AAPG International Conference
Barcelona, Spain
September 21-24, 2003

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Onshore-Offshore Structure of the Northern Colombia Accretionary Complex

Abstract

North from the isthmus of Panama, northern Colombia is occupied by a very large Accretionary Complex that resulted from the B type subduction of the Caribbean Plate underneath the South American plate. The complex extends offshore and onshore from the Uraba Basin in the south and joints the northern accretionary wedge of Venezuela in the north.

Following the Obduction of the Caribbean Oceanic Plateau (Campanian-Maastrichthian time) accretion took place along the Sinu-Lower Magdalena area since Paleogene time (the wedge is still active today). An "Inner Accretionary Wedge" made up by Upper Cretaceous to Oligocene strata floored by oceanic crust is exposed along the San Jacinto and Monteria areas. This reduced starved part of the Prism (exposed onshore) contrast with the large and well-developed Offshore Sinu prism " Outer Accretionary Wedge " mostly consisting of Miocene to Pleistocene imbricates. The Proto-Magdalena and other sedimentary systems contributed to a high sediment supply triggered by the surrection of the Central and Eastern Cordillera since Upper Miocene time. The thickness of syn-sedimentary strata is huge along the Proto-Magdalena delta this results in a blanketing effect of the deformation (i. e. false image of non-deformed strata). As a result of this high sediment supply the offshore wedge growths very fast an reaches the critical taper. To re-equilibrate and reach a more stable profile the wedge collapses (i. e. normal faulting and toe-thrusting). As a result of this complex evolution the structure of the Offshore Sinu Accretionary Wedge consist of NW-vergent imbricates, extensional fore-arc basins and shale ridges.

Regional Setting

Northern Colombia is occupied by a very extensive Accretionary Complex that extends along the Caribbean sea (i. e. Offshore Sinu Accretionary Wedge) which represents the most external part of the Northern Colombia Accretionary Wedge (Fig. 1). The Prism is associated to the B type subduction of the Caribbean Plate underneath the South American plate. Present-day seismicity is associated with this plate boundary.

Following the Obduction of the Caribbean Oceanic Plateau (Campanian-Maastrichthian time) accretion took place along the Sinu-Lower Magdalena area since that time until present day. An Inner Accretionary Wedge made by Upper Cretaceous to Oligocene strata floored by oceanic crust is exposed along the San Jacinto and Sinu areas. This reduced starved part of the Prism contrast with the well-developed Offshore prism " Offshore Sinu Accretionary Wedge " or " Outer Prism " consisting of mostly Miocene to Pleistocene imbricates. The prism extends from Uraba Basin in the south and joints the northern accretionary wedge of Venezuela in the north. The Proto-Magdalena and other sedimentary systems contribute to a high sediment supply triggered by the surrection of the Central and Eastern Cordillera of the Colombian Andes from Upper Miocene time on.

Structure of the Northern Colombia Accretionary Complex

As already mention the accretionary wedge of northern Colombia can be subdivided according to its age of accretion and structural characteristics into "Inner" and "Outer" complex (see section A of Fig. 2).

