

Seismic Source of Moderate Earthquakes in Colombia

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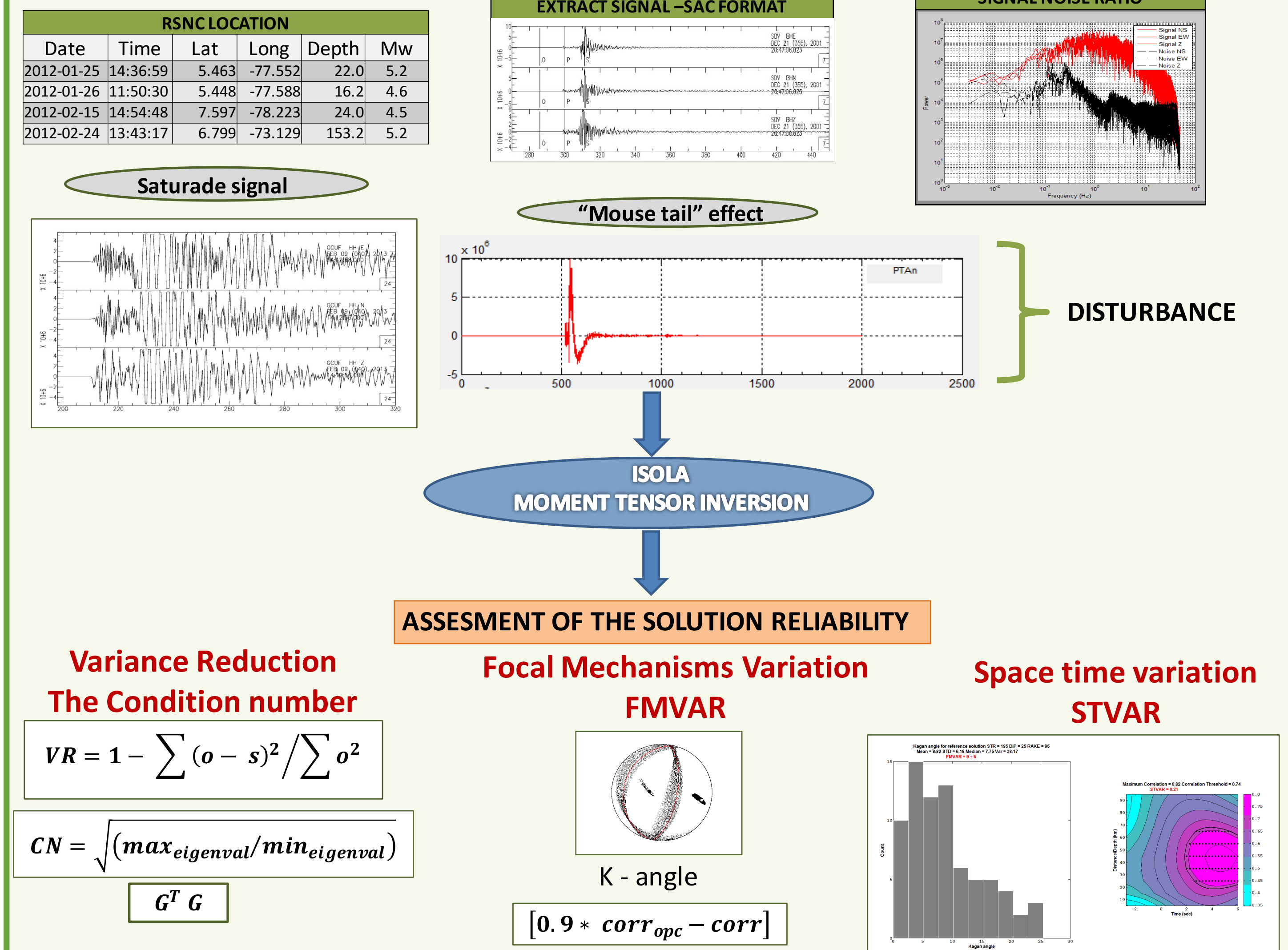
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Abstract

