THE INFLUENCE OF ASEISMIC RIDGE SUBDUCTION IN THE SHAPING NORTHERN SOUTH AMERICA PACIFIC MARGIN: PRELIMINARY PROVENANCE PATTERNS OF THE CENOZOIC TUMACO FOREARC BASIN, SW COLOMBIA

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ABSTRACT

Forearc basins are strongly influenced by major changes on subducted oceanic plate structure, convergence parameters and upper-plate arc evolution. Subduction of aseismic ridges or other anomalous oceanic elements (e.g. seamounts, ridge subduction) have shown to cause major modifications in the uplifting, subsidence and magmatic patterns in the upper-plate from the trench towards extremely far inland. Preliminary provenance analyses of the Tumaco forearc basin (onshore segment) in the Pacific region of southwestern Colombia have delineated the major sources and their tracer compositional assemblages. The results have shown major shifts in detrital input, e.g., during the Miocene, an intermediate to felsic plutonic detrital source replaced the previous prominent volcano-sedimentary filling that characterized the basin. These provenance shift are probably related to a major phase of uplift of apparent deeper plutonic levels in the Western Cordillera, that together with the associated structural segmentation record in the basin, is a consequence of the subduction of some of the major aseismic ridges that characterized the Pacific margin of Northern South America. Besides, the younger record in the Tumaco Basin was strongly controlled by the growth and enlargement of the Late Miocene to Pliocene magmatic arc in the Western Cordillera, which represents a renewed volcanic flux following the Early Oligocene magmatism, and may be also controlled by the subduction of the anomalous Cenozoic features (e.g Carnegie ridge) in the subducted Nazca plate. Ongoing stratigraphic and biostratigraphic analyses, together with higher resolution provenance and thermochronological approaches will patterns, aseismic ridgesallow understanding the influence of the variable features of the Nazca oceanic plate in northern South America Pacific margin and the time-process relations.

Keywords: Tumaco Basin, Cenozoic, subduction, provenance

LOCATION

FIGURE 1. The Tumaco forearc basin is located in the northern Andes to the southwest of Colombian pacific coast. The basin was developed between the Occidental Cordillera and the Ecuadorian-Colombian trench, and it is divided in the onshore and offshore sub-basins. In the figure inset is showed the surveyed area of the onshore part of the basin .

TUMACO FOREARC BASIN

The Colombian trench, accretionary complex and forearc basins lie along the western margin of South America. During the early Cenozoic, convergence took place between the Farallon plate and the South American Plate. The Tumaco forearc basin form part of the active zone of convergence where the East Panama Basin of the Nazca plate is subducted beneath the North Andes Block of South America at a rate of 50–64 km Myr- 1 towards 090–098°. (Mountney and Westbrook, 1997). This direction and rate of subduction off-shore Colombia was established in the Early Miocene, following a major plate reorganization in the Pacific ,after the break-up of the Farallon plate and the South America Plate(Lonsdale, 2005) and has remained active to the present day (Figure).

The Tumaco forearc basin is divided in two sub-basins by the coastal uplift "Alto de Remolinogrande" the onshore and the offshore. In its onshore part, stratigraphically is composed by two megasequences, the lowest, a Late Cretaceous- Paleocene? volcanic and volcaniclastic basement, and the upper, defined by the Oligocene-Pleistocene sedimentary cover with up to 9000 m thick (Figure). A lithofacial survey was carried out in the outcrops around the Tumaco Bay and description and log analysis of the old wells cuttings (Remolinogrande-1, Majagua-1 and Chagui-1) will allow to make biostratigraphical age calibration based on nannofossils and will define the chronostratigraphical correlations between the lithological units.

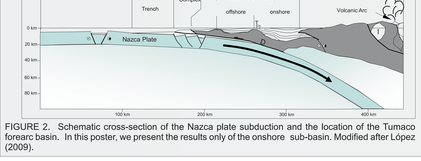


FIGURE 2. Schematic cross-section of the Nazca plate subduction and the location of the Tumaco forearc basin. In this poster, we present the results only of the onshore sub-basin. Modified after López (2009).

