TRANSTENSIVE TECTONIC COMPLICATIONS IN THE WESTERN BORDER OF THE ECUADORIAN ANDES: THE EXAMPLE OF MINDO

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INTRODUCTION

The Mindo Basin, in the western border of the Ecuadorian Andes, is located 35 km west of Quito, over the large Santo Domingo-Los Bancos alluvial fan (Figure 1). This fan, along with other similar structures, characterizes the western cordillera foothills.

GEOLOGY

The geology of this region is little known or even unknown. It is mainly determined from the alluvial fan deposits. This deposit is present for over 20 km in the direction parallel to the cordillera, and 500 km in the transversal direction. This alluvial fan consists of two sources that form juxtaposed cones. To the south the source are the Toachi River sediments that extend towards the Santo Domingo region, and to the north the source are the Blanco and Guayllabamba Rivers that extend to the San Miguel de los Bancos region.

The fan consists of blocks, gravel, sand, and clasts from a volcanic origin. The grade of alteration is variable, but in general, it is high due to the presence of hot and humid weather. The thickness of the sediments is unknown. Younger ash layers that are up to 7 m thick cover these materials.

The age of the fan is unknown, but it can be estimated assuming that the major and more recent Andean uplift occurred during Lower to Mid Miocene. This uplift was followed by a period of erosion in the Upper Miocene (Ego, 1995). This erosion could be a reason for the formation of these alluvial fans, dating them to the Upper Miocene. Subsequently, they received sediments from Plio-Quaternary volcanic deposits.

MORPHO-TECTONIC ANALYSIS

After an aerial photograph and terrain modeling analysis, we can see that the Mindo Basin is a depression limited with vertical walls that can reach 400 m. On these walls, sedimentary deposits that form the fan are exposed. Their approximate shape is rectangular with their maximum axis in NNE-SSW direction.

The main drainage in this area is the Mindo River that runs from East to West. On the western border of the basin, the Canchupi River and the Saguambi "estero" are captured by the Mindo River as these rivers descend towards the depression (Figure 1). In the same zone we can see a scarp with a NE-SE direction which makes up the eastern limit of the basin. This scarp has a very important erosion rate. It can be followed to the Hacienda El Carmelo (Figures 1 and 2).

A well-defined scarp with a NE-SW direction characterizes the western limit of the basin. On the road that descends to Mindo, it was possible to take microtectonic measurements that showed strike-slip dextral movement, although morphology also suggests a normal movement component (Figure 2). The western scarp is crossed by a NNW-SSE lineament that displaces it a little in a dextral sense. Its prolongation towards the east is not clear but we can see some anomalous drainage and a more eroded scarp.

Following the Mindo River, near Finca La Palma, a small plane is observed, limited to the east by a NNW-SSE scarp with triangular facets. These suggest a normal movement. There is also a sinestral drainage control. This lineament can be followed to the south by the southern limit of the basin. In this zone a sinestral movement component is suggesting (Figure 2).

The Northern border of the basin shows an eroded scarp with a WNW-ESE direction, parallel to the main drainage of the fan (Figure 2). Movement markers could not be found in this zone. It could be a erosion scarp or an older and inactive structure.

FAULT KINEMATICS AND STRESS STATE ANALYSIS

Measurements were taken over two periods. In the first phase, they were taken in three points, two of them in conglomerate deposits (Mindo 1,2, Figure 1), and the third one in basement (Mindo 3,

Figure 1). This set of data was regrouped according to the sedimentary environment, and afterwards cinematic analyses were done with the data from the basement and the conglomerates in order to obtain only one tensor.

The inversion results show a very complex stress state. For extension, three tensor directions were obtained: N293 (compatible with the three points), N171 (compatible with points 1 and 2), and N35 using the three point data. Chronology observed in the field shows that this last direction is older than the N171 direction.

For compression, only two tensor directions were obtained: a unreliable N215 (only three families of planes were used for the calculation), and N290 (using the three point data). During the second phase, measurements were taken in point Mindo 4 in the conglomerate. This point shows a compression tensor that was added to first phase data giving a compression tensor of N114.