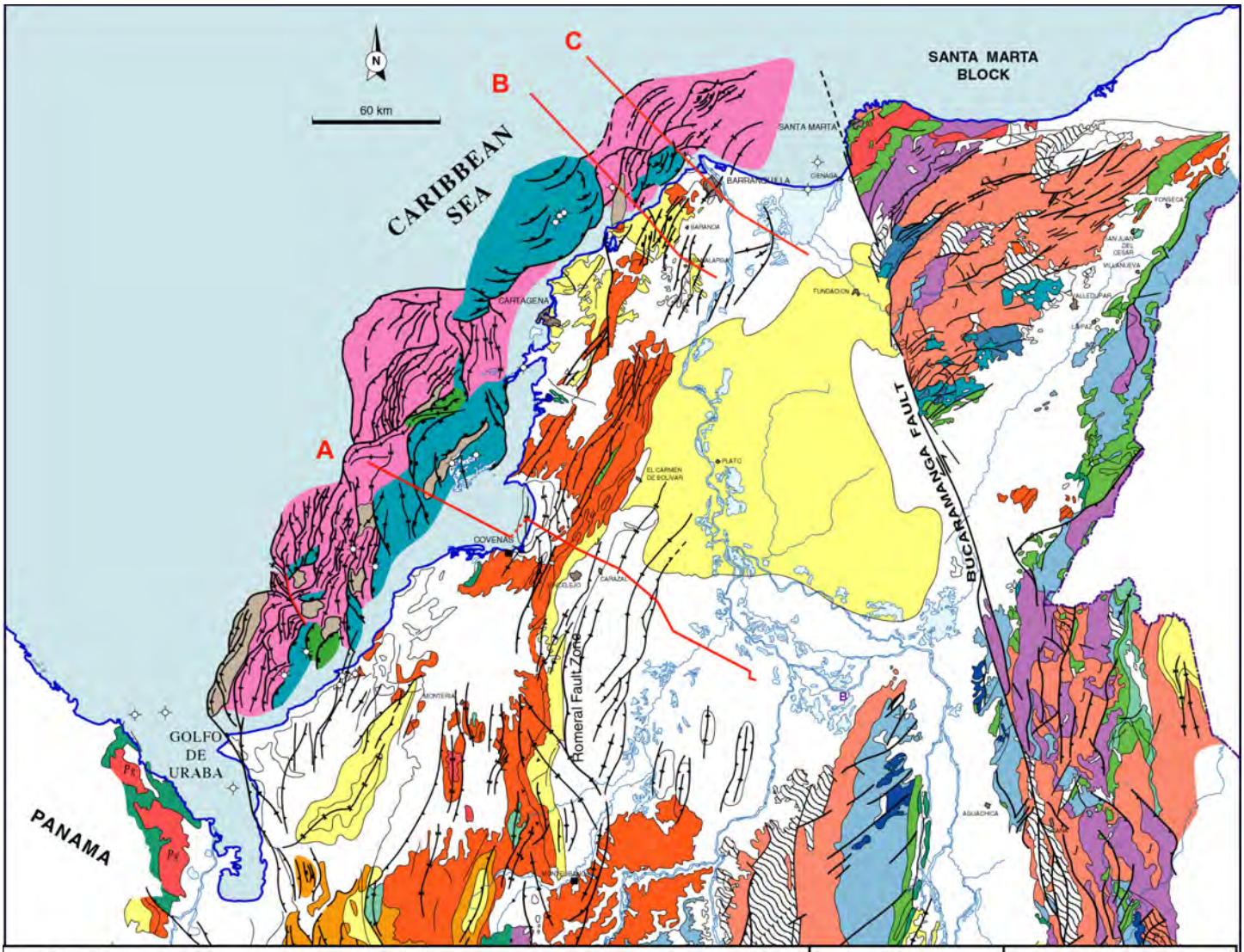

Fig. 1. Geologic map of northern Colombia (Flinch 2003) merge with the structural map of the offshore area (i. e. Outer Accretionary Wedge).

Inner Accretionary Wedge (Exposed Onshore)

The most internal and older part of the Northern Colombia Accretionary Wedge is exposed along the San Jacinto Mountains and Sinu area, west from the Plato-San Jorge Basin. This "Inner Accretionary Wedge" consist of west-vergent thrust related imbricates involving the Cretaceous Oceanic Crust a thin Cretaceous sedimentary cover represented by the Cansona Formation and pelagic and flysch type Paleogene to Lower Miocene sediments. Growth

