RUPTURE PROCESS OF FOUR MEDIUM SIZE EARTHQUAKES THAT OCCURRED IN THE GULF OF CALIFORNIA

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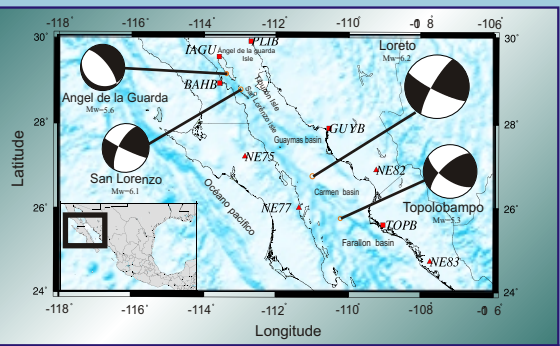

Figure 1) Earthquake location of the Angel de la Guarda, San Loenzo, Loreto and Topolobampo events as well as their focal mechanisms. Triangles are the location of the NARS-Baja broadband seismic stations and squares are the RESBAN broadband seismic stations. It is also shown the bathymetric features.

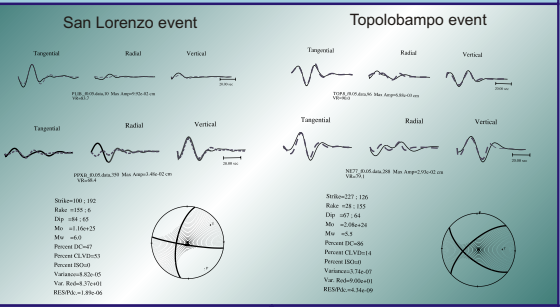

Figure 2) Time domain moment tensor inversion of the San Lorezo event. The observed tangential, radial and vertical (continious line) are compared with the synthetic (discontinuous line) waveforms. The focal mechanism, fault geometry and the results of the inversion are also presented. Seismc moment is in dyne-cm.

Figure 3) Time domain moment tensor inversion of the Topolobampo event. The observed tangential, radial and vertical (continuous line) are compared with the synthetic (discontinuous line) waveforms. The focal mechanism, fault geometry and the results of the inversion are also presented. Seismic moment is in dyne-cm.

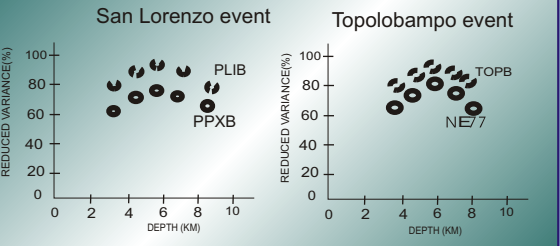

Figure 4) Plots of the reduced variance versus source depth of the Topolobampo and San Lorenzo events. These plots show that the maximum variance lay around a source depth of 5 km.

Vp(km/seg)	Vs(km/seg)	ρ(kgm/m3)	h(kms.)	Qp	Qs
5.00	2.88	2.30	5.00	600	300
6.10	3.52	2.60	5.00	600	300
6.70	3.87	3.00	16.00	600	300
7.80	4.50	3.30	400.00	600	300

Table 1.One-dimensional crustal velocity model used to locate the events and to calculate the synthetic seismograms

Abstract

Four earthquakes with magnitudes of 5.3, 5.6, 6.1 and 6.2 located in the Gulf of California Extensional Province were studied to obtain their cinematic rupture process. A network of broadband seismic stations located around the Gulf of California recorded the events (NARS-Baja and RESBAN). Body waveform modeling and the inversion of the seismic moment tensor were used to obtain the fault geometry. From forward body waveform modeling and from the time domain moment tensor inversion we obtained source depths of the order of 5±1 km (Dreger 2002). We used Yagi et al. (1999) inversion code to invert near-source broadband and strong-ground-motion waveforms to get the spatial slip distribution over the fault. We found that the source rupture process of the magnitude 5.3 and 5.6 have simple moment-rate functions and source time duration of 10 and 17 seconds respectively. Magnitude 5.3 event was a normal event and magnitude 5.6 was a right lateral strike-slip event. Magnitude 6.1 and 6.2 were right lateral strike-slip events with a complex rupture process with three sources of seismic moment release. Time duration of these events were 30 and 35 seconds respectively. Time duration of the moment-rate functions are large compared with similar magnitude events calculated elsewhere, we think that this is because we are inverting a large window of the seismogram that contain energy that it is not seen at regional distances or teleseismic distances.

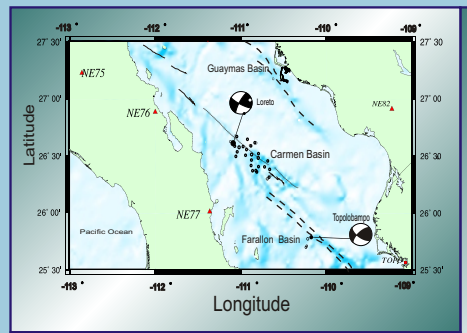

Figure 5) Location of the Loreto event and its aftershocks (bold circles). It is also shown the location of the Topolobampo event and its aftershocks, light circles. Inferred transform faults from the batymetric features are also shown. Triangles are NARS-Baja seismic stations and squares are RESBAN seismic stations.

Date	Time H:M:S	Lat North	Long West	Depth km	Mw	Duration seconds	Strike	Dip	Rake	Mo N-m
Loreto 20030312	23:41:32.00	26.584	-111.099	5.7	6.3	35	117°	79°	168°	3.60e18
Angel de la Guarda 20031112	04:54:57.69	29.000	-113.240	5.3	5.6	17	320°	70°	-80°	0.29e18
San Lorenzo 20040924	14:43:10.74	28.852	-112.900	5.2	6.1	30	100°	84°	155°	1.79e18
Topolobampo 20050222	19:15:54.05	29.103	-110.221	5.6	5.3	10	227°	67°	28°	0.10e18

Table 2. Earthquake locations and source parameters of the reported events.

