Three major faults in northeastern Colombia (Sierra Nevada de Santa Marta & Perija Range): seismotectonic model and scope of its seismic hazard

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Abstract

In the northeastern Colombia, the northernmost foothills of the Andes are present, whose representatives are the Sierra Nevada de Santa Marta (SNSM) and the Perija Range. This orogenic system is delimited by three major faults that limit three large basins. In its order from west to east are the Santa Marta Fault that limits the Sierra Nevada de Santa Marta with the Lower Magdalena Basin. The Oca Fault that limits with the low basin of the Rancheria River to the north in the south of Guajira Peninsula, and toward the east the Perija – El Tigre Fault that limits with the Maracaibo Basin. Each of these faults have a great size. Since 2008, when the National Seismological Network of Colombia (RSNC) increased its number of seismological stations in this region of Colombia, the recording of surface seismicity that is associated with the tectonic mobility of this orogenic system began. The strong earthquakes in this region do not exceed in magnitude M = 5.5, emphasizing earthquakes with M [?] 4.5 in average. The origin of the tectonic mobility of this orogenic system obeys to the convergence between the Caribbean Plate and the northwestern corner of South America. As a historical antecedent in this region is the earthquake of May 22, 1834 that destroyed the city of Santa Marta. Along the western sector of the Oca fault, this is composed of parallel faults and towards the east when it crosses the basin of the Ranchería River, present evidences of neotectonics. This fault becomes a good candidate to produce an earthquake with magnitudes greater than 5.0. For the Santa Marta fault, the alteration of the landscape by anthropic effect has erased evidence of active tectonics in its northern sector, while towards SE it shows morphotectonics related to its fault plane, and the Perijá - El Tigre fault due to inaccessible conditions Because it is a jungle area, very large and lacking communication routes as well as having a long history of armed conflict, it has been impossible to study it in the field and it has only been verified from a morphotectonic point of view with the help of remote sensors. To this fault is attributed to the earthquake of September 11, 2014 with M = 4.1 and inverse focal mechanism according to the report of the RSNC. In this work a tectonic model is shown, the kinematic behavior of each fault, and its probable seismic risk for this region of Colombia.

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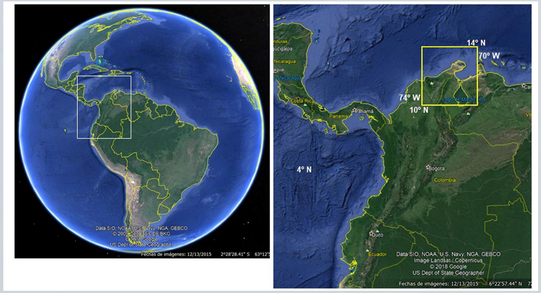
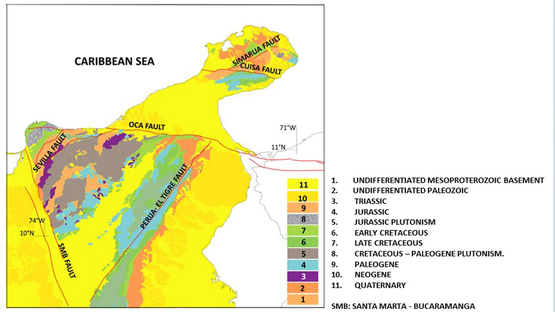
ABSTRACT

In the northeastern Colombia, the northernmost foothills of the Andes are present, whose representatives are the Sierra Nevada de Santa Marta (SNSM) and the Perija Range. This orogenic system is delimited by three major faults that limit three large basins. In its order from west to east are the Santa Marta Fault that limits the Sierra Nevada de Santa Marta with the Lower Magdalena Basin. The Oca Fault that limits with the low basin of the Rancheria River to the north in the south of Guajira Peninsula, and toward the east the Perija – El Tigre Fault that limits with the Maracaibo Basin. Each of these faults have a great size. Since 2008, when the National Seismological Network of Colombia (RSNC) increased its number of seismological stations in this region of Colombia, the recording of surface seismicity that is associated with the tectonic mobility of this orogenic system began. The strong earthquakes in this region do not exceed in magnitude M = 5.5, emphasizing earthquakes with M ≈ 4.5 in average. The origin of the tectonic mobility of this orogenic system obeys to the convergence between the Caribbean Plate and the northwestern corner of South America. As a historical antecedent in this region is the earthquake of May 22, 1834 that destroyed the city of Santa Marta. Along the western sector of the Oca fault, this is composed of parallel faults and towards the east when it crosses the basin of the Rancheria River, present evidences of neotectonics. This fault becomes a good candidate to produce an earthquake with magnitudes greater than 5.0. For the Santa Marta fault, the alteration of the landscape by anthropic effect has erased evidence of active tectonics in its northern sector, while towards SE it shows morphotectonics related to its fault plane, and the Perijá - El Tigre fault due to inaccessible conditions Because it is a jungle area, very large and lacking communication routes as well as having a long history of armed conflict, it has been impossible to study it in the field and it has only been verified from a morphotectonic point of view with the help of remote sensors. To this fault is attributed to the earthquake of September 11, 2014 with M = 4.1 and inverse focal mechanism according to the report of the RSNC. In this work a tectonic model is shown, the kinematic behavior of each fault, and its probable seismic risk for this region of Colombia.