The National Seismological Network of Colombia, operated by the Colombian Geological Survey, receive in real time seismic data from 48 broad band stations and 47 strong motion stations installed along the Colombian territory, and data from stations of neighboring countries. This high density of the data allows the retrieval of source parameters for moderate earthquakes. Moment tensor solutions for earthquakes with Mw>4.0 recorded between 2012 and 2017 in Colombia and offshore areas were obtained. Moment tensor inversions were calculated with the inversion of complete regional waveforms in the range of 0.01–0.1Hz using the ISOLA code. The epicenters, depths and magnitudes estimated by national network were used as input, and centroid position and depth were refined by spatial and temporal grid-searching around the starting parameters; the quality of the solutions was assessed taking advantage of the ISOLA tools. This new catalogue, with its considerable increase in the total number of available solutions, has great potential to improve our understanding of the regional seismicity and of the ongoing tectonics.

Methodology

The epicenters, depths and magnitudes estimated by national network were used as input and then the centroid position and depth were refined by grid-searching around the starting parameters. The joint assessment of the signal-to-noise ratios, variance reduction, conditional number and the space-time variability of the solution allowed us to establishing the reliability of the results.



Colombian Broad Band and Strong motion Networks

Colombian Geological Survey (SGC, according to its initials in spanish) maintains a permanent seismic network and some temporally seismic networks for special studies. 48 stations have broad-band sensors and 30 stations have strong motion sensors, all of them transmit data in real time using satellite system communication. Additionally, it receive data from broad-band stations of neighboring countries.