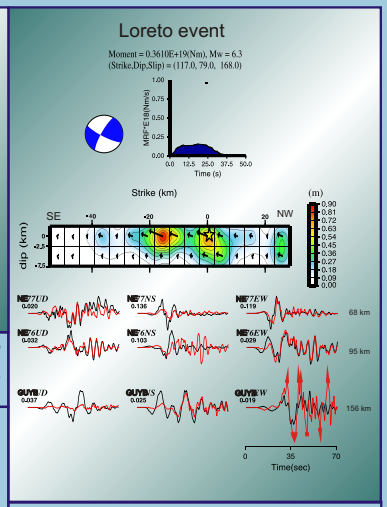

Figure 6) Results of the inversion process of the Loreto event. It is shown the focal mechanism, the moment rate function, slip distribution on the fault plane and the comparison of the observed and synthetic waveforms. Maximum amplitudes of the waveforms are in cm. At the right of each waveform is the epicentral distance. Star show the location of the hypocenter used in the inversion and the arrows show the direction of the rake. This is a complex event with three sources.

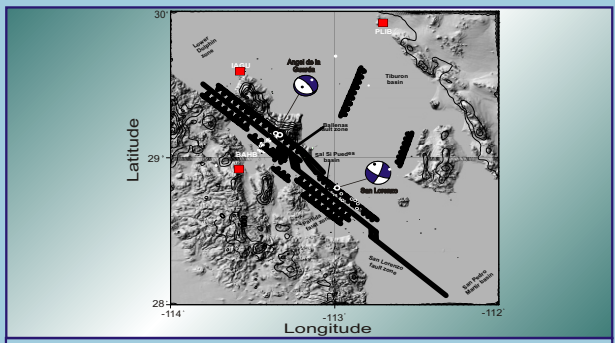

Figure 7) This map show the earthquake location and fault plane solutions of the Angel de la Guarda and San Lorenzo events. Small empty circles are the aftershocks locations. It is also shown the main tectonic features taken from Losdale 1989. Squares are the location of the RESBAN seismic stations.

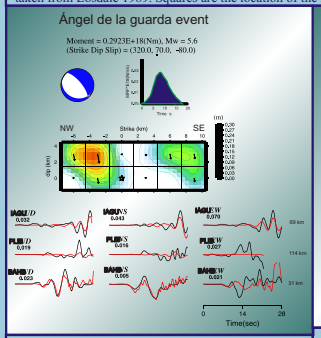

Figure 8) Results of the inversion process of Angel de la Guarda event. It is shown the focal mechanism, the moment rate function, slip distribution on the fault plane and the comparison of the observed and synthetic waveforms. Maximum amplitudes of the waveforms are in cm. At the right of each waveform is the epicentral distance. Star show the location of the hypocenter used in the inversion and the arrows show the direction of the rake. We can consider this event as a simple event with a single source.

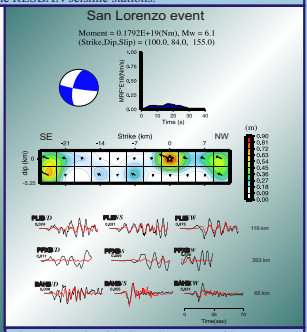

Figure 9) Results of the inversion process of San Lorenzo event. It is shown the focal mechanism, the moment rate function, slip distribution on the fault plane and the comparison of the observed andsynthetic waveforms. Maximum amplitudes of the waveforms are in cm. At the right of each waveform is the epicentral distance. Star show the location of the hypocenter used in the inversion and the arrows show the direction of the rake. We can consider this event as a complex event with three source.

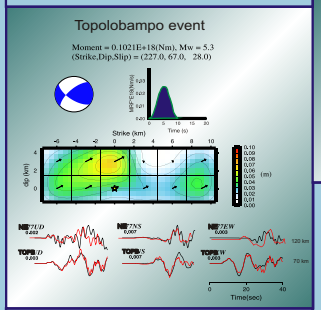

Figure 10) Results of the inversion process of Topolobampo event. It is shown the focal mechanism, the moment rate function, slip distribution on the fault plane and the comparison of the observed and synthetic waveforms. Maximum amplitudes of the waveforms are in cm. At the right of each waveform is the epicentral distance. Star show the location of the hypocenter used in the inversion and the arrows show the direction of the rake. We can consider this event as a simple event with one source.

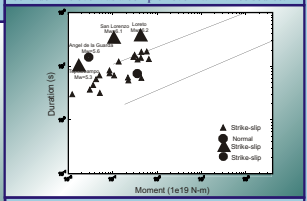

Figure 11) This plot show the source duration versus seismic moment of the events that have occurred in the Gulf of California. Triangles are the source time duration that have been reported by Goff et al., (1987) and Rebollar et al., (2001). Continuous lines are the boundaries of the source time durations of events that have been reported worldwide and compiled by Houston (2001). Source times durations of the Loreto, San Lorenzo, Angel de la Guarda and Topolobampo events (empty triangles and circle) are large compared with the source time durations calculated with the inversion of the waveform modeling at teleseismic distances. Full circle is the source time duration of the Loreto event calculated with the first oscillation of the S-wave at near field distances (Lopez-Pineda and Rebollar, 2005) compared with the source time duration calculated with the inversion of a large time window. This difference in source time duration could be due to the large time window used in the inversion.