# NEOGENE TO PRESENT TECTONIC EVOLUTION AND STRESS FIELD IN ECUADOR

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Résumé : L'analyse de la microtectonique, celle des déformations synsédimentaires et celle de la morphologie des bassins néogènes et quaternaires de la zone intracordillèraine des Andes d'Equateur montrent une persistence de la tectonique compressive NNE-SSW à E-W du Miocène inférieur à l'Actuel. Des modifications locales du champ de contrainte peuvent être dues à des contitions particulières.

Key Words : Syn-sedimentary deformations, stress, Neogene, Andes, Ecuador

- an intermediate sedimentary unit (U2) corresponding to most of the infill. This unit lies in discordance with unit U1 and correspond to the Neogene infill of the basins (22 to 8 Ma; 1500 to 4000 m thick). The unit can be divided into two megasequences: M1 and M2.

-an upper volcano-sedimentary unit (U3, Llacao and Tarqui Fm.) which disconformably overlies the previous units.

The IAD infilling consist of Pliocene to Recent volcaniclastic continental, fluviatile and lacustrine sediments. In recent studies we have shown that these deposits consist of four distinct sedimentological units (Lavenu et al., 1992).

- The oldest unit, U1, is essentially composed of lahars, pyroclastic levels, interstratified andesitic flows (400 m thick; 1.4 to 1.8 Ma).

- Unit U2 forms a progressive unconformity over the previous unit (fluvial and lacustrine deposits, 50 to 80 m thick).

These two units represent the Latacunga Formation.

- Unit U3 lies unconformably over the previous units (Chalupas Fm.; 1.2 Ma; >50 m thick).

- Unit U4 is composed of recent pyroclastic tuffs (Cangagua Formation).

## NEOGENE SOUTH ECUADORIAN BASINS

Synsedimentary folding deformations affected the basin sediments (Lavenu and Noblet, 1989).

The M1 megasequence deposits (lower Miocene) display sedimentary wedges which indicate the presence of a normal component in the N20-N40°E faults during sedimentation. An additional folding deformation corresponds to a NNE-SSW shortening direction, perpendicular to the NW-SE tensional direction. This tensional deformation characterizes the basin's opening.

In megasequence M2 a synsedimentary folding deformation with a N60°E trending shortening direction affects the lower to middle Miocene deposits. The development of these folds is kinematically compatible with a right-lateral component of the movement along the N20°E faults.

The upper levels of the megasequence M2 (upper Miocene) show a series of progressive unconformities related to synsedimentary N-S folding with a mean E-W trending shortening.

A microtectonic study evidences an ongoing compressive stress regime during at least the Miocene period.

Lower sediments (M1) and substratum (U1) of the basins display a first direction of the major stress component $\sigma 1$ during lower Miocene, between N23°E and N64°E. Then, in the deposits of middle to upper Miocene (M2) and substratum, the direction of major stress component $\sigma 1$ is between N71°E to N107°E. A relative chronology of the striations is coherent with a NE-SW compression followed by an E-W compression.

## PLIOCENE-QUATERNARY INTERANDEAN BASINS

The IAD is characterized by a large late Pliocene - Quaternary basin situated between N-S reverse basement faults.The formation of the IAD probably began in the Upper Miocene. An E-W shortening drives the reverse faults since upper Pliocene.The shortening became more pronounced during and after deposition of unit U1 (Latacunga Fm.). Analysis of folds and flexures demonstrates that at least between 1.7 and 1.2 Ma, the southern part of the IAD was subject to major shortening along an E-W direction. This deformation began while U1 sediments were being deposited, and continued and intensified during the deposition of U2. The morphology (deviation of rivers, landslides etc...) reveals the continuation of the shortening during the recent Quaternary. The seismicity and focus mechanisms highlight the present-day persistence of the E-W shortening. All of these arguments are in favor of a "push-down" basin interpretation.

## CONCLUSION

From a sequential analysis of infill deposits in the South Ecuadorian basins, a phase of deepening of the lower Miocene basins, followed by infilling in the middle to upper Miocene has evidenced. Synsedimentary deformations affected the entire Miocene. They reveal a normal component on N20°E-N40°E trending faults during M1 and compressive tectonics during M2. Shortening directions deduced from fold axes of synsedimentary folds