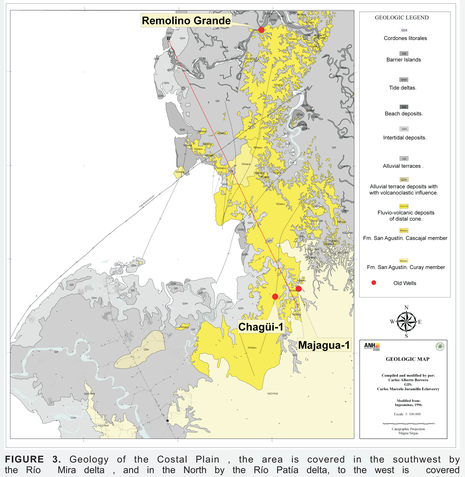


FIGURE 3. Geology of the Costal Plain , the area is covered in the southwest by the Río Mira delta , and in the North by the Río Patía delta, to the west is covered by the volcaniclastic fans related to the active volcanic arc located at the top of the Cordillera Occidental. In yellow colors are the units of the Tumaco forearc outcrop only on theNorth-South Alto Remolinogrande located close to the Pacific Coast in Tumaco Bay.

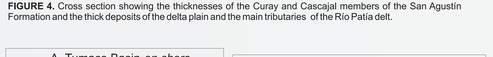


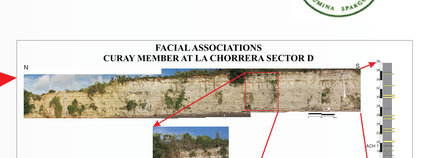
FIGURE 4. Cross section showing the thicknesses of the Curay and Cascajal members of the San Agustín Formation and the thick deposits of the delta plain and the main tributaries of the Río Patía delt.

FIGURE 5. A. Chrono-correlation of the lithological units surveyed in surface and the old wells units described in Figure. B. Biostratigraphic information available in the literature. The information of nanofossils, forams and radiolarians of different authors was the base for the chronostratigraphic table of A.

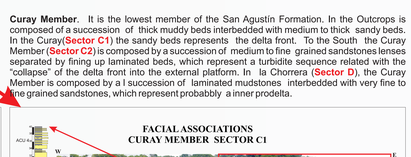
FIGURE 6. Location map of the stratigraphic logs around the Tumaco Bay.

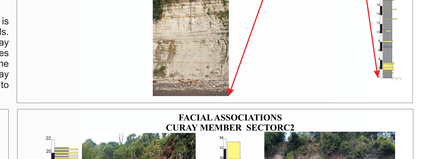
Cascajal Member. It corresponds to the Upper member of the San Agustin Formation, in its type locality of this member situated in the North of the Tumaco Bay (Sector A), the member is composed by a succession of thick very coarse to medium grained sandstones interbedded with fine mudstone beds, which represent the distal part of a probably fan-delta. This member in the El Morro (Sector B) located in the western beach of the Tumaco town is composed by a thick succession of fine to medium sandstone with conspicuous volcanic crystals, which represent a remnant of a volcaniclastic fan in the Late Miocene coastal plain.

OUTCROPS AND STRATIGRAPHIC LOGS



Curay Member. It is the lowest member of the San Agustín Formation. In the Outcrops is composed of a succession of thick muddy beds interbedded with medium to thick sandy beds. In the Curay(Sector C1) the sandy beds represents the delta front. To the South the Curay Member (Sector C2) is composed by a succession of medium to fine grained sandstones lenses separated by fining up laminated beds, which represent a turbidite sequence related with the "collapse" of the delta front into the external platform. In la Chorrera (Sector D), the Curay Member is composed by a l succession of laminated mudstones interbedded with very fine to fine grained sandstones, which represent probabbly a inner prodelta.