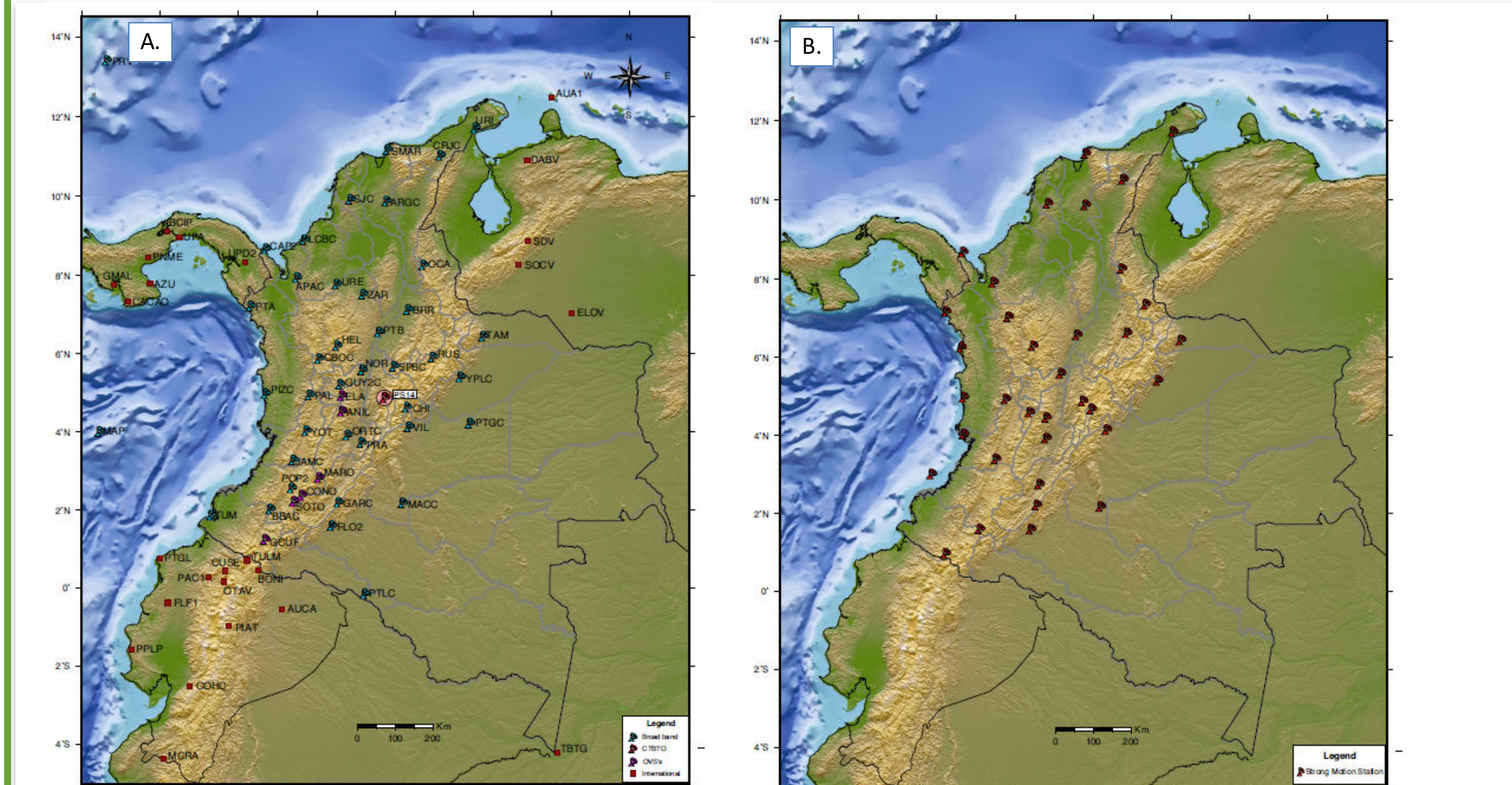


Figure 1. A) National broadband stations network (blue), vulcanologic broadband stations (purple), PS14- CTBTO station (pink), neighboring stations (red). B) National strong motion stations network.