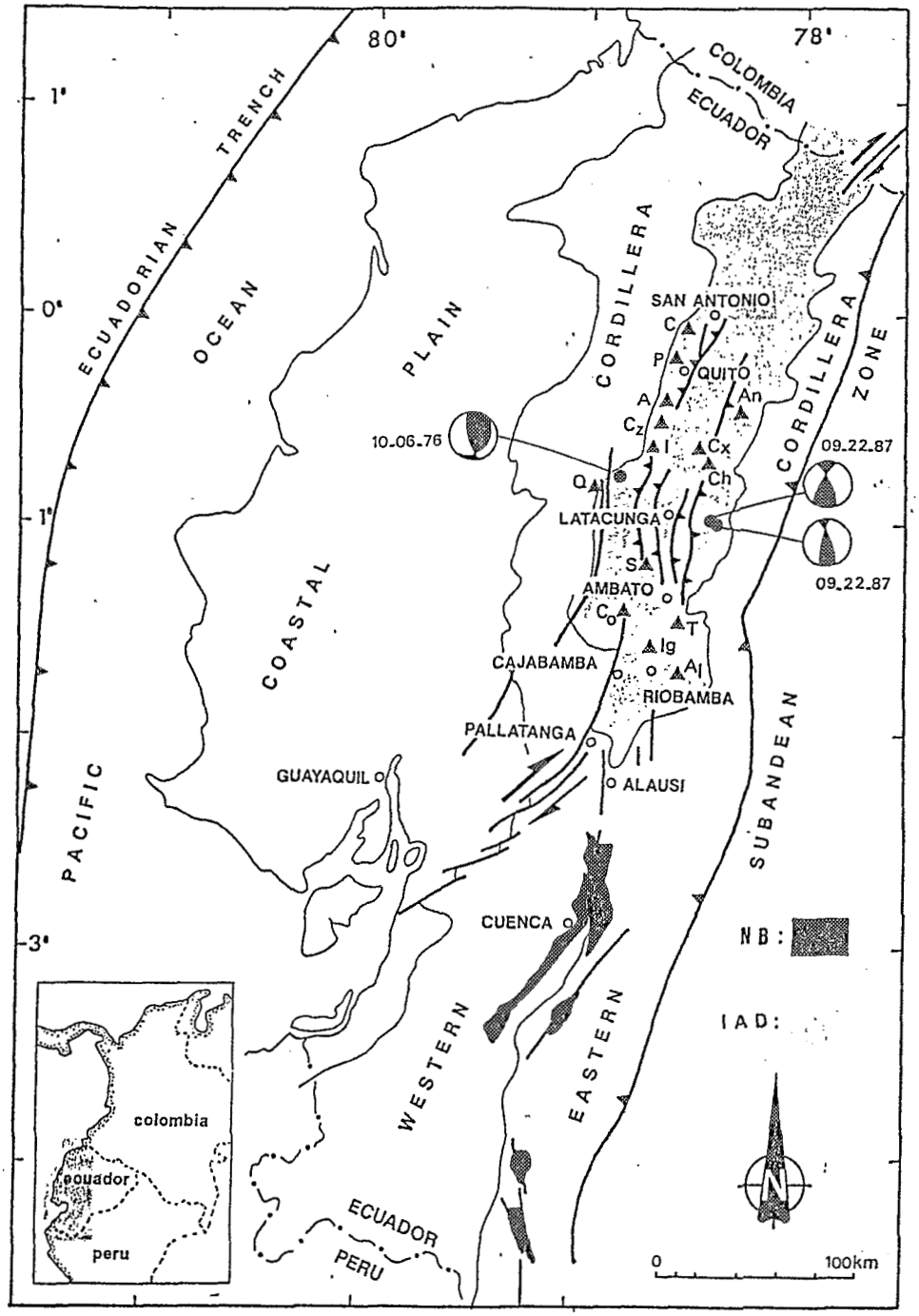


Figure: Schematic tectonic map of the mean recent and active faults. Location of the Neogene basins.

IAD: Interandean Depression; NB: Neogene basins; Black triangles, volcanoes: A= Atacazo, Al= Altar, C= Casitagua, Co= Chimborazo, Cx= Cotopaxi, Cz= Corazon, I= Iliniza, Ig= Igualata, Q= Quilotoa, P= Pichincha, S= Sagoatoa, T= Tungurahua. Focal mechanism solutions of three shallow-focus (>30 km) earthquakes (lower hemisphere projection). P axis in white quadrant. At the present time Andes of central Ecuador are affected by an E-W trending shortening.

vary between N60°E at the base of M2 to N80°E-N130°E at the top of M2. Microtectonic analysis has evidenced a state of compressive stress with σ1 following a NNE-SSW direction in the lower Miocene. The lower Miocene deepening is the consequence of right-lateral strike-slip movements along N-S faults and right-lateral-normal movements along N20°E-N40°E faults. The stress field in the middle and upper Miocene is characterized by a major stress σ1 approximately E-W. Results of the microtectonic analysis, the sedimentological study and the analysis of synsedimentary deformations, suggest that the basin infilling is due to movements with a strong reverse component along N-S and N20°E faults.

The E-W shortening observed in the IAD is kinematically compatible with the present right-lateral kinematics (with a slight reverse component) of the Pallatanga Fault (Winter and Lavenu, 1989; Winter et al., in press). It is also compatible with the pull-apart basin interpretation given for the Gulf of Guayaquil and related to right-lateral movements since the Miocene along the D-G M fault.

The central part of the Ecuadorian IAD between Quito and Ambato is characterized by structures (folds, flexures, reverse faults) which are due to E-W shortening.

To the south of this area, active Quaternary structures have reverse-right strike slip movements, of NE-SW direction which are also due to the E-W compression (Pallatanga Fault).

To the north of this area, in the south of Colombia, a system of active NE-SW right-lateral faults is also due to E-W compression.

The behavior of the Quito-Ambato zone can be illustrated as a compressive N-S relay in a system of large right strike-slip structures.

So, sedimentological, synsedimentary folding deformation and microtectonic analyses show a persistent and continuous compressional stress regime in the Interandean basins of Ecuador, from Miocene times to Present-day.

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