloques principales. Esto explica los datos históricos de terremotos relativamente fuertes en dicha ciudad.

COMPARISON OF LATE CRETACEOUS-PALEOCENE AGE ROCKS OF NORTHERN HISPANIOLA AND SOUTHEASTERN CUBA: IMPLICATIONS FOR THE TECTONIC EVOLUTION OF THE GREATER ANTILLES

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The Rio San Juan Complex in the Cordillera Septentrional of northern Hispaniola is composed of amphibolites, gabbros, blueschist-eclogite melanges and fine grained mafic metavolcanic rocks and minor carbonates metamorphosed to blueschist and greenschist facies. The latter unit is lithologically identical to rocks which occur in the Campanian Purial Complex of southeastern Cuba. It is suggested that these two sets of rocks are parts of the same unit. In Hispaniola, the Paleocene-Lower Eocene Imbert Formation contains distinctive white tuffs, serpentinite-bearing conglomerates and sands, and is associated with serpentinites and shallow water limestones. To the southwest of the Imbert outcrop, Paleocene-Lower Eocene volcanic flows are exposed in the Palma Picada area. The Paleocene rocks of Oriente are represented by the Cobre Group which, like the Imbert/Palma Picada units, is characterized by clastic sediments, volcanic lavas and tuffs. It is suggested that the Imbert/Palma Picada is equivalent of the Cobre group. It is concluded that the Cordillera Septentrional and Oriente originally formed a single terrane and that the two areas have been subsequently separated by 400 km of motion on the Oriente (Cayman) transform fault, which forms the present boundary between the Caribbean and North American Plates. Estimates of the slip rates based on rates of opening of the mid-Cayman spreading center suggest that this separation began sometime between medial Oligocene to medial Miocene time. As the separation of the Septentrional and Oriente regions accounts for only 400 km of the estimated 1000 km of strike slip on the northern Caribbean plate boundary, motion prior to this time must have been accommodated along other major faults other than the Oriente (Cayman) transform. It is suggested that most of these are located in Hispaniola. Estimating the motion on these faults it is possible to reassemble the crustal Hispaniola. This reconstruction suggests that the original Upper Cretaceous Hispaniola-Oriente island arc was a NW trending structure that was obliquely dissected by a series of northward migrating WNW trending faults. Post middle Miocene movement on these faults has been mainly dip slip or oblique, rather than strike slip.

GEOCHEMICAL CHARACTERISTICS OF MESOZOIC OCEANIC TERRANES IN THE NORTHERN CARIBBEAN

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Geochemical characteristics are now known from mafic rocks of most areas of the ophiolitic associations and other Mesozoic "ocean areas" from Puerto Rico, Hispaniola, Jamaica, Cuba, and the Central Caribbean basin. Three belts of rocks of mafic composition are known from Hispaniola, although the chemical characteristics of the northern subduction related belt are not known. Mafic lavas of Upper Cretaceous age from the Southern Peninsula show distinct characteristics of "plume" generated magmas and are similar to basalts from Site 151 in the Caribbean Sea (Sen et al, 1988). Three distinctive chemical types are reorganized in the Median Belt of central Hispaniola. High-Mg metabasalts (greenstones and amphibolites) of the Duarte Complex show chemical affinities with present-day seamounts of the Pacific. Mafic lavas of the upper Duarte Complex have features similar to T-type MORB. Basalts and diabases of the Peravillo/Siete Cabezas Formations show essentially horizontal REE (chondrite normalized) patterns similar to N-type MORB, but the relative element concentrations differ in detail. More detailed chemical analyses are required on the Cuban ophiolites, but the data at hand (Fonseca et al, 1984) suggest abyssal basalt (MORB) affinities. Other mafic rocks in Cuba such as the Purial metabasic rocks and the Mabujina amphibolites are more problematical. Basalts from Bath, eastern Jamaica (Jackson, unpublished), and the Bermeja complex amphibolites, Puerto Rico (Lee and Mattson, 1976) show MORB affinities.