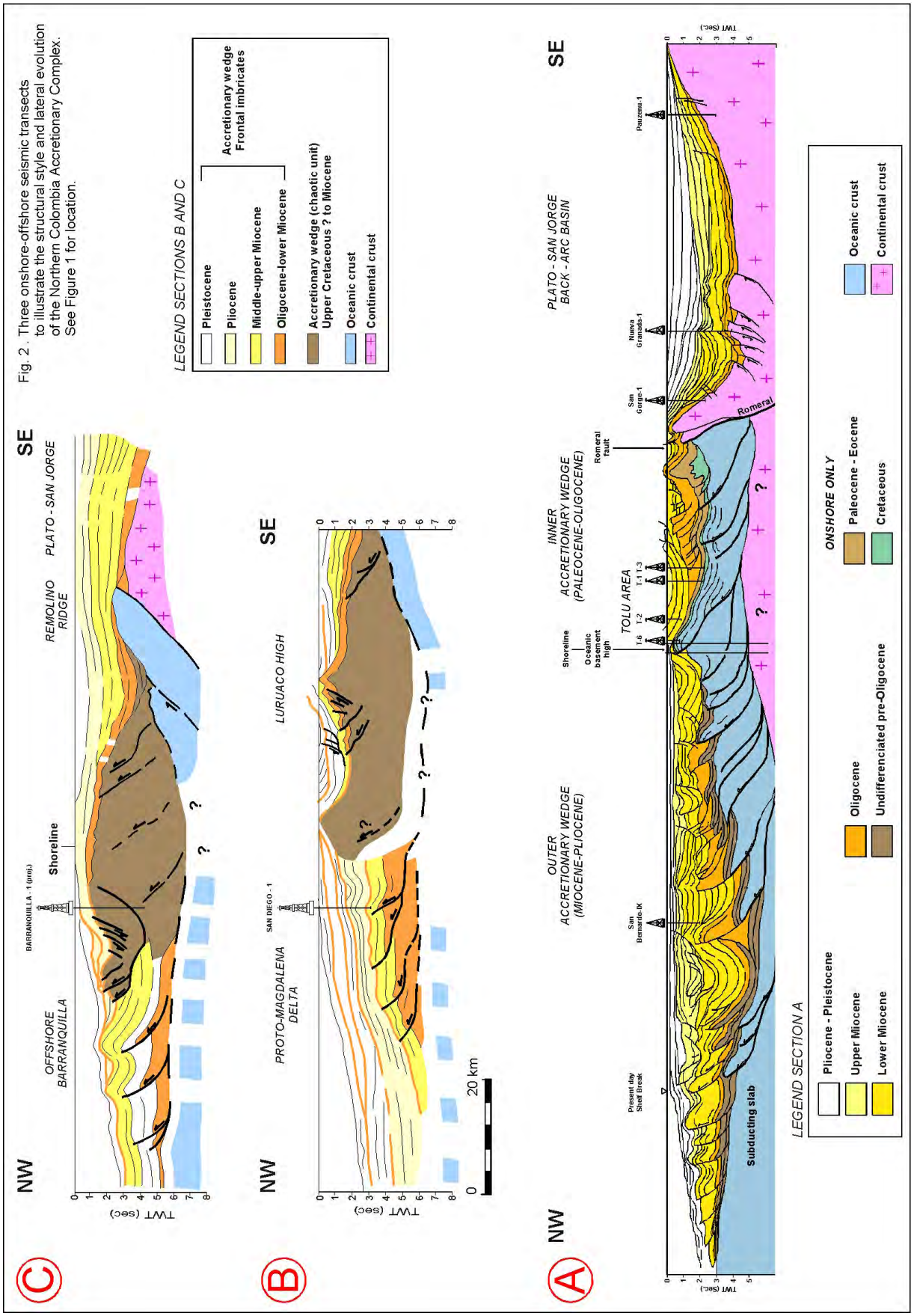
Fig. 2 . Three onshore-offshore seismic transects to illustrate the structural style and lateral evolution of the Northern Colombia Accretionary Complex. See Figure 1 for location.
LEGEND SECTIONS B AND C
Pleistocene
Pliocene
Middle-upper Miocene
Oligocene-lower Miocene
Accretionary wedge
Frontal imbricates
Accretionary wedge (chaotic unit)
Upper Cretaceous ? to Miocene
Oceanic crust
Continental crust
C
NW
SE
OFFSHORE BARRANQUILLA
REMOLINO RIDGE
PLATO - SAN JORGE
BARRANQUILLA - 1 (proj.)
Shoreline
TWT (sec)
B
NW
SE
PROTO-MAGDALENA DELTA
LURUACO HIGH
SAN DIEGO - 1
TWT (sec)
0
20 km
A
NW
SE
OUTER ACCRETIONARY WEDGE (MIOCENE-PLIOCENE)
INNER ACCRETIONARY WEDGE (PALEOCENE-OLIGOCENE)
PLATO - SAN JORGE BACK - ARC BASIN
TOLU AREA
Shoreline
Oceanic basement high
Romeral fault
San Bernardo-IX
San Gregorio-1
Nueva Granada-1
Pauxomu-1
Romeral
Present day Shelf Break
Subducting slab
TWT (sec.)
LEGEND SECTION A
Pliocene - Pleistocene
Upper Miocene
Lower Miocene
Oligocene
Undifferenciated pre-Oligocene
ONSHORE ONLY
Paleocene - Eocene
Cretaceous
Oceanic crust
Continental crust

strata depocenters shift from east to west as accretion progresses towards the west (Flinch 2003). Seismic, well and surface geological data can be used to characterize the internal structure of the prism in the southern San Jacinto region. This contrast with the northern Barranquilla area where the image is chaotic

Outer Accretionary Wedge (Offshore Sinu Prism)

The offshore and more widespread part of accretionary wedge extends from the offshore Caribbean sea from Uraba to Santa Marta and is occupied by three well-defined structural provinces (Fig. 1), from west to east:

1. Undeformed Abyssal Plain floored by the oceanic crust and its volcanic cover. This unit is characterized by chaotic reflectors local highs that could represent seamounts and a thin cover of un-deformed or parallel reflectors locally affected by normal faulting.