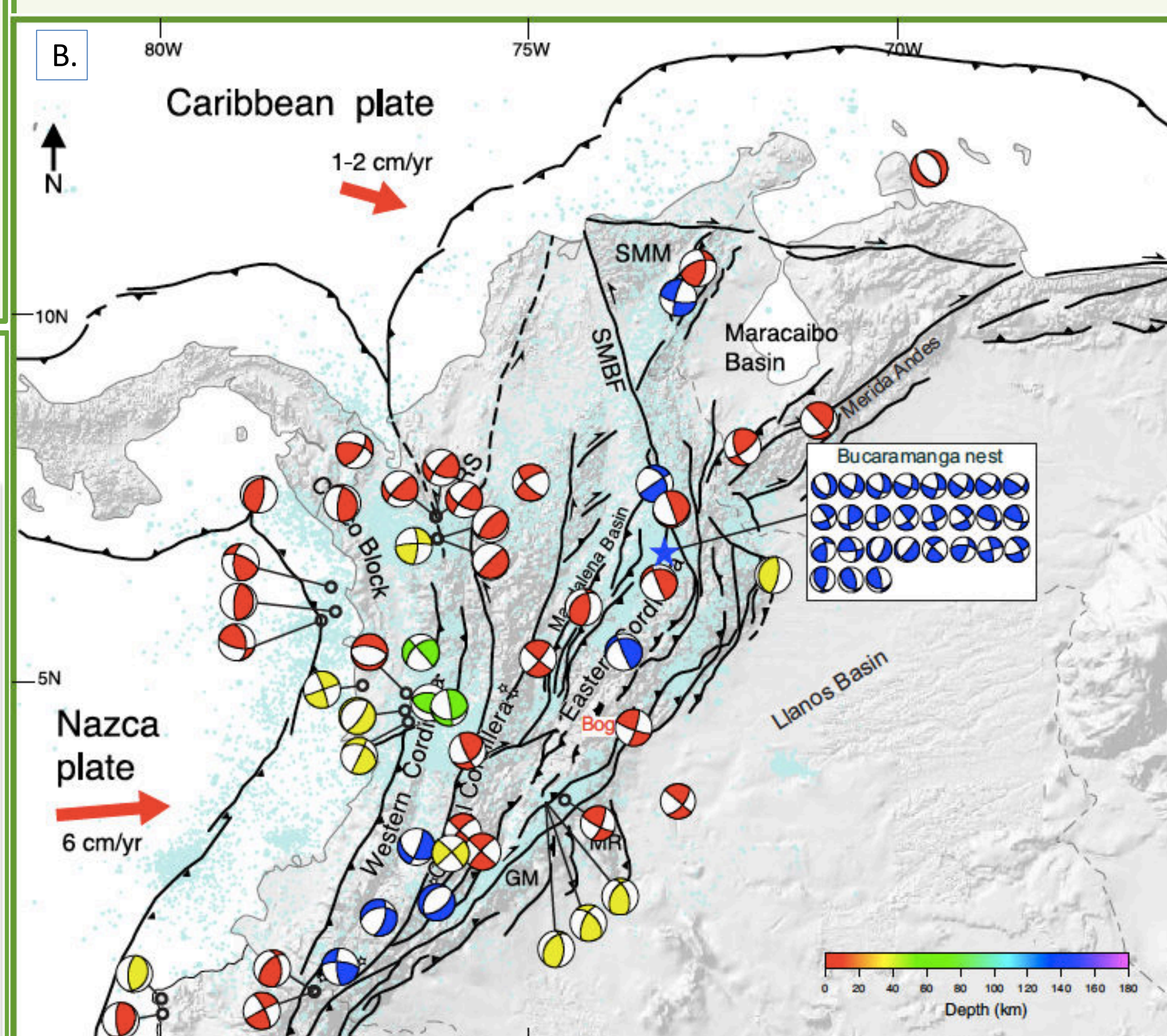
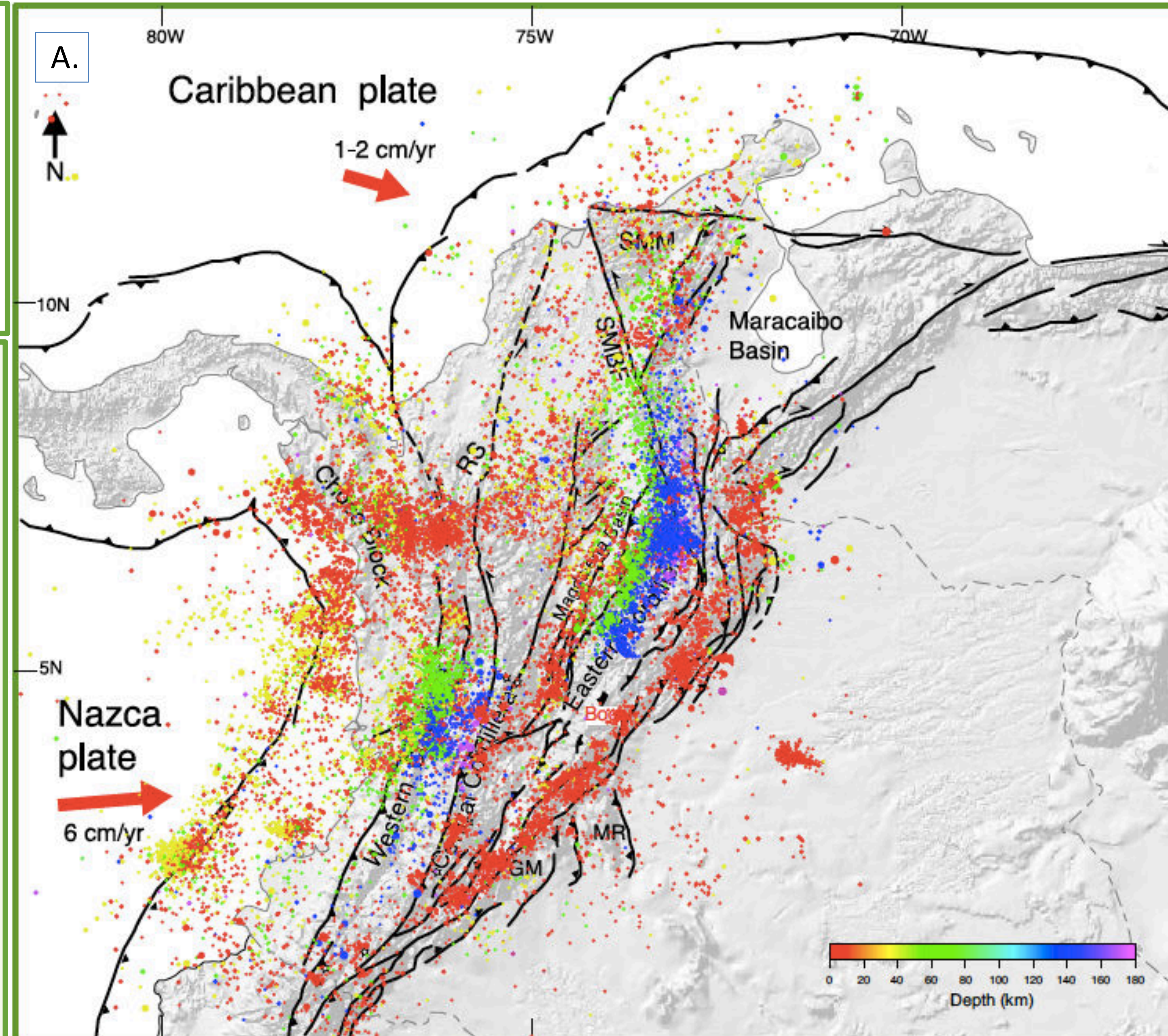


