NEOGENE STRIKE-SLIP BASINS AND THE WEAK FAULT CONCEPT FOR THE COLLISIONAL SUTURES OF ECUADOR AND COLOMBIA

Roger BAUDINO

Laboratoire de Géodynamique et Modélisation des Bassins Sédimentaires. IPRA. Université de Pau. 64000 PAU. FRANCE

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INTRODUCTION

The accretion of exotic terranes to the south American margin during Mesozoic and Cenozoic time characterizes Northern Andes. In Ecuador and Colombia several allochtonous terranes (or blocks) limited by collisional sutures have been identified (Fig. 1; Mc Court *et al.*, 1984; Mégard, 1989; Duque-Caro, 1990; Van Thournout *et al.*, 1992; Aspden & Litherland, 1992, and references therein). In northwestern Colombia the Chocó block is bounded to the east by the *Cordillera occidental* and to the south by the Istmina fault zone (IFZ). The coastal plain with the *Cordillera occidental* of Colombia and Ecuador form the oceanic Coastal Terrane. The Calacalí-Pallatanga Suture (CPF) and the Cauca Fault (CF) limit the latter from the Chaucha-Amaime Terrane which accreted along the Peltetec (PF) and Romeral (RS) Sutures. In northern Peru, the Amotape-Tahuin Block (ATB) is bounded to the north by the Raspas Fault (RF) and to the east by the Las Aradas Fault (LAF). Strike-slip motion, related to increased subduction rate, occured along the sutures triggering basins formation during the Neogene (Baudino, 1995). The study of two Neogene strike-slip basins of Ecuador, structurally linked to the CPF and PF sutures, revealed that their evolution is however incompatible with classical pull-apart models.

BASINS ANALYSIS

The Chota basin, in the northern ecuadorian Andes is located between the CPF and the PF (Fig. 1). Unconformable non-marine deposits of Miocene age, with a minimum thickness of 2400 m, overlie a Mesozoic metamorphic basement and are discordantly topped by Plio-Quaternary volcanics. The sedimentary fill is bounded by NE and N striking faults.

Sedimentologic analysis shows that the sedimentary fill can be divided into two main sequences (Baudino, 1995; Barragan *et al.*, 1996). Fining upward fluvial and lacustrine deposits form the lower main sequence, whereas the upper one is made of coarsening upward lacustrine and alluvial fan deposits. Local unconformities separate the two main sequences which correspond to different stages of the basin's evolution : opening during lower to middle Miocene and closing during upper Miocene.

Structural analysis revealed near horizontal slickensides, the migration through time of the deposition center towards the most active zones and flower structures, which are arguments for strike-slip basin related to dextral motion of the bounding faults. In addition, synsedimentary tensional faults, resulting of N120°E extension, indicate simultaneous fault-normal extension during lower to middle Miocene. Folding and faulting, resulting of N120°E (along NE striking bounding faults) and E-W (along N striking faults) compression indicate simultaneous fault-normal compression during upper Miocene.

