A great variety of complex structures found in northern Colombia, northern Venezuela, the Lesser Antilles, Barbados, Trinidad, and Tobago record the eastward movement of the Caribbean plate relative to the South American plate through time. The development of these structures includes transtensional and foredeep basins as well as fold-and-thrust belts that become younger eastward since the Cretaceous. In northern Colombia, terrane accretion began in the Triassic and ended in the late Cretaceous, along the Gulf of Urabá, and the Sinu–San Jacinto Belt. Further east, the structure offshore Guajira, east from the Bucaramanga fault, is characterized by accretion involving the South American metamorphic basement. Well and seismic data in the Maracaibo Basin record the Paleogene flexure related to terrane collision and accretion. In the Gulf of Venezuela, offshore eastern Falcon, and La Vela, transtensional basins record the eastward movement of the Caribbean plate.

Onshore northern Venezuela, the Villa de Cura subduction mélangé in the Cordillera de la Costa nappes represents the accretionary wedges involving ophiolites of Eocene age. The Guarico flysch records the flexure of the accretionary wedge during Oligocene time and fills the foredeep of the same age. The Cariaco, Carupano, and La Blanquilla are pull-apart basins related to a younger Oligocene–Miocene-stage strike-slip as the Caribbean plate advances toward the east. Ophiolitic obduction of the Caribbean oceanic domain onto the accreted terranes is represented by the thrusted ophiolites of Isla Margarita. The Monagas area or Serrania del Interior Folded Belt is a characterized Oligocene to Miocene thin-skinned thrusting involving the passive margin units of the South American plate and is overlain by the Carapita accretionary wedge. The Maturin Basin is the flexural basin associated with the loading of the Serrania del Interior thrust stack and extends to the east toward the Delta Centro and Punta Pescador areas, in the Orinoco Delta and south of Trinidad. The Gulf of Paria pull-apart basin in eastern Venezuela and Trinidad developed since the late Miocene and is the easternmost strike-slip basin related to the eastward advance of the Caribbean plate, and terminates against the frontal accretionary wedge of the Caribbean plate of Barbados and Trinidad that is a Miocene to present-day shale-dominated accretionary wedge.
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ABSTRACT

A great variety of complex structures found in northern Colombia, northern Venezuela, the Lesser Antilles, Barbados and Trinidad and Tobago record the eastward movement of the Caribbean plate relative to the South American plate through time. The development of these structures includes transtensional and foredeep basins as well as fold-and-thrust belts that become younger eastward since the Cretaceous. In northern Colombia, terrane accretion began in the Triassic and ended in the Late Cretaceous, along the Gulf of Uraba, and the Sinu-San Jacinto Belt. Further east, the structure offshore Guajira, east from Bucaramanga fault, is characterized by accretion involving the South American metamorphic basement. Well and seismic data in the Maracaibo Basin record the Paleogene flexure related to terrane collision and accretion. In the Gulf of Venezuela, offshore eastern Falcon, and La Vela transtensional basins record the eastward movement of the Caribbean Plate. Onshore northern Venezuela, the Villa de Cura subduction melange in the Cordillera de la Costa nappes represent the accretionary wedges involving ophiolites of Eocene age. The Guarico flysch records the flexure of the accretionary wedge during Oligocene time and fills the foredeep of the same age. The Cariaco, Carupano and La Blanquilla pull-apart basins related to younger Oligocene-Miocene stage strike-slip as the Caribbean plate advances towards the east. Ophiolitic obduction of the Caribbean oceanic domain onto the accreted terranes is represented by the thrust faults of the Isla Margarita. The Maturin Basin is the flexural Basin associated with the loading of the Serrania del Interior thrust stack and extends to the east toward the Delta Centeno and Punta Pescador areas, in the Orinoco Delta and south of the Trinidad Island. The Gulf of Paria pull-part basin in eastern Venezuela and Trinidad developed since the Late Miocene and is the easternmost strike-slip basin related to the eastward advance of the Caribbean Plate, and terminates against the frontal accretionary wedge of the Caribbean Plate of Barbados and Trinidad that is a Miocene to present day shale-dominated accretionary wedge.

Plate tectonic map of the Caribbean and neighboring areas
(modified from Pindell and Barrett, 1990; Muhlbberger, 1992, and Flinch, 2003)

Structural map of northern South America from Panama to Trinidad and Tobago
(modified from Audemard, 1996; Audemard and Audemard, 2002; Barrios et al., 2011; Castillo, 2001; Castillo and Mann, 2006; Di Croce, 1995; Di Croce et al., 1997, 1999, 2001, 2004; Flinch, 2001; Hung, 1997, 2005; Mann et al., 2006; Martinez et al., 2010; Montes et al., 2010; Perez de Armas, 2005a, b; Ysaccis, 1997).
Record and Constraints of the Eastward Advance of the Caribbean Plate in Northern South America

Flinch, J. (1); and Castillo, V. (2)
(1) Repsol Exploracion S.A., Madrid, Spain
(2) Repsol USA, Exploration Caribbean Basins

Regional seismic transects across Maracaibo Basin

TRANSECT G

TRANSECT F

TRANSECT E

TRANSECT D

TRANSECT C

TRANSECT B

TRANSECT A

Structural map of the Gulf of Paria Pull-Apart Basin (modified from Flinch et al., 1997)

Southern Thrust Sheet
Northern Thrust Sheet

STRUCTURAL UNITS

Accretionary Wedge
Mountains Front Thrust
Northern Detachment
Central Detachment
Southern Detachment
Easterly Detachment