OLD WELLS TUMACO BASIN

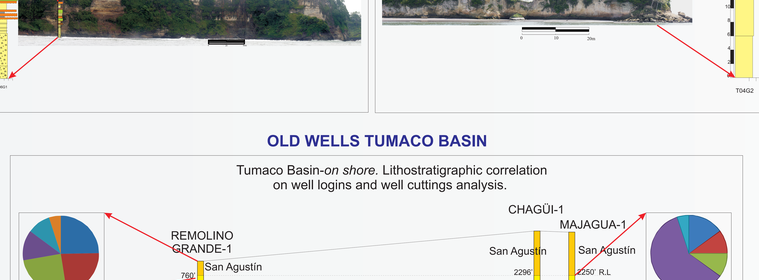


FIGURE 7. The proposed stratigraphy of the old wells (Remolinogrande-1, Majagua-1 and Chagui-1) is taken from Suarez(1990). Representative compositional pies show the main constituents of the different units:

-The Cayapas formation is predominantly composed by mudstone fragments with sporadic chert grains.

-The Viche and Angostura formations are composed by chert and fine sedimentary (mudstone and very fine sandstones), and mafic aphanitic volcanic fragments and a important proportion of calcareous constituent (calcareous sandstones and mudstones).

-The Chagui formation is composed by fine sedimentary fragments and coarse grained phaneritic intermediate to acid plutonic fragments, followed by the first apparitions of porphyritic andesite to dacite fragments , mainly in the middle and upper segments of the formation and a minor phase of milky quartz.

- The San Agustín formation, in this unit, the volcanic supply is very conspicuous by the broken quartz, feldspar, amphibole and biotite crystals and porphyritic andesite- dacite fragments, which replaced the dominant mafic volcanic supply of the lower stratigraphic levels (associated with the basement and western cordillera sources). Also, is notorious the coarse to medium grained phaneritic granitoids fragments , and poly- and mono- crystalline quartz grains , and minor sedimentary lithics.

CONCLUSIONS

The impact of ancient buoyant features aseismic ridges associated to the Nazca plate subduction during the Oligocene-Pliocene development of the Tumaco forearc basin is deduced taking into account the results of the compositional trends of the forearc's formations described in Figure. Detrital modes of the mudstones of the Oligocene Unidad 1 Sur formation and the Early Miocene Cayapas, Viche and Angostura formations, composed by mudstones and minor sandstones and chert, mixed calcareous rocks, and mafic volcanic fragments, which resemble the accreted Cordillera Occidental and the basement of the forearc basin. During the Oligocene – Early Miocene, probably the magmatic arc was in a building state, but it was not yet exhumated (Figure Map).

In the middle part of the Middle Miocene Chagui formation appears the first coarse grained phaneritic granitoides, and at the top of this formation appear the volcanic lithics, which mark the initiation of the magmatic system that affected the forearc system.

The Upper Miocene San Agustín formation marks the climax of the volcanic activity (Figure Map). The moderate sedimentary lithic component in the cutting of the old wells would indicate uplift and erosion of the Oligocene – Early Miocene forearc sedimentary sequences.

The break of the initial compositional trend in the Middle Miocene probably is related with the subduction of the aseismic ridge which caused rapid tectonic block rotation that allowed a major development of the incipient Early Miocene magmatic arc in many locations throughout the southwestern Colombia. Additionally, the compressional deformation of the forearc due to subduction of the ridge is relatively minor, suggesting that the gently sloping aseismic ridge coupled with Nazca plate was able to slide beneath the forearc without significantly deforming it.

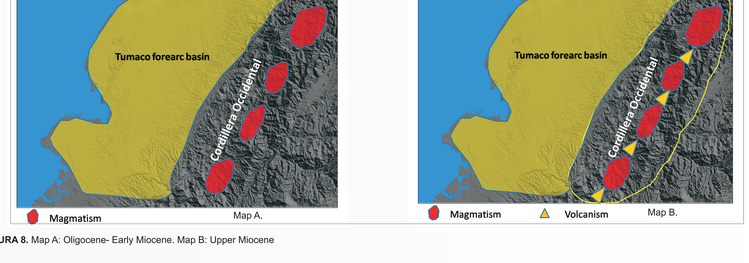


FIGURA 8. Map A: Oligocene- Early Miocene. Map B: Upper Miocene

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