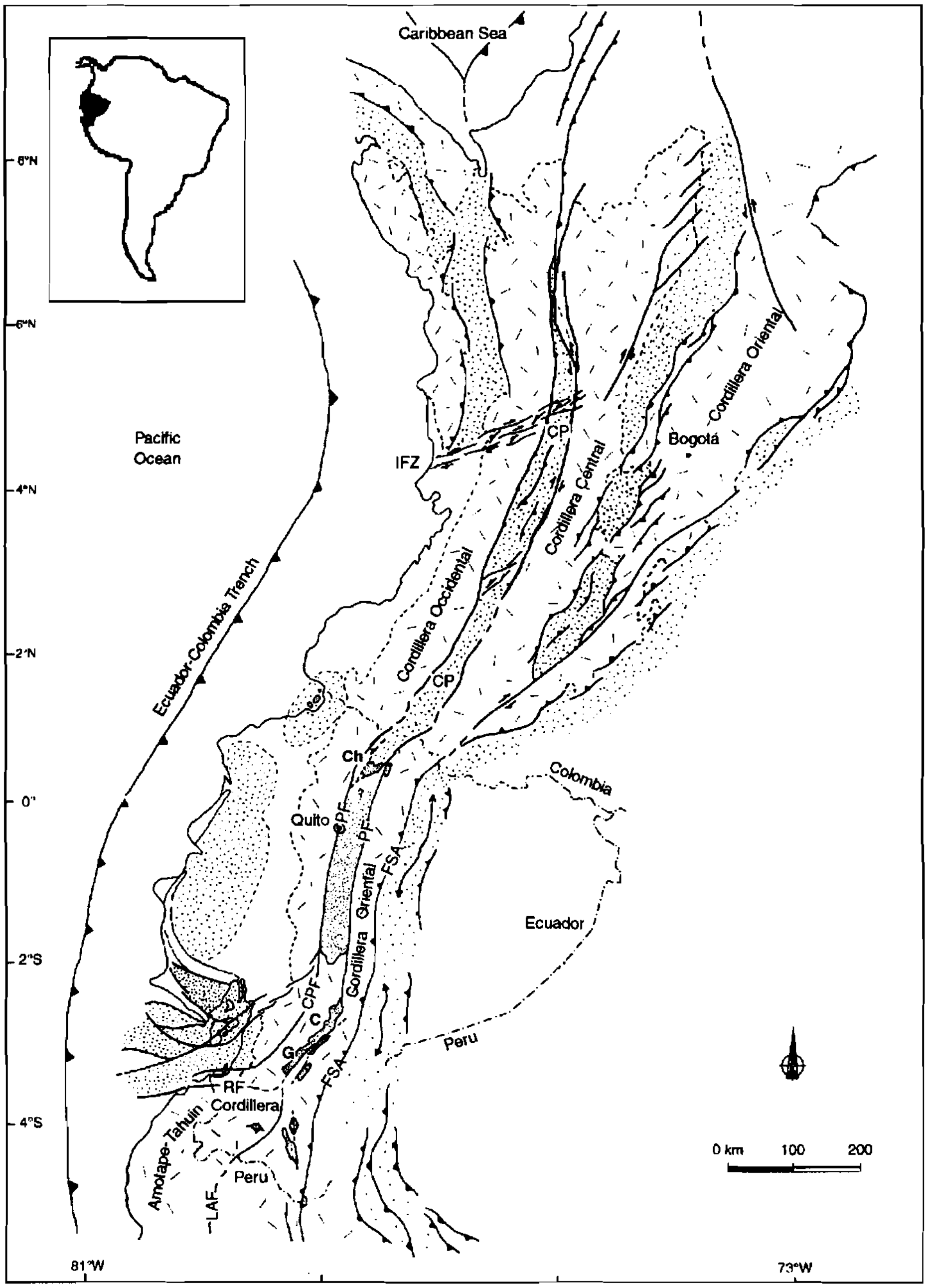

Figure 1: Morpho-tectonic map of Northwestern Andes showing ranges (hached) and Neogene sedimentary basins (dotted); Ch. Chota basin; C-G. Cuenca-Girón basin; CP. Cauca-Patía Depression; IFZ. Istmina Fault Zone; CPF. Calacalí-Pallatanga-Palenque Suture; PF. Peltetec Suture; RF. Raspas Fault; LAF. Las Aradas Fault; FSA. Ecuadorian Subandean Tectonic Front.

The Cuenca-Girón basin, in the southern ecuadorian Andes is an episutural basin situated upon the PF (Fig. 1). More than 5000 m of Miocene continental deposits unconformably overlie a late Oligocene and Mesozoic basement, and are discordantly topped by Plio-Quaternary volcanics. The Cuenca and Girón basins were formerly considered separately, but recent studies have shown that it is a unique asymetric basin with a thicker sedimentary fill near the eastern bounding fault (Baudino, 1995). This bounding fault is NE striking in the Girón and southern Cuenca basins (the active Girón Fault) and N striking in the northern Cuenca basin.

