A long lasting seismic swarm in Guatemala and its affectation in El Salvador since July 18th 2011. (A preliminary report)

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ABSTRACT

A seismic swarm of more than 8,000 earthquakes located around 60 Km from Guatemala city and 50 Km from the border with El Salvador, were recorded by the Salvadoran Seismic Network. Five of these earthquakes, generated by the activation of the the fault system of Jalpatagua, were recorded by accelerographs installed even 140 Km away. Three people were killed and at least one hundred houses were damaged along almost three month of seismicity and mainly by the earthquake magnitude 5.4 Mw of September 19 at 12:33 pm, local time.

1. Introduction

El Salvador, popularly known as the hammock valley is frequently the target of seismic swarms, some of them have been precursor of destructive earthquake like the one occurring on may 3, 1965 when only 125 people died thanks to a seismic swarm occurring since February. The most recent seismic swarm recorded by the Salvadoran Seismic Network has been located in Guatemalan territory and around 8,000 earthquakes have been recorded even by accelerographs located as far as 150 Km from the epicentral area.

2. Historical seismicity

The area where this seismic swarm took place has been historically the target of seismicity similar to the one that started on July 18, 2011. According to a report prepared by CONRED, the Guatemalan institution in charge to coordinate the disaster mitigation, on May 3, 1830 two magnitude 6.0 earthquakes generated damages in Cuilapa, Santa Rosa, there are report of damages in another four more villages and were also strongly felt in Sonsonate, El Salvador. On May 12, 1870 another events with magnitude as large as 6.0, damaged Cuilapa and Santa María Ixhuatan, landslides on the flanks of Tecuanburro and Moyuta volcanoes were reported. On March 8, 1913 a seismicity with earthquakes as large as 5.9 destroyed the towns of Cuilapa and Barberena. This earthquake left 60 people killed and between 600 and 900 houses destroyed. The most recent activity occurred on July 14, 1930 when a series of earthquakes occurred from the beginning to the middle of July. The largest earthquake had a magnitude 6.9. (CONRED, 2011).

3. Seismicity

3.1 Epicentral area

On July 18, 2011 at 10:01 local time an earthquake magnitude, Mc = 2.3, started a seismic swarm whose ending is unknown since by the time of writing this preliminary report it is still occurring (October 18, 2011). The epicentral area is located 60 Km southeast Guatemala city, It was called at the beginning Chiquimulilla, because it was the closest town to the first epicenter, however it is called by the Guatemalan colleagues as the Santa Rosa seismic swarm.

From July 18 to October 17 around 8,000 earthquakes were recorded and 700 of them located, since they were detected by at least three seismic stations, one of them closer than 10 Km from the epicentral area. The temporal distribution and location of these is shown in Figure 1 and 2 respectively. As can be seen in Fig. 1, there were days with more than 250 earthquakes. Figure 3 shows the profile on the A-B direction and the location of the seismic swarm can be clearly observed. “The characteristics of the seismic records (waveforms and frequency contains of the signal spectras) are consistent with seismic activity of tectonic nature”, (Arriola et al, 2011)

