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The Subduction Geometry Change under Colombia and Orogenic Evolution of the Northern Andes In Late Neogene Times

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Subduction geometry under the Colombian territory was checked in two ways. The first one was with the seismology based mainly with two methods: Hipocentral profiles analysis and the seismic tomography. The other one was with using the geological support in which the geotectonic context shows this situation based on the tectonic and stratigraphic data. According to the latter case, a topographic increase prevails for a flat subduction where the orogen is both wide and presents a posterior orogenic front located far away from the subduction trench (≥500km). Owing to the seismological information, it has been verified that close to the posterior limit of the orogen, the subduction angle has a sharp increase. This is the rule for Colombia -between 5ºN and 7ºN - as well as for other regions around the world that exhibit a flat subduction and where these characteristics can be seen since in southern Alaska, western North America, Peru and the Pampas between Argentina and Chile, among others.

Another characteristic of flat subduction is its relation to the subduction of an ocean crust that shows an abrupt topography caused by either a ridge or an ocean plateau. Generally, the abrupt topography and the cortical thickening of the continental produced by a ridge or oceanic plateau subduction can cause a buoyant phenomenon that may be, for a very short time, tantamount to the adjacent continental crust that produces a sublithospheric collision of the plates when it begins to shove into the subduction channel. This event makes the asthenospheric wedge move away from the trench zone because this anomalous intrusion inhibits the development of an accommodation space for it. The location of the asthenospheric wedge is related to the shift of the subduction angle and this result in an isosthatic change in the crust which pushes it upwards creating a considerable topographic lift with a visible mountainous front on the surface.

In Colombia, there are several characteristics that comply because:

1. The oceanic crust's topography adjacent to Colombia (Nazca Plate) that subducts under this South American area is abrupt because it constitutes by aseismic Coiba and Malpelo ridges which are a result of the Galápagos Spreading Center and its geological age is less than 15 million years (15 Ma).

2. Between 5ºN and 7ºN the Colombian territory has a vast orogeny whose width is 500km in average and its posterior mountain front (Llanos Foothills) is located at about 650km from the trench. The asthenospheric wedge pushed the crust in this area isostatically originating one of the highest altitudes in the Eastern Cordillera (Sierra Nevada del Cocuy).

3. Both the Western Cordillera (which has its greatest altitudes) and the Central Cordillera show between 5ºN and 7ºN its basements that were exhumed during this process and the absence of Late Neogene strata.

4. A tear, shown seismologically, separates two subduction zones and shows a change in the width of the orogeny and its distance with the subduction trench. South of 5ºN the orogeny is narrower (250km), it keeps a Superior Neogene strata of mainly volcanic constitution, and the shift of the subduction angle is closer to the trench (<500km).

According to the above, it is estimated here that the subduction under Colombian territory is very young in geological terms with an age that is not greater than 15 million years. The certainty of this statement is explained by the fact that the extinct or aseismic ridges like to Coiba and Malpelo began to subduct under this South American area 10 million years ago since volcanism is absent north of the 5ºN and the fragmentary outcrop in the regions that are very close to this latitude on the Central Cordillera

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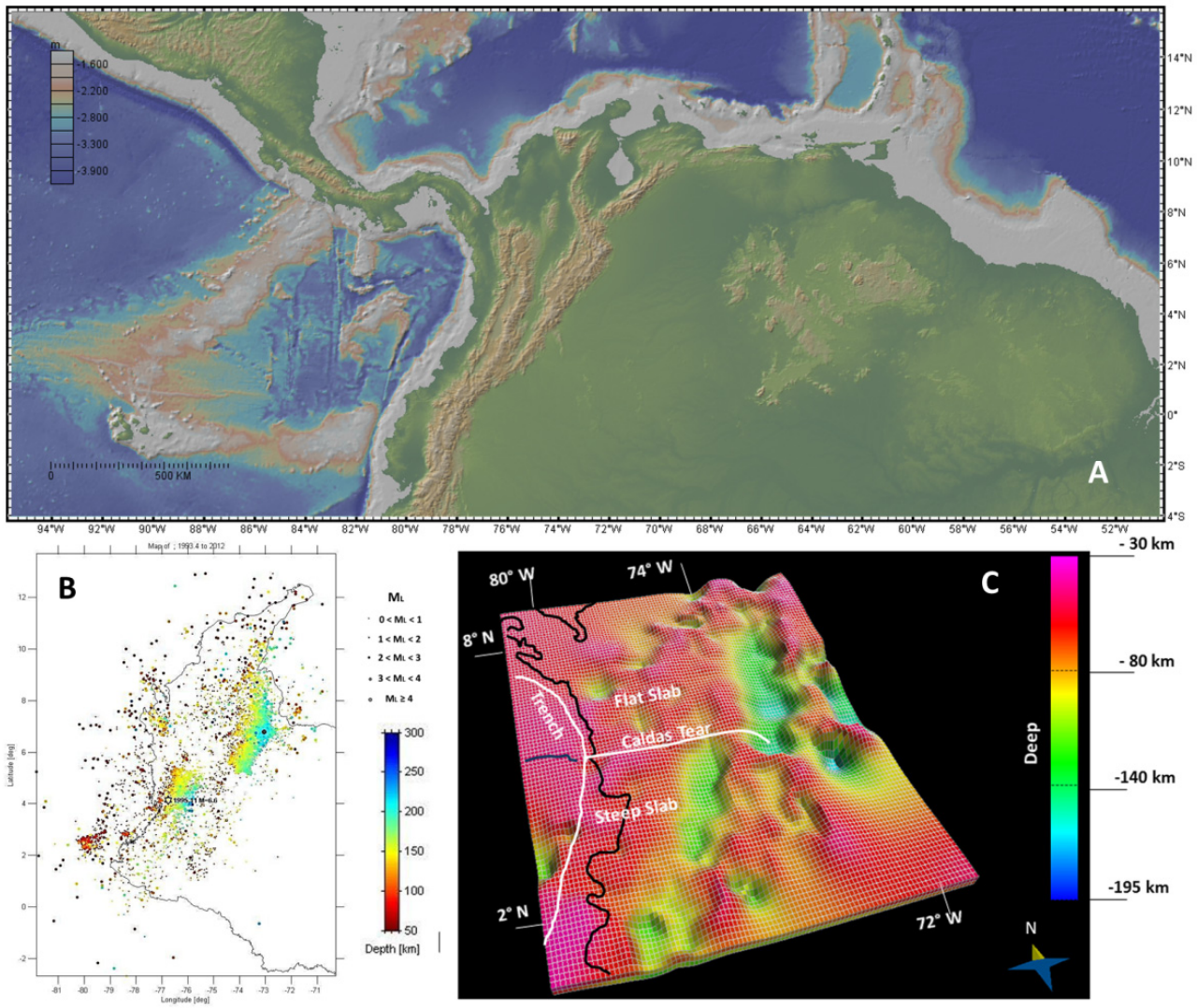