GEOLOGIC HISTORY OF THE SOUTHEASTERN GULF OF MEXICO

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A seismic stratigraphic analysis is combined with the drilling results of DSDP Leg 77 to present a view of the geologic history of the deep southeastern Gulf of Mexico located just north of western Cuba. Basement consists of attenuated lower Paleozoic continental crust (metamorphic rocks) intruded by Lower Jurassic diabase dikes and sills and represents an excellent example of "transitional" crust. The Mesozoic history began with deposition in east-west rift basins during the Late Triassic(?) - Early Jurassic(?). Extensive rifting and syn-rift sedimentation continued during the Middle Jurassic(?) in the northern part of the area, while broad carbonate platforms developed to the south. The rifting apparently was related to the early opening of the Gulf basin. During the Late Jurassic a narrow seaway was established, connecting for the first time the newly-formed deep Gulf of Mexico basin with a proto-Caribbean basin. Shallow carbonate platforms formed over basement highs, while deeper, shelfal basins formed in the intervening lows. By Early Cretaceous time, well-established carbonate platforms flanked a still narrow, relatively starved deepwater seaway. At the end of the Neocomian, the western platform experienced tectonic collapse, leaving high-standing basement blocks such as Catoche Knoll drilled during Leg 77. The platform margin stepped back and became well-established along the Campeche Escarpment, its location being structurally controlled. The platform continue to aggrade throughout the middle Cretaceous (Aptian to mid-Cenomanian). To the east a highly productive rimmed carbonate platform margin located along the Florida Escarpment provided thick wedges of sediment to the eastern part of the deep basin throughout the middle Cretaceous. During middle Cenomanian time a widespread erosion surface and sequence boundary was formed (middle Cretaceous sequence boundary - MCSB), probably due to a major drop in sea level followed by a rapid rise. This was accompanied by a major drowning of the mid-Cretaceous carbonate platform margins and a general starvation of the area throughout the Late Cretaceous. A general comparison of Mesozoic facies between the southeastern Gulf and western Cuba suggests that the entire region was contiguous during the Mesozoic and was part of one large mixed carbonate/clastic province located along a complex, south-facing, rifted continental margin of the North American plate. During the

mid-Cenomanian to early Paleocene, the southern part of the region began to record the effects of a collision between a northward-migrating island arc (now part of Cuba) and a salient of the North American plate. More than 2 km of gravity-flow deposits accumulated in an elongate structural corridor or foredeep along the base of the modern Cuban slope, while the slope itself was the site of both folding and overthrusting. Clastics continued to dominate the depositional regime until the late Eocene, at which time the Cuban arc had been firmly welded to North America. A late middle to early late Eocene hiatus in Site 540, which coincides with a prominent regional seismic unconformity, marks the transition from predominantly terrigenous input to pelagic/hemipelagic deposition. Since the late Eocene, the southeastern Gulf has recorded multiple cycles of deposition and erosion. Unconformities displayed on seismic profiles are numerous. Erosional agents have included the Gulf Stream system, and turbidity currents and debris flows concentrated in the vicinity of submarine canyons. Continuing slope instability is indicated by slide/slump planes along canyon walls. The area is ideal for further deep sea drilling by the Ocean Drilling Program. First, a set of sites could easily sample the thick Jurassic section inferred by seismic data to lie beneath the deepwater Lower Cretaceous rocks drilled during Leg 77. When integrated with regional seismic studies and correlated to equivalent age rocks on Cuba, this drilling will provide key data for documenting the early paleogeographic and tectonic evolution of the Gulf/Caribbean region during the initial breakup of Pangea when South America/Yucatan moved southward away from North America. Secondly, the drilling could sample the younger post mid-Cretaceous section, documenting both the Late Cretaceous-early Cenozoic deposition in the foredeep north of Cuba as well as the Late Cenozoic paleoceanography of the Straits of Florida.

LA FALLA DE LAGUNA GRANDE (ESTADO SUCRE, VENEZUELA). TECTONICA CUATERNARIA Y CAMPO DE ESFUERZOS ASOCIADOS

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La región nororiental de Venezuela presenta importantes deformaciones neotectónicas, ya que a lo largo de ella se sitúa el borde actual entre la placa del Caribe y la placa de América del Sur. La falla de Laguna Grande (ENE-WSW), ubicada dentro de la zona principal de contacto de placas, muestra evidencias de actividad tectónica durante el Cuaternario, con movimiento predominante sinistral al cual se le asocia una pequeña componente inversa. La orientación actual de σ_1 al norte de la falla de Laguna Grande es aproximadamente norte-sur, mientras que al sur de ésta, en las cercanías de la falla dextral de El Pilar (límite principal de placas), la orientación de σ_1 es NW-SE.