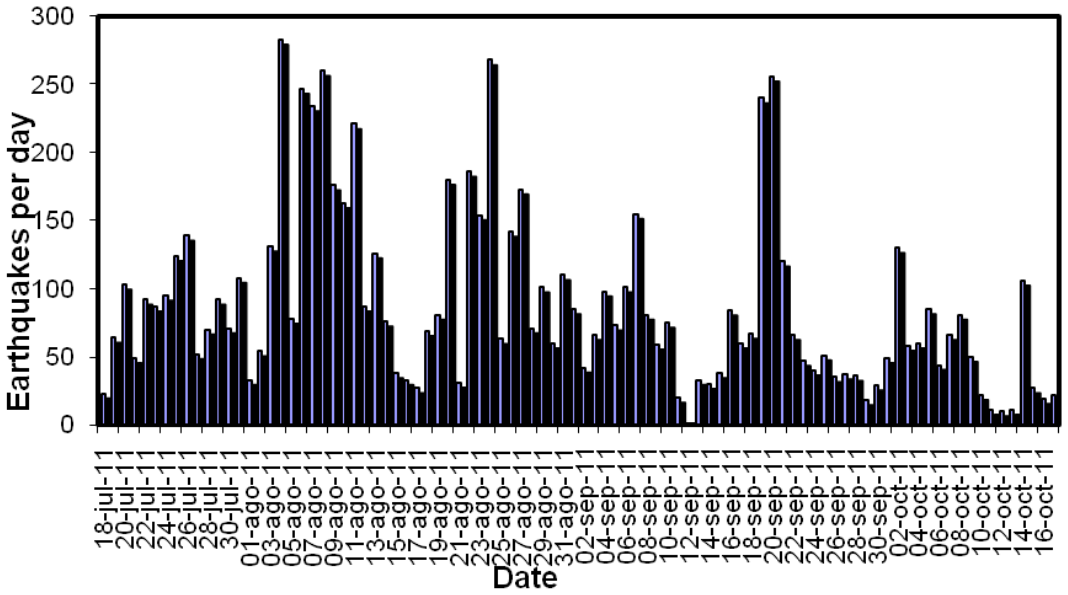

Figure 1. *Temporal distribution of Chiquimulilla seismic swarm in Guatemala from July18 to October 17, 2011*

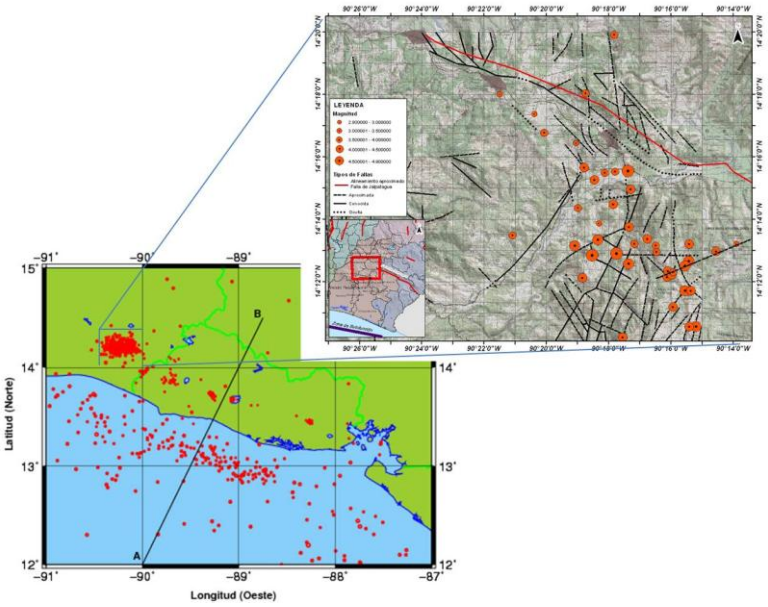

Figure 2. *Location of Chiquimulilla seismic swarm from July 18 to October 17, 2011 (map with faults was taken from Arriola et al, 2011)t*

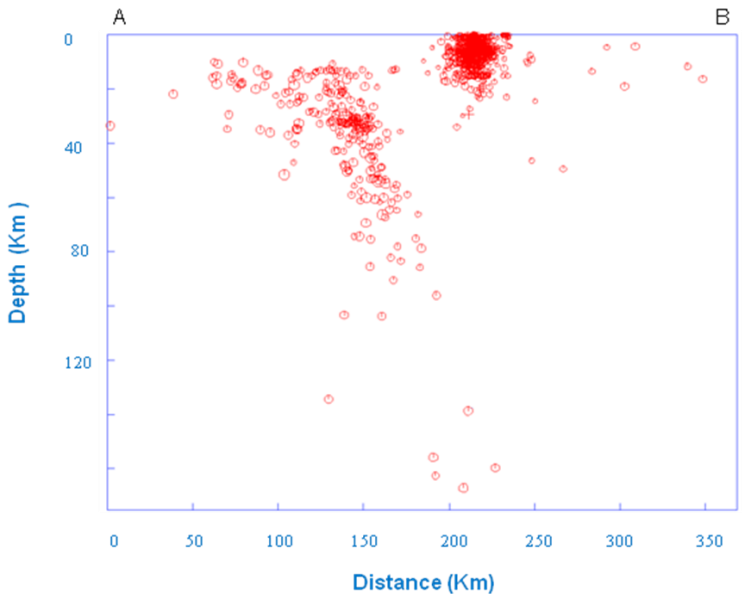

Figure 3. *Cross section of the epicenters shown in Fig. 2 on the direction A-B from July 18 to October 17, 2011*

3.2 Magnitude distribution

The magnitude of the located events for the Chiquimulilla seismic swarm was in the range of 1.5 – 5.4. On Table 1 is shown a magnitude distribution of the 700 earthquakes and based on the fact that inland earthquakes with magnitude from 2.5 are felt, can be stated that at least 539 earthquakes could have been felt in the epicentral area during the almost three month period.