Figure 2. A) Distribution of seismicity located by Colombian Geological Survey for the period 06/1993 – 12/2016 over main structural features of northern Andes B) Colombian Seismic Moment Tensor solutions for the period 01/2012 – 12/2016.

Results

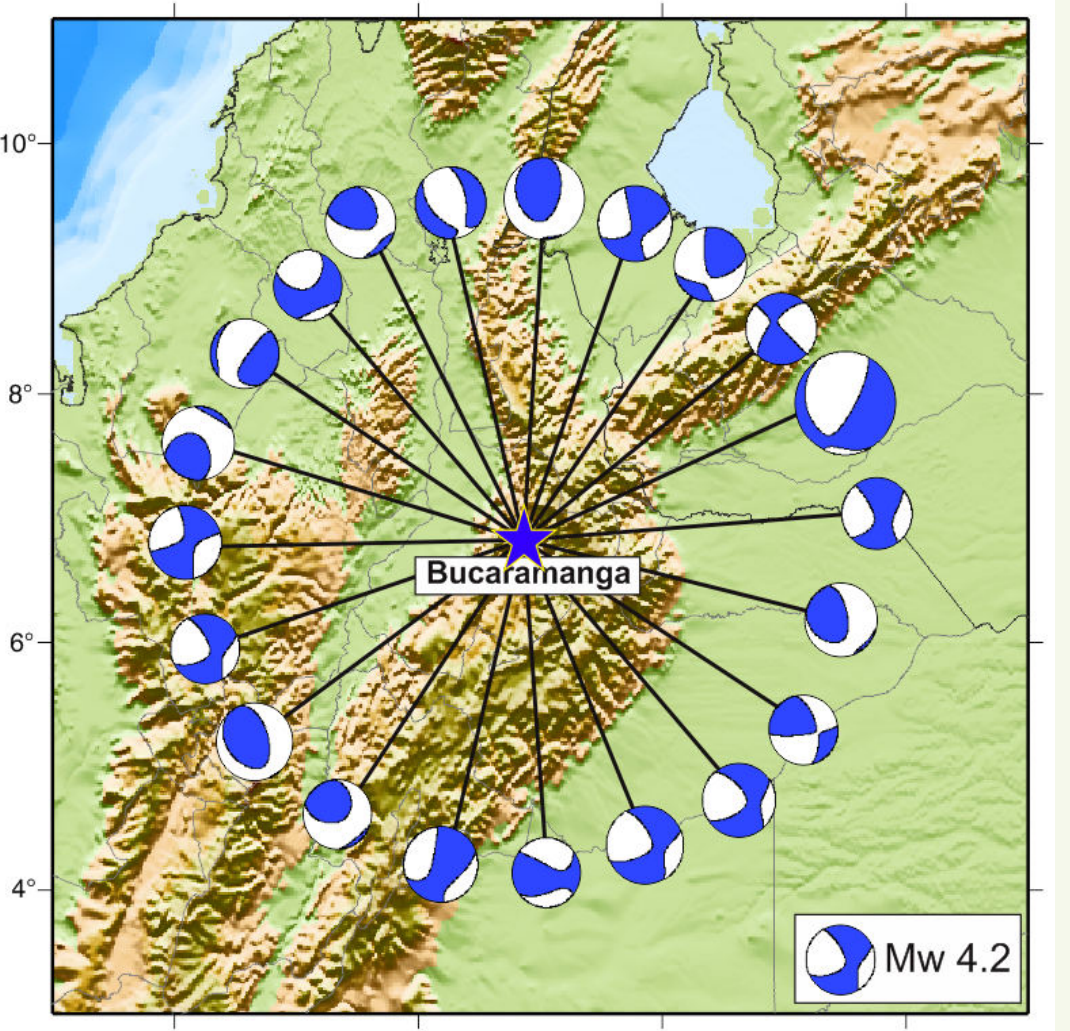
Table 1. Summary of some results. The moment tensor solutions were obtained in the frequency band 0.04 – 0.1 Hz.