AMERICA CENTRAL Y LAS ANTILLAS: PUENTE, BARRERA Y FILTRO BIOLOGICO ENTRE NORTE Y SUDAMERICA DEL CRETACICO AL PRESENTE

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Basados en los estudios y comparaciones paleovertebradológicas de América iniciados por G. Simpson -entre otras-, desde hace cinco décadas, y utilizando, además, una gran cantidad de trabajos recientes sobre paleontología, paleogeografía, sedimentología, geotectónica y geofísica, se presenta una sinopsis sobre los varios y cortos intercambios faunísticos que se establecieron entre Norte y Sudamérica desde hace unos 75 m.a., los cuales se pueden agrupar en cinco períodos principales seguidos. Dicha información da una base sólida para entender mejor la paleogeografía y la ecología actual. Un primer intercambio se documentó en el Cretácico Superior (Campaniense-Tardío), a través del ancestral arco de islas de Las Antillas, volviéndose a establecer esta vía terrestre en forma efímera durante el Paleoceno Inferior (Riochican). Después de estas cortas migraciones,

América del Sur se mantuvo como una isla biogeográfica por espacio de varias decenas de millones de años, teniendo únicamente el causal arribo de unos pocos grupos faunísticos procedentes probablemente de África o de Norteamérica por transportes erráticos (balsas) a través del océano, durante el Oligoceno Inferior (Deseadense) o quizás desde el Eoceno. En el Mioceno Inferior, América Central Meridional consistía en una giralda de islas moderadamente continua, unida a América Central Nuclear y a Norteamérica, pero, sin embargo, más al este persistía una barrera oceánica infranqueable: la cuenca de Bolívar. También debemos de considerar el efecto biológico de la geotectónica con el fenómeno de barcos-islas. Durante el Mioceno Superior y en el Plioceno Inferior (Rusciniense?), las tierras emergidas y las islas volcánicas centroamericanas, permitían un tímido intercambio de fauna, tiempo en el cual todavía persistían barreras interoceánicas. No fue sino hasta el Plioceno Superior (Villafranquiense Inferior) en que el istmo de Panamá funcionó como un verdadero puente en el cierre concomitante definitivo del intercambio de aguas entre el Atlántico y el Pacífico, realizándose varias olas de migraciones en ambos sentidos. Pese a ello, Mesoamérica activó como un filtro biológico, situación que todavía persiste. Resultado de este último intercambio masivo, es la gran variedad de especies vegetales y animales en América Central y en Las Antillas. Sin embargo, filtros parecidos debieron de estar presentes durante el Cretácico y en el Paleoceno. Al final del Pleistoceno el hombre arribó al continente americano, conviviendo y alimentándose de megamamíferos; no obstante, hasta el momento no se han reportado hallazgos arqueofaunales en América Central. Los restos fósiles más abundantes en esta región, corresponden a mastofauna.

EVOLUTION OF MAGMATISM OF THE PALEO-OCEAN CONTINENTAL TRANSITIONAL ZONE (ON THE EXAMPLE OF CAUCASUS MINOR)