The sedimentary evolution is characterized by two main sequences (Noblet *et al.*, 1988; Mediavilla, 1991; Baudino, 1995) : a lower fining upward main sequence (made of fluvial and lacustrine deposits), and an upper coarsening upward main sequence (made of lacustrine and coarse alluvial fan deposits). These two sequences correspond to different stages of the basin's evolution : opening during lower to middle Miocene and closing during middle to upper Miocene.

In the light of detailed structural analysis, the Cuenca basin was defined a strike-slip basin related to dextral motion of regional faults by Noblet *et al.* (1988). These authors and Lavenu *et al.* (1995) proposed that a compressive stress field affected the basin with NNE-SSW to NE-SW shortening (and normal NW and WNW-ESE related extension) during the opening stage, rotating to an E-W and WNW-ESE shortening during the closing stage. However, the same authors described a synsedimentary extension normal to the bounding faults which counters the compressive stress field hypothesis during the opening stage. The NNE-SSW to NE-SW shortening was deduced from conical synsedimentary folds. These folds are however located near and have axis normal to the bounding faults, and appear then to be better explained by strike-slip motion of the faults rather than being characteristic of a regional compressive stress field. I think, thus, that transtension (simultaneous strike-slip motion and fault-normal extension) should be better used to characterize the tectonic regime affecting the Cuenca basin during the opening stage. Compression was coeval with strike-slip motion during the closing stage (Noblet *et al.*, 1988; Lavenu *et al.*, 1995). Moreover, a carefull examination of synsedimentary folds location show that compression is normal to the bounding faults, giving rise to N-S elongated folds in the northern part of the Cuenca basin and NE-SW elongated folds in the southern part. Transpression, thus, can be better used to characterize the tectonic regime affecting the basin during the closing stage.

In the Girón basin, transtension (with Girón Fault-normal extension) during the opening stage, and transpression (with fault-normal compression) during the closing are well documented (Baudino, 1995).

DISCUSSION

Stress fields associated with right-lateral strike-slip motion on the N and NE trending bounding faults of the Chota and Cuenca-Girón basins, and nearly parallel folding and faulting (normal or reverse) are incompatible with classical faulting theory. In the latter, the direction of maximum horizontal compression is expected to be 30°-45° for a vertical strike-slip fault plane (Anderson, 1951). One could invoke rotations affecting pull-apart basins and triggering tectonic inversion on a same fault in a stable compressional stress field (e.g. Richard *et al.*, 1995). In the present dextral strike-slip setting, however, this should be a clockwise rotation of the basins and not the anti-clockwise rotation suggested by Noblet *et al.* (1988) and Lavenu *et al.* (1995) for the Cuenca-Girón basin. Neither the Chota nor the Cuenca-Girón basins can thus be interpreted as pull-apart basins. An alternative to pull-apart basins has been proposed by Ben-Avraham & Zoback (1992) : relatively large-scale extensional or compressional features can develop parallel to transform faults that are best explained by the strong crust - weak transform conceptual model developped by Zoback *et al.* (1987) for the San Andreas fault system. In such cases, the horizontal principal stresses have to rotate to orientations approximately parallel and perpendicular to the weak transform fault so as to minimize shear stress on the fault. This reorientation resulted in fault-normal extension during lower to middle Miocene and fault normal compression during upper Miocene in the ecuadorian strike-slip basins genetically linked to collisional sutures. The Neogene basins of the Cauca-Patía Depression of Colombia, are related to strike-slip motion along the Cauca and Romeral Sutures (Fig. 1). Transtension during lower to middle Miocene and transpression during upper Miocene is also well documented in these basins (discussion in Baudino, 1995).

CONCLUSIONS

In the light of the previuous considerations it appears that the collisional sutures of the Andes of Ecuador and Colombia, which are deep crustal faults comparable to transform, acted as weak faults during the Neogene. Northward motion of the allochtonous terranes triggered transtension along the sutures. Strongest coupling between the subducting and overriding plates with buttressing effect provided by the Chocó block accretion and underthrusting of the Caribbean plate are probably responsible for the occurence of transpression during the upper Miocene (Baudino, 1995).

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