2. " Frontal Imbricates " consisting of thin Upper Cretaceous? to Oligocene section overlain by a thick Miocene and specially Pliocene-Pleistocene section. Most of the deformation is Pliocene in age but the prism is still active today. Seismic expression west to northwest vergent thrust related imbricates well-bedded seismic facies. Growth strata can be clearly seen in the area. This unit is strongly variable along strike especially along the Proto Magdalena fan (i. e. Pliocene-Pleistocene Delta and Deep-Sea fan of the Magdalena River).

3. " Chaotic Unit ", this is the part of the prism affected by normal faulting and toe-thrusting, shale ridges are common in this domain which is characterized by transparent seismic facies. This part of the prism is made up by older rocks mostly Oligocene overpressure shale and Miocene sediments. This unit is overlain by thick sedimentary fore-arc basin like the San Bernardo Basin, which is controlled by normal faults and shale ridges. This area corresponds with bottom sea evidences of gas escape and mud-volcanoes of large dimensions.

Three Regional Onshore-Offshore Cross-sections

A regional picture of the northern Colombia Accretionary Wedge can be well illustrated by several regional cross sections from the abyssal plain to the onshore Plato-San Jorge Basin (Fig. 2 ; see figure 1 for location).

Section A extends from the Monteria area to the Caribbean abyssal plain through the Tolu basin (Fig. 2A). This section clearly illustrates the different size between the Inner and Outer Accretionary Wedge and the different degree of Oceanic Crust involvement. The hypothetical continuity of the Cretaceous sedimentary section (i. e. Cansona Formation) towards the offshore area is the major unknown. The Outer Accretionary Wedge is floored here by a thick Oligocene overpressure shale section that plays the role of the basal detachment. Notice that locally here the subduction contact between the oceanic and continental crust is offset by the Romeral fault.

Section B extends from the Plato area towards the offshore area (N from Cartagena) along the Proto-Magdalena delta and deep sea fan (Fig. 2B). Notice the thick syn-tectonic section that partially onlaps the prism imbricates. Here the Inner Accretionary wedge is as large as the Outer one, but its internal structure difficult to characterize due to poor seismic resolution.

Section C starts west from the Bucaramanga fault and through the Remolino Ridge (where the Remolino well is located) extends towards the offshore Barranquilla area, just north from the Proto-Magdalena Delta and south from the present day mouth of the Magdalena river (Fig. 2C). This section illustrates the eastward termination of the Accretionary Wedge and how it pinches out above the Cretaceous oceanic crust of the obducted Proto-Caribbean Plate. The internal structure of the inner prism is difficult to discern, toe-thrusting is common in the most external part. The Outer Accretionary wedge is characterized by west vergent imbricates involving Oligocene to Holocene strata.

Structural Evolution

Following Upper Cretaceous obduction of the Cretaceous oceanic crust (and its Cretaceous sedimentary cover) of the Proto-Caribbean plate above the South-American plate, subduction took place along the Northern Colombian margin

(Flinch et al. 2000). Since that time until present west-vergent accretion took place along the margin. Accretion migrated from east to west being mostly Paleocene to Oligocene in the "Inner Accretionary Wedge", exposed onshore along the San Jacinto and Sinu areas, and becoming Neogene towards the offshore "Outer Accretionary Wedge". In the so-called "Chaotic unit" accretion took place during Miocene time and in the frontal Imbricates mostly during Pliocene to Pleistocene time. Due to the dynamics and internal thickening of the prism, the accretionary wedge becomes unstable reaching the critical taper (Davis et al. 1983) and collapses. This collapse mostly Pleistocene to present in age overprinted previous compressional structures and it is linked to an Oligocene shale detachment (shale tectonics is also common in this domain). So part of the Outer Accretionary Wedge is the result of gravitational collapse that overprints pre-existing compressional structures.

Conclusions

The northern Colombia Accretionary Wedge can be subdivided into: an Inner and an Outer Accretionary Wedge exposed onshore and offshore respectively. The Inner Accretionary Wedge consists of Paleocene to Oligocene W-vegent imbricates also involving the Cretaceous Oceanic crust. The Outer Accretionary wege present along the Offshore Sinu area is characterized by a Chaotic Unit involving Paleogene to Miocene Strata (in the east) and the "Frontal Imbricates" made of W to NW vergent thrust imbricates involving Miocene to Pleistocene Rocks (in the west). Deformation is mostly Pliocene/Pleistocene in the "Frontal Imbricates" further East Pleistocene extension overprints previous deformation. Folding and thrusting is less evident along the Proto-Magdalena area due to high sediment rate during deformation.

Cited References

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