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Magmatism is the reflection of all complex geochemical processes in ocean-continent transitional zones, where paleo-oceanic and modern continental crusts join and interact. From this point of view comparative analysis of paleo-analogues with the aim of reconstruction of petrology-geochemical processes and ways of their evolution methodically is approved. One of these transitional zones is Caucasus Minor. As a segment of Mediterranean plicate zone the forms took part in meso-cainozoic period in rapprochement East-European, African-Arabian plates with paleo-oceanic crust of Tetis. This process is accompanied with tectonic clustering of rocks of paleo-oceanic, islands arc and continental types of crust. 1. Paleo-oceanic type of Caucasus Minor association is represented by Jurassic-Cretaceous melange complex of rocks having spotty-striated spreading in near Sevan (Amasia-Sevan-Akera), Vedi (South) and Zangezur tectonic zones. The members of the association underwent tectonic squeezing out, pulling asunder the scales plates and accumulation of powerful flysch-olistostrome thicknesses. This is accompanied by withdrawal to the surface shelf deposits and separate blocks of eopaleozoic fundament of old Persian mesocontinent. In the structure of ophiolites the following formations has been stated: harzburgite, gabbroid (stratified) and basalt (diabase)-keratophyre-siliceous. Ophiolit studies state, distinct geochemical contrast from their modern oceanic analogues, little depth and retrograde metamorphism (45-50 km) with prevalence of amphibolitic greenschaled and prehnite-pumpellyite facieses, wide development of disbalanced and incompatible mineral associations (diamonds mussonites, with olivine, plagioclas) and geochemically paradoxical sign of "paleo-oceanic mantle" (low K/Rb; high Ba/Sr; high $^{87}\text{Sr}/^{86}\text{Sr}$ and other relations). 2. Islands arc (Mediterranean) type of crust is represented by "grafting" formation of island arc (Somhetto-Kharabakh-Khaphan) and "immature" crust magmatism with prevalence of Ca over K in its composition and further development of K metasomatism, magmatic substitution and intrusion of tertiary granitoids with combined cuprico-molibdenum and gold-sulphide metallization. 3. Continental type of crust development is brightly expressed by volcanogene formations of andesite-trachyandesite series with the fluctuation tendency of the melt alkalinity level. The dynamics of magmatism hotbeds is followed in the conditions of tight interaction in space of active "hot" crust regions and upper mantle along Bazum-Zangezur tectonic zone.

1:100 000 SCALE GEOLOGIC COMPILATION MAP AND REGIONAL STRATIGRAPHIC SYNTHESIS OF SOUTHERN HISPANIOLA

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A geological map, four regional cross sections and stratigraphic correlation charts have been prepared for southern Hispaniola (southern Dominican Republic and easternmost Haiti) with the goals of: 1. improving regional stratigraphic correlation particularly across the Dominican-Haitian frontier; 2. better understanding the tectonic controls on Late Cretaceous-Cenozoic sedimentation and volcanism; and 3. illustrating the cumulative structural effects of superimposed late Cretaceous-Cenozoic deformation. From north to south the map area includes: the Southern Cordillera Central; the San Juan-Azua Basin; the Sierra de Neiba; the Enriquillo Basin; the Sierra de Baharucó and the westward extension of all of these features into easternmost Haiti. Data sources included over 30 published and unpublished maps, reports, theses and our own unpublished field data. In order to systematically evaluate and revise the stratigraphic nomenclature, we also constructed correlation charts by author which follow the definition of stratigraphic units from the 1910's to the present. These maps and revised stratigraphic correlations help constrain the development of the following tectonic features: 1. fundamental contrast in late Cretaceous basement types across the Enriquillo Valley; 2. style of Eocene backarc thrusting associated with the collision of the Greater Antilles arc with the Bahama Platform; 3. style of late Neogene, strike-slip-related Neogene thrusting along the margins of the Enriquillo-San Juan ramp basins; and 4. late Neogene faulting and related volcanism associated with the onshore extension of the Beata Ridge Fault zone.