Legend

Transitional Units

Oligocene

Pliocene-Pleistocene

Cretaceous

Cenozoic

Paleogene

Exhumed basement

Basement

Transitional Units

Northern Thrust Sheet
Central Detachment
Southern Thrust Sheet

Fig. 14

San Juan River

Columbus Channel

Base Pliocene

Base Pleistocene

Shale Ridge

Discovery Anticline

Anticline

Syncline

Normal fault

Highs

Lows

Allochthonous Metamorphic Terranes

Northward vergent Thrust faults

Southward vergent Thrust faults

Syncline

Anticline

Inversion Anticline

Transfer Zone

Northern Monagas Fold-and-Thrust Belt (modified from Flinch et al., 1997)

Regional depth section from the Plato–San Jorge to the offshore Sinu accretionary prism (modified from Flinch et al., 2010)

Onshore–offshore seismic line drawing through the offshore San Jorge Basin accretionary wedge (modified from Flinch et al., 2003). Focal mechanisms are from Malave and Suarez (1995)

Onshore–offshore seismic line drawing through the Gulf of Paria Pull-Apart Basin (modified from Flinch et al., 2003)

Onshore–offshore seismic line drawing through the off shore Sinu–San Jacinto accretionary wedge (modified from Flinch et al., 2010)

Main Vergence South-vergent Thrust Transfer Zone

Normal Fault Pliocene-Pleistocene

V=H
CONCLUSIONS

There are time differences from the initial subduction of the Caribbean island arc to the deformation and ultimate uplift of frontal fold-and-thrust belts and finally to the age of the flexure that was generated by tectonic loading. Back-arc extensional basins overlying the allochthonous Caribbean plate migrated eastward like the underlying accretionary complexes and island arc sections. Comparison of the timing between the geochronology of metamorphic events and AFTA cooling ages suggests that subducted and obducted island arc segments have been dismembered because of ocolinal bending and strike-slip; therefore, units that were initially close together were separated later on by hundreds of kilometers during tectonic evolution. Migration of the Caribbean plate was mostly accounted for by compressional overthrusting and dextral strike-slip faulting. Within the allochthonous Caribbean plate, the structural style is characterized E-W (in the west) to NE-SW (in the east) trending extensional basins bounded by NW–SE-trending strike-slip systems and NW–SE-trending pull-apart basins. West of Maracaibo Basin, along the deformed passive margin units of northern South America, strain partitioning resulted in thrust sheets with NE–SW-trending foreland thrust axis bounded by NW–SE-trending tear faults that represent major dextral strike-slip systems. The leading edge of the Caribbean plate was somewhere near the Sinu area in late Cretaceous time. In Paleogene time, the Maracaibo–Urumaco–Falcon fault system was the frontal pull-apart of the moving plate, and during the early Miocene, the Caribbean island arc was probably located at the edge of the Paleoe–Caraco trough. Later, during middle Miocene time, widespread thrusting and folding migrated to the eastern Venezuelan Folded Belt. Finally from late Miocene to Pliocene, strike-slip was active along the Gulf of Paria and the basins located north of Trinidad and Tobago, indicating that the deformation migrated toward the Barbados accretionary complex. The age of the successively younger foredeep sections is the best indicator to separate the timing of the eastward advance of the Caribbean domain. The age of the sediments that fill pull-apart basins related to step-overs between major dextral E-W strike-slip systems is another indicator of the migration of the deformation through time from west to east. GPS satellite data and neotectonic and seismological studies suggest that the Caribbean plate is still advancing toward the east against the subducting North Atlantic plate.

REFERENCES

"Record and Constrains of the Eastward Advance of the Caribbean Plate in Northern South America"

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SUMMARY

CONCLUSIONS

There are time differences from the initial subduction of the Caribbean island arc to the deformation and ultimate uplift of frontal fold-and-thrust belts and finally to the age of the flexure that was generated by tectonic loading. Back-arc extensional basins overlying the allochthonous Caribbean plate migrated eastward like the underlying accretionary complexes and island arc sections. Comparison of the timing between the geochronology of metamorphic events and AFTA cooling ages suggests that subducted and obducted island arc segments have been dismembered because of ocolinal bending and strike-slip; therefore, units that were initially close together were separated later on by hundreds of kilometers during tectonic evolution. Migration of the Caribbean plate was mostly accounted for by compressional overthrusting and dextral strike-slip faulting. Within the allochthonous Caribbean plate, the structural style is characterized E-W (in the west) to NE-SW (in the east) trending extensional basins bounded by NW–SE-trending strike-slip systems and NW–SE-trending pull-apart basins. West of Maracaibo Basin, along the deformed passive margin units of northern South America, strain partitioning resulted in thrust sheets with NE–SW-trending foreland thrust axis bounded by NW–SE-trending tear faults that represent major dextral strike-slip systems. The leading edge of the Caribbean plate was somewhere near the Sinu area in late Cretaceous time. In Paleogene time, the Maracaibo–Urumaco–Falcon fault system was the frontal pull-apart of the moving plate, and during the early Miocene, the Caribbean island arc was probably located at the edge of the Paleoe–Caraco trough. Later, during middle Miocene time, widespread thrusting and folding migrated to the eastern Venezuelan Folded Belt. Finally from late Miocene to Pliocene, strike-slip was active along the Gulf of Paria and the basins located north of Trinidad and Tobago, indicating that the deformation migrated toward the Barbados accretionary complex. The age of the successively younger foredeep sections is the best indicator to separate the timing of the eastward advance of the Caribbean domain. The age of the sediments that fill pull-apart basins related to step-overs between major dextral E-W strike-slip systems is another indicator of the migration of the deformation through time from west to east. GPS satellite data and neotectonic and seismological studies suggest that the Caribbean plate is still advancing toward the east against the subducting North Atlantic plate.

REFERENCES