Event	Strike	Dip	Rake	Mw	Depth	DC%	VR	CN	FMVAR	STVAR
08/02/2012	40	82	176	4.3	25	93.3	0.41	2.4	3±1	0.13
30/09/2012	231	31	-99	7.2	165	82.8	0.81	2.9	4±2	0.19
09/02/2013	270	68	15	6.8	170	48.8	0.56	2.0	8±5	0.14
13/08/2013	127	69	-16	6.5	14	95.7	0.61	3.2	18±10	0.03
25/08/2013	235	68	-159	4.7	21	74.9	0.61	3.3	13±8	0.07
09/01/2014	223	73	-175	4.9	14	56.5	0.72	2.1	10±6	0.42
21/02/2014	264	87	-161	5.1	31	86.1	0.61	8.2	34±25	0.19
11/03/2014	230	33	127	4.2	4	78.3	0.23	2.9	44±31	0.17
14/03/2014	194	77	-160	5.0	120	79.4	0.51	3.8	28±34	0.32
30/04/2014	352	68	40	4.4	154	44.6	0.55	3.9	16±28	0.23
19/08/2014	152	23	-157	4.2	160	68.6	0.64	3.7	3±2	0.19
01/06/2014	40	78	76	4.8	16	48.1	0.87	1.9	15±7	0.13
14/08/2015	97	9	142	4.1	6	78.3	0.79	2.5	18±11	0.51
19/09/2015	225	38	126	4.2	5	57.9	0.62	4.8	1±1	0.05
14/10/2015	236	88	130	5.2	138	78.2	0.37	2.8	2±1	0.21
16/12/2016	23	72	167	4.1	27	85.7	0.47	2.6	6±3	0.38
28/12/2016	258	46	-37	4.7	154	96.1	0.49	3.2	2±1	0.30
12/01/2017	104	66	-89	5.0	14	53	0.35	1.7	4±3	0.26