Table 1. *Magnitude distribution and number of events with magnitude equal or larger than M for the period July 18 to October 17, 2011 in Chiquimulilla, Guatemala.*

From	To	Events	Accumulated	N>M
1.5	1.9	12	12	700
2.0	2.4	149	161	688
2.5	2.9	339	500	539
3.0	3.4	161	661	200
3.5	3.9	31	692	39
4.0	4.4	4	696	8
4.5	4.9	3	699	4
5.0	5.4	1	700	1

3.3 Strong motion records

The five largest magnitude earthquakes were recorded by some stations of the Salvadoran Accelerographic Network. The total number of accelerographic records obtained were 14 and the event of September 19 at 12:33 pm, local time, with magnitude Mw 5.4 was felt in San Salvador, located some 120 Km away from the epicentral area. Tables 1 and 2 show the main parameters of the five recorded earthquakes and the absolute values of acceleration respectively. The stations of JUA, SONS and UNCO are located on the western part of El Salvador, however the stations of APOP and SNET are installed around 140 Km from the epicentral area. As can be observed the largest acceleration was 6.8 cm/sec^2 recorded at SONS station, located around 90 Km from the epicentral area and is consistent with an intensity of IV on the Modified Mercally Intensity scale. The accelerographic record with the Peak Ground Acceleration (PGA) for each component of the largest magnitude event is shown in Figure 4 and the location of the five accelerographic stations where this event was recorded is shown in Figure 5.

Table 2. *Main parameters of the events recorded by accelerographic stations*

No	Year	Month	Day	Hour GMT	Lat. (N)	Long. (W)	Depth Km	Mag.	Type
1	2011	8	27	11:28	14.192	-90.254	6.0	4.4	Ml
2	2011	9	19	17:59	14.238	-90.293	5.0	4.5	Ml
3	2011	9	19	18:33	14.224	-90.315	0.0	5.4	Mw
4	2011	9	19	19:17	14.267	-90.316	10.0	4.8	Ml
5	2011	9	20	4:28	14.230	-90.323	14.1	4.5	Ml

Table 3. *Absolute values of acceleration in cm/sec^2 recorded by some Salvadoran accelerographic stations*

No	Date	Hour GMT	Accelerographic station	Code	E-W	N-S	Vertical
1	27-Aug	11:28	Alcaldía de Juayúa	JUA	1.9	2.2	1.6
2	27- Aug	11:28	Ágape, Sonsonate	SONS	2.7	3.2	2.0
3	27- Aug	11:28	Universidad de Occidente	UNCO	3.4	3.0	1.9
4	19-Sep	17:59	Alcaldía de Apopa	APOP	3.2	3.2	2.3
5	19-Sep	17:59	Agape, Sonsonate	SONS	3.4	3.0	2.4
6	19-Sep	17:59	Minist. de Medio Ambiente	SNET	0.9	1.1	0.7
7	19-Sep	17:59	Alcaldía de Juayúa	JUA	2.1	2	1.7
8	19-Sep	18:33	Alcaldía de Apopa	APOP	4.9	4.5	3.1
9	19-Sep	18:33	Agape, Sonsonate	SONS	6.0	**6.8**	4.3

10	19-Sep	18:33	Alcaldía de Juayúa	JUA	4.3	3.7	3.4
11	19-Sep	18:33	Minist. de Medio Ambiente	SNET	3.1	3.4	1.3
12	19-Sep	18:33	Universidad Don Bosco	UDBS	2.5	2.9	1.4
13	19-Sep	19:17	Alcaldía de Apopa	APOP	3.2	2.5	1.8
14	20-Sep	04:28	Agape, Sonsonate	SONS	3.4	3.6	2.1

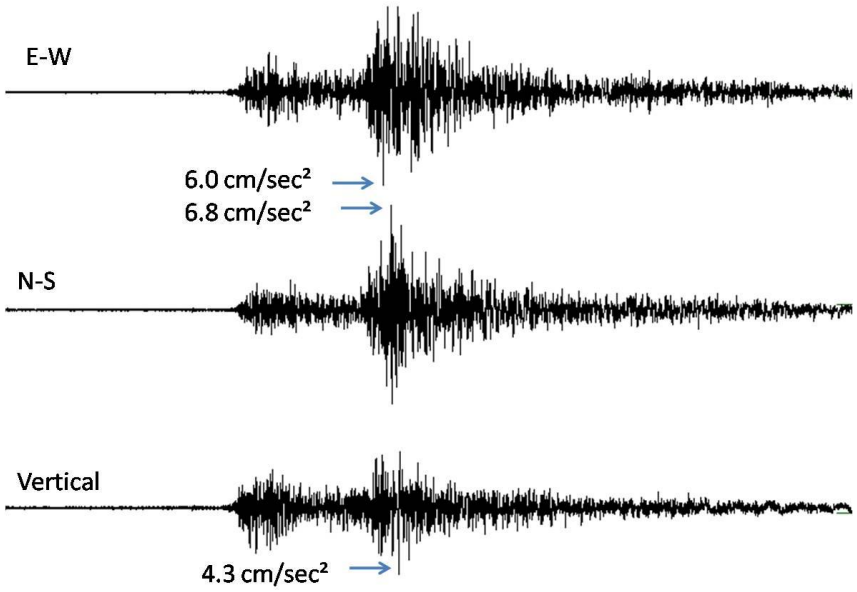

Figure. 4 *Peak ground accelerations of the earthquake of September 19, 2011 at 18:33 GMT (12:33 local time), magnitude 5.4 Mw, obtained at SONS station*