DISCUSSION

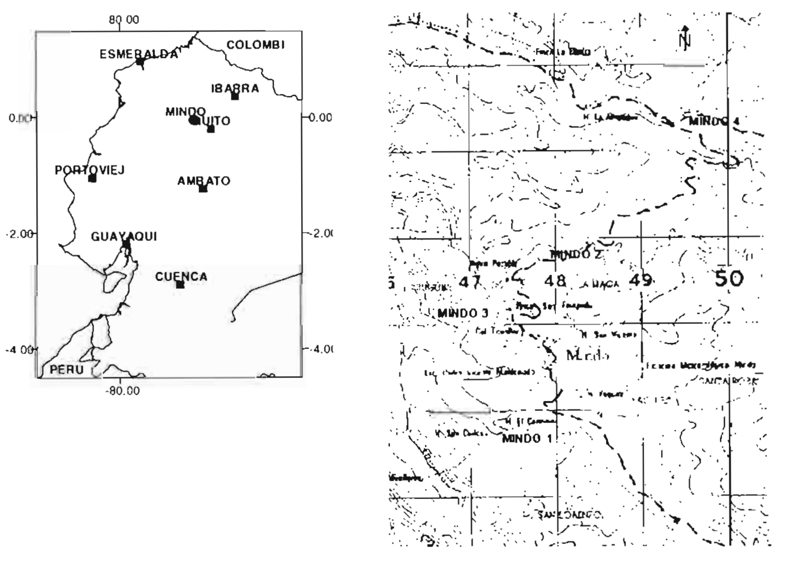

Figure 1. Mindo basin location. Microtectonic measure stations are named as Mindo 1,2,3 y 4.

In the interpretation of this data a few questions have been proposed: how the basin was formed, and how a pattern so complex fits into this scheme. This suggests the possibility of different periods of formation. Because of this, we offer an evolutionary model considering all data available.

In order to form the basin, we suppose that there was a system of transtension where would work the North and South borders of the basin. This transtensive system would permit the basin to open with perpendicular normal faults in which the evidence would be seen in western and eastern fault scarps (Figure 3a). On the other hand this opening would generate an extension in the direction NW-SE and NNW-SSE that could correspond to the extension tensors determined later inversion. While the basin was opening, the fault located in the western border prolongated to the north. This would form a triangular block with a southern sinestral fault, reducing the activity of the East and North borders. This would lead us to obtain the scheme that we observe currently (Figure 2). This new system permits the ejection of the block to the north between the fault of direction NNE-SSW and NNW-SSE (Figure 3b). For this new state and later to calculate the tensor, we see that there exists a compression with a direction of N114 degrees.

The significance of the direction of this tensor can be explained, by a variation of the regional tensor direction or by a local tensor that mechanically adjusted the system of observed faults. By now we think that the second option is better because we have no evidence of recent variations in the field of regional forces (Ego,1995).

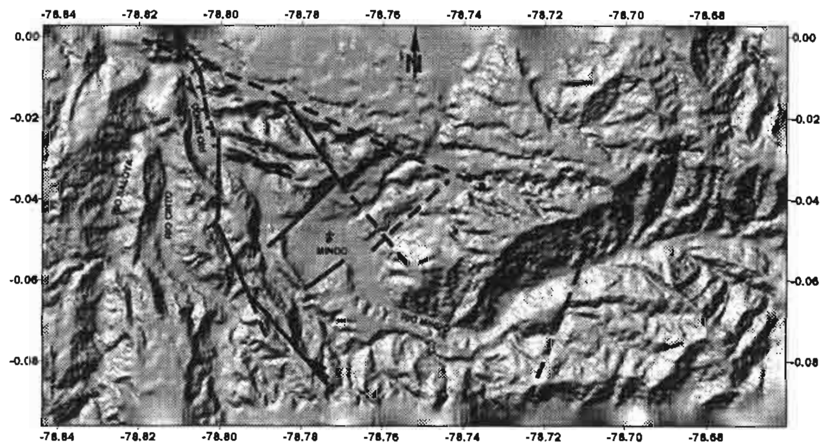

Figure 2. MNT with the main alignements including those observed in aereal photographs.

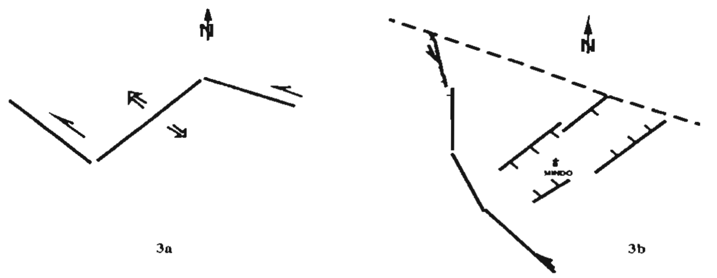

Figure 3.Schematic model proposed for the formation of the Mindo basin

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