FOUR-PHASE TECTONIC DEVELOPMENT OF THE NORTH AMERICAN-CARIBBEAN PLATE BOUNDARY ZONE, NORTHERN HISPANIOLA

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We have recently compiled a 1:100,000 scale geological-tectonic map of northern Hispaniola in order to constrain the Cenozoic geologic history of the North American-Caribbean plate boundary (PBZ). This map incorporates all previous work over the last 50 years as well as detailed 1:25,000 mapping by ourselves of critical areas. Geologic map relations, and over 200 biostratigraphic ages indicate four tectonic phases: Phase 1: Late Cretaceous-early Eocene forearc tectonics and sedimentation is indicated by a highly faulted, heterogeneous assemblage of igneous, metamorphic and deep-marine volcanoclastic sedimentary rocks. This assemblage can be divided into an "outer forearc" assemblage of ultramafic and metamorphic rocks to the northeast and a coeval "inner forearc" assemblage of calc-alkaline volcanic rocks, small tonalite stocks, and pelagic limestone to the southwest. The youngest volcanism of the "inner forearc" is early or possible medial Eocene. Phase 2: Medial Eocene regional folding and uplift is indicated by an angular unconformity between tightly folded early Eocene "inner forearc" rocks and less folded late Eocene basal conglomerates. Phase 3: Long-lived, terrigenous source areas to the NW are indicated by late Eocene-early Miocene marine turbidite sedimentation (>5000 m) on a uniformly SE-dipping paleoslope. NE and SW basin edges are poorly exposed but may have been controlled by strike-slip faults. Phase 4: Medial Miocene to present localized folding and uplift is indicated by an angular unconformity between gently folded Eocene-Miocene turbidites and tilted late Miocene shallow-water carbonates. This event is related to the development of a Neogene strike-slip restraining bend which locally has unlifted Pliocene platform carbonates 1200 m above sea level.

FACIES CARBONATADAS A Ranikothalia DEL PALEOCENO SUPERIOR DE COSTA RICA (AMERICA CENTRAL)

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El Paleógeno de Costa Rica muestra un desarrollo de facies neríticas carbonatadas que comienza en el Thanetiano con la formación de packstone y wakestone, ricos en macroforaminíferos, algas coralígenas, corales solitarios y escasos foraminíferos planctónicos. Estas facies, testigos de plataformas carbonatadas efímeras, sólo se encuentran en forma de "debris" asociados a formaciones de aguas profundas hallados en las penínsulas pacíficas de Quepos y Burica. En la zona de Quepos cantos y bloques de caliza somera datados del Thanetiano están incluidos en la Formación Caótica Punta Quepos. En la península de Burica bloques y calcarenitas de caliza somera constituyen sedimentos de talud carbonatado (Formación Pavones) que sobreyacen basaltos oceánicos. Entre los macroforaminíferos se encuentran Nummulites que alcanzan un diámetro maximal de 4 mm. Muestran un cordón marginal prominente, en particular a partir de la segunda vuelta de la espira y otras características del género Ranikothalia, Caudri (1944). Las poblaciones estudiadas poseen poca diversidad genérica y una gran variabilidad intraespecífica. Hay formas lenticulares aplastadas, formas globulosas con un umbo prominente y bordes, tanto redondeados como adelgazados, formas elípticas y formas lenticulares comprimidas en la zona central, e individuos teratológicos. Los especímenes aislados, así como los observados en secciones delgadas están recristalizados. Sin embargo, mediante la cathodoluminiscencia se observaron las siguientes características de la morfología interna: el tamaño real del aparato embrionario, tamaño y forma de las cámaras, espesor de los septos, sistema de lamelas internas y externas, perforaciones de la pared lateral de las cámaras, etcétera. En la zona de Quepos se determinaron: Ranikothalia sp., Discocyclina barkeri, Discocyclina cf. weaveri y Amphistegina sp. En la localidad de Mangle se determinaron: Ranikothalia antillea, Ranikothalia tobleri, Ranikothalia sp., en esta última incluimos especímenes muy pequeños no descritos actualmente en la región del Caribe y América Central, Discocyclina sp., Amphistegina sp., Miscellanea sp. Entre los microforaminíferos asociados a esta fauna se encuentra Globorotalia velascoensis. Estas facies a Ranikothalia son las únicas reportadas de la América Central y aparecen paleogeográficamente muy aisladas de la región caribeña donde dichas facies están ampliamente distribuidas. Se interpretan como vestigios de plataformas sobre "seamounts" pacíficos.

DESPLAZAMIENTO DEXTRAL ACUMULADO A LO LARGO DE LA FALLA DE BOCONO, ANDES VENEZOLANOS

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La falla de Boconó, considerada como el límite principal actual entre las placas de América del Sur y del Caribe, desplaza dextralmente unidades geológicas de diferentes edades en los andes venezolanos. Un análisis de los criterios utilizados para cuantificar este movimiento sugiere que el desplazamiento dextral máximo es de unos 30 km y su funcionamiento como límite de placas habría comenzado hace unos 3 m.a., es decir, durante el Plioceno superior.