Fig. 1. A. Batimetric and topographic map of south Central America, north of South America and Cocos and Nazca plates. B. Seismicity map of Colombia by Colombian National Seismological Network for 1993 – 2012 lapse. C. Sublithospheric topography verified from the seismic tomography with a Digital Elevation Model.Compare the coincidences among the orogenic pattern with the sublithospheric geometry under Colombia. The figure B is for a better understanding of the figure C.

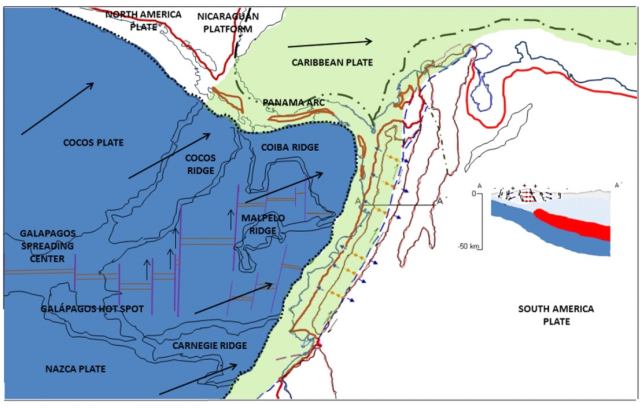

Fig. 2. Hypothetic geodynamic scheme showing the evolution of orogenic setting for Caribbean plate (Blue), Nazca plate (Green) and NW South America during Late Miocene - Early Pliocene lapse. A – A´ profile for best understanding.

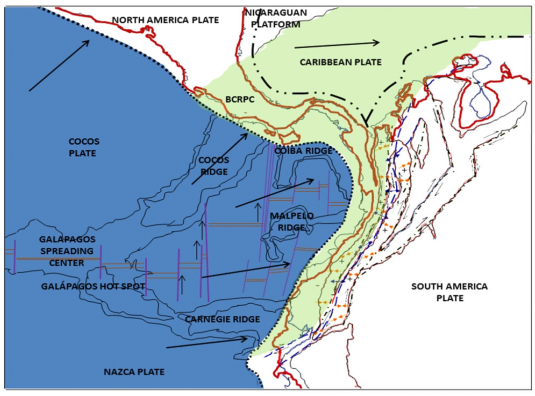

Fig. 3 Hypothetic geodynamic scheme showing the evolution of orogenic setting for southern Central America, NW South America and Caribbean and Nazca plates during Late Pliocene - Early Pleistocene lapse.

exhibit a Neogene volcanic activity that stopped towards the end of the Miocene (Combia Formation).

It is equally suggested that when aseismic ridges subducted, they produced changes in the subducted crust's buoyancy which created a tear due to the collision and the decrease in speed of the subduction north of 5ºN when the portions of the aseismic ridges were shoved into the subduction channel. The development of the flat subduction that originated between 5ºN and the 7ºN provoked a sharp cease of the volcanic activity and an eastern displacement of the asthenospheric wedge until the subducted plate began to shift its angle due to the gravitational effect which in turn produced it to get buried more than 500km from the trench. This latter situation caused a local crust rip up that consequently induced a volcanic activity in the Eastern Cordillera between 5ºN and 6ºN from 1 to 2 million years ago.

Key words: Flat Subduction, Northern Andes, Galápagos Spreading Center, Tear, Seismic Tomography

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