Bucaramanga Nest

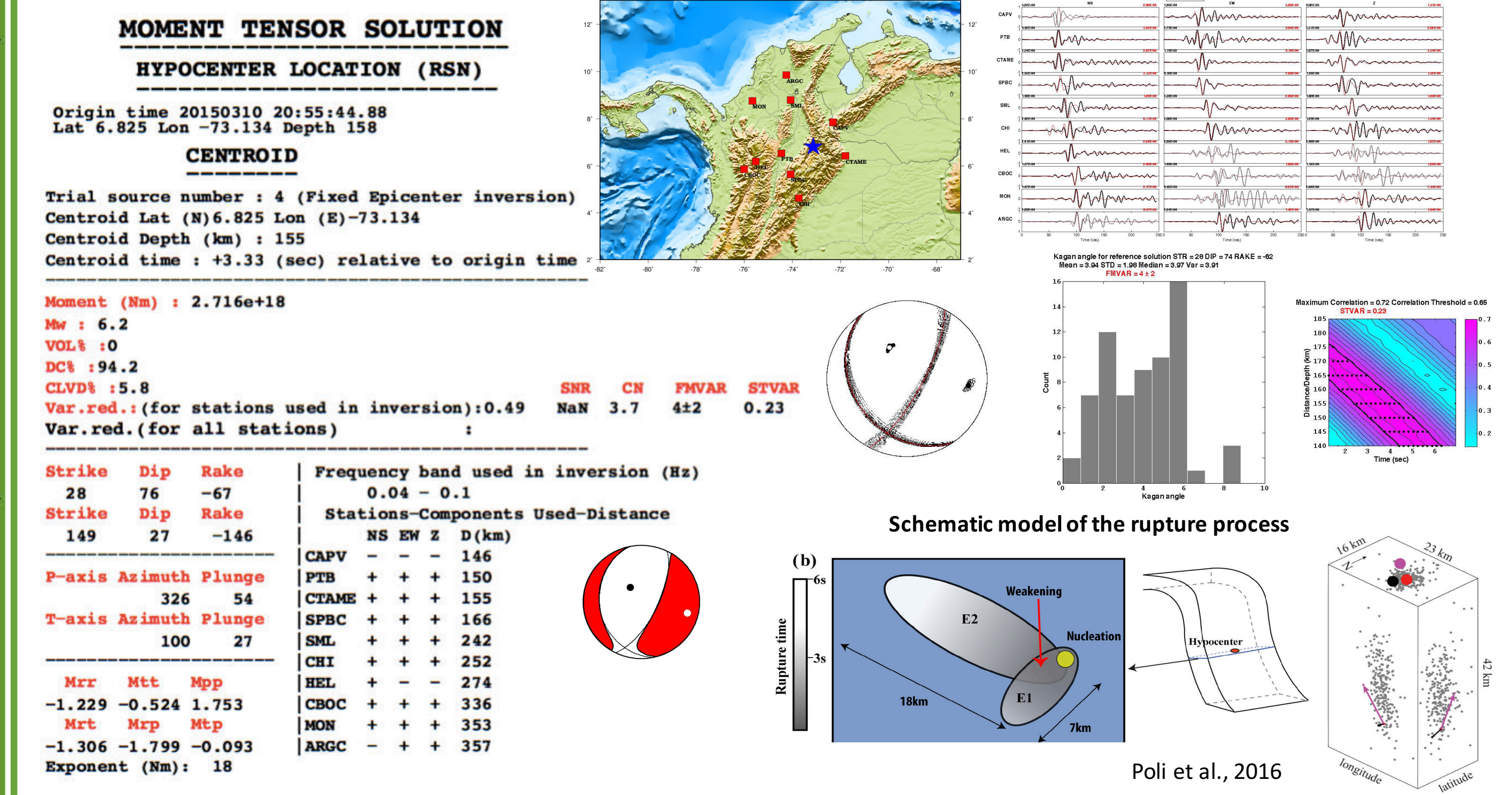
Beneath Bucaramanga city there is a cluster of seismicity with a depth around 160 km known as "the Bucaramanga seismic nest". Almost 60% of the seismicity registered by SGC are located in this region. It is one of the highest concentration intermediate-depth seismicity of the world (Trygvasson and Lawson, 1970; Pennington et al., 1981; and many others). Several physical mechanism have been proposed of these seismicity like dehydration embrittlement (Frohlich, 2006) or thermal shear runaway (Prieto et al., 2012).

The regional seismic moment tensor solutions obtained for the period 01/2014–12/2016 show diverse focal mechanisms in a very small volume and most solutions have a low non-double-couple component, values around 30%. These results confirm that Bucaramanga Nest seems to have planar features, some sub-horizontal and some sub-vertical, as Prieto et al. (2012) suggested.



Bucaramanga Nest Earthquake 2010 – Mw 6.3

On March 10, 2010, a Mw 6.3 earthquake occurred at Bucaramanga nest. Moment tensor inversion shows dominant normal faulting. Poli et al. (2016) determine a complex rupture process with two distinct stages, the first one with low rupture velocity and high stress drop, and with evidence for a strong weakening event during the dynamic rupture.



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