1. LOCATION

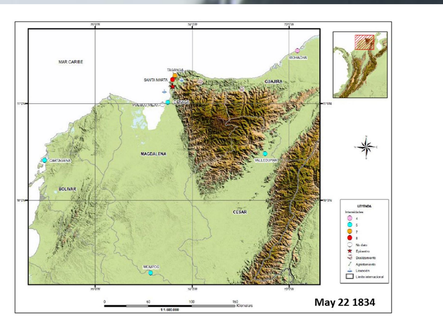


2. REGIONAL GEOLOGY



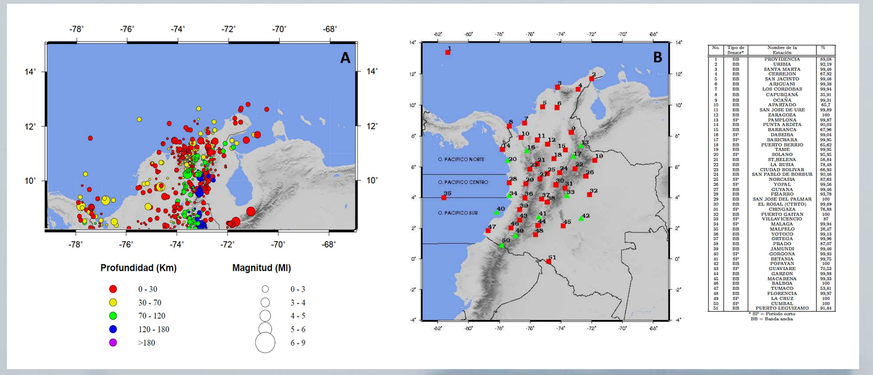
Chicangana et al., 2011

3. HISTORICAL EARTHQUAKE



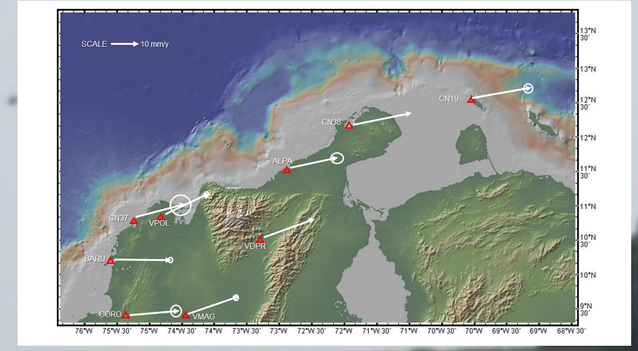
Cifuentes & Sarabia, 2006

4. REGIONAL SEISMICITY



As an example of the seismicity registered in the Colombian Caribbean platform: A. Seismicity recorded by the RSNC for the lapse July-December 2017. B. Location of the stations of the National Colombian Seismological Network (RSNC). The green triangles and the red boxes represent the stations with short period and broadband sensors respectively. Modified from Servicio Geológico Colombiano (2018).

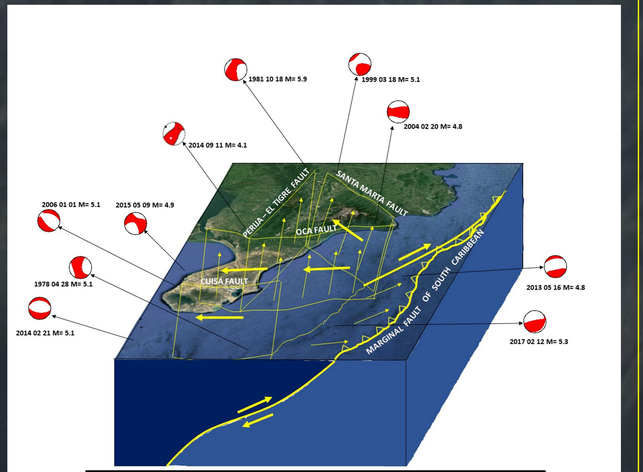
5. GPS VELOCITY FIELD

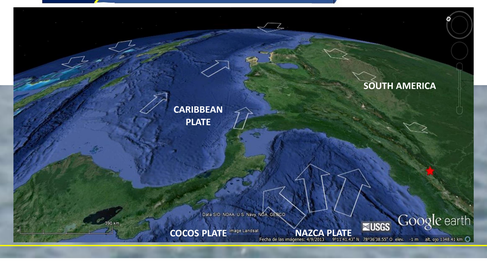


The new GPS velocity field results shown by Mora et al. (2019), show that the sites locate toward North of the 8 ° N latitude have large displacements to the ENE while that towards the south of this latitude, the North Andean block tends toward the NE with short displacements. These authors conclude that the large displacements of the Colombian Caribbean Platform or South Caribbean Deformed Belt, is due to the influence of the Panama Arc collision with the northwestern margin of South America.

6. CONCLUSION

In this sector of the southern margin of the Caribbean the Marginal Fault of South Caribbean (Kellogg, 1984) represents the contact within the South American continent with ancient slab of Caribbean plate (Farallon). This subduction ceased during the Eocene - Oligocene lapse when the Caribbean Plate was accreted with the continental margin. The subsequent displacement of the Caribbean plate towards the E is the result of the push that the Cocos - Nazca Subduction System produces on the Panama Arc - Caribbean Plate and the NW of South America. The earthquake tensors show the different kinematic responses that from the subduction of Nazca - Cocos subduction and the collision of the Panama Arc produced in this region.





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Kellogg, J. N. (1984). Cenozoic tectonic history of the Sierra de Perijá, Venezuela – Colombia and adjacent basins. In: The Caribbean - South America plate boundary and Regional tectonics, William E. Bonini, Robert B. Hargraves & Reginald Shagam, Eds., GSA Memoir, 162, 239 - 261.

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