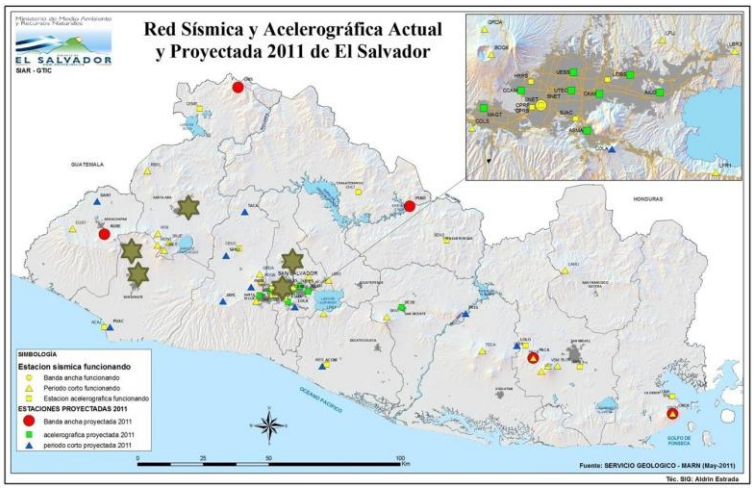

Figure 5. *Salvadoran seismic network (large stars denote the location of accelerographic station where the largest event was recorded*

4. Damage and material loss

4.1 In Guatemala

According to CONRED on a visit in July 26 to the towns of El Cacao, El Zarzal and La Mina with INSIVUMEH (Instituto de Sismología, Vulcanología Meteorología e Hidrología) personnel, the damages were concentrated on adobe housing. Before the strongest earthquakes of September 19 the municipalities more affected had been Santa María Ixhuatán and Oratorio. The number of houses with damages from light to moderate had been 25 and the three houses with the highest level of damage were in the municipality of Oratorio, however no people had been reported killed.

When there seemed to be that the seismic swarm was going to end, the three strongest events occurred on September 19 at 17:59, 18:33 and 19:17 GMT, with magnitude 4.5, 5.4 and 4.8 respectively. These events caused the death of three people at Cuilapa municipality and more than a dozen were reported injured, twenty adobe constructed houses were knocked down and at least one hundred of houses and buildings were severely damaged. On Figure 6 one of the houses destroyed is shown.

Figure 6. *Type of the destroyed houses in Santa Maria Ixhuatan (Taken from www.prensalibre.com*

4.1 In El Salvador

The average number of earthquakes felt per month in El Salvador is around 15, however from the seismic swarm with epicenter on the southwestern part of Guatemala increased this number to 33 per month. Even though the high number of felt reported earthquakes only seven had intensity larger than I and only the events of September 19 caused light damages in adobe constructed houses on the western part of the country. The type of damages observed on Salvadoran houses is shown in Figure 7.

Figure 7*. Type of the damage observed in adobe constructed houses in Salvadoran border houses.*

5. Conclusion

The seismic swarm occurred in the southeastern part of Guatemala destroyed poorly constructed housing which is the case of inland events of the area. As was mentioned in the report written by CONRED authorities for the people living in the epicentral area the lack of information of what was happening was the worst concern.

Despite of the number of events the level of destruction was considerable low and the type of construction was the key to withstand the severity of shaking.

The area of the Departmento de Santa Rosa located 50 Km from Guatemala city has been historically shaken by this kind of seismicity with similar pattern and the activation of any of the large number of faults is the origin of this kind of events.

References

CONRED (Coordinadora Nacional para la Reducción de Desastres), 2011, “Informe de evaluación por enjambre sísmico en comunidades de Santa Rosa entre Julio y agosto del año 2011”. Guatemala, 13 pp.

Arriola, L., Giron, J., Monterroso D., Mota M. and Oliva J. P., 2011. Análisis Técnico de Caso Enjambre Sísmico, Departamento de Santa Rosa 19 de Julio a 30 de septiembre de 2011. Guatemala, 2 pp.