FOCAL MECHANISM OF SIX LARGE EARTHQUAKES IN NORTHERN OAXACA, MEXICO, FOR THE PERIOD 1928-1973

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RESUMEN

Con el fin de ayudar a comprender el neotectonismo en la región norte de Oaxaca, se estudiaron 6 temblores fuertes ($m_b \geqslant 6.5$) de profundidad intermedia que ocurrieron durante los últimos 50 años (1928-1973) en dicha región. Para el temblor de Orizaba del 28 de agosto de 1973 ($m_b = 6.5$) se redeterminaron cuidadosamente la profundidad y su localización epicentral; además se halló el mecanismo focal utilizando las fases P, S, PKP, pP, sP y pPKP. Igualmente se redeterminaron la profundidad, el epicentro y el mecanismo focal de otros cinco eventos usando las mismas fases sísmicas. Para obtener una solución más confiable se compararon registros de diferentes eventos para la misma estación respecto al temblor del 28 de agosto de 1973.

Los valores hallados para la profundidad relativos a los dados por el USGS varían en general ± 15 km y las localizaciones cambian hasta alrededor de 50 km. El mecanismo focal para todos los eventos representan fallas normales similares a la solución del temblor del 28 de agosto de 1973.

Los resultados indican que la placa de Cocos que desciende bajo la placa de Norteamérica está buzando alrededor de 20° en esta región. El carácter tensional de estos temblores de profundidad intermedia, al norte de Oaxaca, pudiera tener relación con la actividad volcánica al este del Eje Volcánico.

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We study the 6 largest intermediate earthquakes ($m_b \geqslant 6.5$) that occurred at the North of Oaxaca, Mexico (17.5° – 18.5°N; 95° – 98°W) from 1928 to 1973 (Jiménez, 1977). The main purposes of the study were to redetermine accurately their focal depth epicenter position, study their focal mechanism and compare the results with previous detailed studies of the August 28, 1973 large (m_b = 6.8) intermediate earthquake. Originals and good copies of seismograms from all over the world were used; few arrival times and first motion data from Bulletins were also used.

A systematic and detailed analysis of time interval of pP-P, sP-P and pPKP-PKP phases was done; the depth for each event was determined using standard travel time tables (Jeffeys and Shimshoni, 1964). The epicenters were redetermined using a standard computer program available at the Seismological Service of Mexico (see Figure 1 and Table 1). The main results are the following: (1) Depths changed about 15 km from the values reported by USCGS data file, with only one exception (April 17, 1928) that moved from 360 km to 115 km. (2) Epicentral locations changed about 50 km from the data reported by USCGS data file, with only one exception (April 17, 1928) that moved about 200 km to the West. Isoseimal curves for this earthquake support this result (Figueroa, 1975). (3) From 90 pP-P or pPKP-PKP time intervals we obtained a depth of 83 km for the August 28, 1973 earthquake. Otherwise from 30 sP-P time intervals we obtained a depth of 73 km suggesting that the velocity structure of continental plate beneath northern Oaxaca differs from Jeffreys-Bullen model.

To determine the focal mechanism, polarity of the first arrival (P or PKP) and reflected waves (pP or pPKP) were analyzed directly from seismograms. Data from the local network of the Seismological Service of Mexico allowed to constrain very well the position of the nodal plane with low dip angle. Additional data from S-wave polarities and angle of polarization were used to constrain the position of the second nodal plane, as for Mexican and Middle-america earthquakes a poor coverage of seismic stations exists due to the proximity of Pacific and Atlantic oceans. The main results are the following (see Figure 2 and Table 2); (1) All earthquakes show a normal fault solution similar to the 28

August, 1973 earthquake (Singh and Wyss, 1976); (2) If we select the steepest nodal plane as the plane of faulting, the average values for the geometrical parameters describing the ruptures are: $\phi = 315° \pm 2°$, $\delta = 66° \pm 4°$, $\lambda = -99° \pm 9°$; (3) Average direction for T-axis indicate that they dip 20° ± 5° to the N52° ± 12°E; (4) Average direction for the Null-axis show that they are almost contained in the horizontal plane with strike N41° ± 7°W; (5) Average values of P-axis indicate that they dip 66 ± 7° to the N149° ± 24°W.

Since no other deeper and larger earthquakes have been reported in the northern part of Oaxaca for the last 50 years, we considerer that the events reported here define the lower edge of the Wadati-Benioff fault zone for this region of Mexico. If we accept that the direction of the T-axis is coincident with Wadati-Benioff boundary for this region, then, we obtain 20° ± 5° for the dip of this boundary; this phenomenon has been also observed in other subduction regions (Stauder, 1976). On other hand, Stewart and Chael (1979) based on studies of the focal mechanism for the November 29, 1978 earthquake ($m_S = 7.8$) conclude that the Wadati-Benioff boundary dip 14° to the north in the coast of Oaxaca.

Further studies of focal mechanism and focal parameters of shallow and intermediate earthquakes for the Oaxaca and other regions of Mexico should be done in order to understand the tectonics and the relationship between seismic activity and vulcanism. As is well known, the mexican volcanic belt is not parallel to the trench (Mooser, 1972). Our results suggest that the tensional character of the intermediate earthquakes (normal faulting) in the north of Oaxaca could have some relationship with the volcanic activity in the eastern flank of the Mexican Volcanic Belt and maybe with processes of back-arc opening as discussed by Uyeda and Kanamori (1978).

RECALCULATE ORIGIN TIME, GEOGRAPHIC COORDINATES AND DEPTH

EVENT		ORIGIN	LOCATION		DEPTH		MAG	STAND
NO.	DATE	TIME	LAT.N	LONG.W	pP-P	CGS	CGS	ERROR
1	Feb 10, 1928	04 38 37.5	18.26	97.99	84	100	6.5G	1.7
2	Abr 17, 1928	03 25 27.5	17.69	96.44	115	360		2.3
3	Jul 26, 1937	03 47 13.1	18.45	96.08	85	100	7.3G	2.0
4	Oct 11, 1945	16 53 02.2	18.32	97.65	95	96	6.5G	2.3
5	May 24, 1959	19 17 42.5	17.72	97.15	80	65	6.8(CGS)	1.9
6	AGT 28, 1973	09 50 40.3	18.30	96.53	82	75	6.8(CGS)	1.4

G: Gutenberg Magnitude

CGS: U.S. Coast and Geodetic Survey Data File.

TABLE II

FOCAL MECHANISM SOLUTIONS

					AXIS OF COMPRES-SION		AXIS OF TENSION		NULE AXIS	
NO	DATE	ϕ	δ	λ	AZ.	DIP	AZ.	DIP	AZ.	DIP
1	Feb 10, 1928	343	70	-117	228	62	86	25	349	15
2	Abr 17, 1928	317	70	-109	200±7	61±2	61±3	22±2	324±2	18±5
3	Jul 26, 1937	313	70	- 95	215±7	65±1	46±4	25	315±2	5±4
4	Oct 11, 1945	343	65	- 61	290±14	63±5	55±1	16±6	154±4	20±7
5	May 24, 1945	315	61	-102	202±15	69±4	54±6	18±1	321±1	12±8
6	Agt 28, 1973	317	65	- 90	226±6	70	45±3	20±1	137±2	0±3

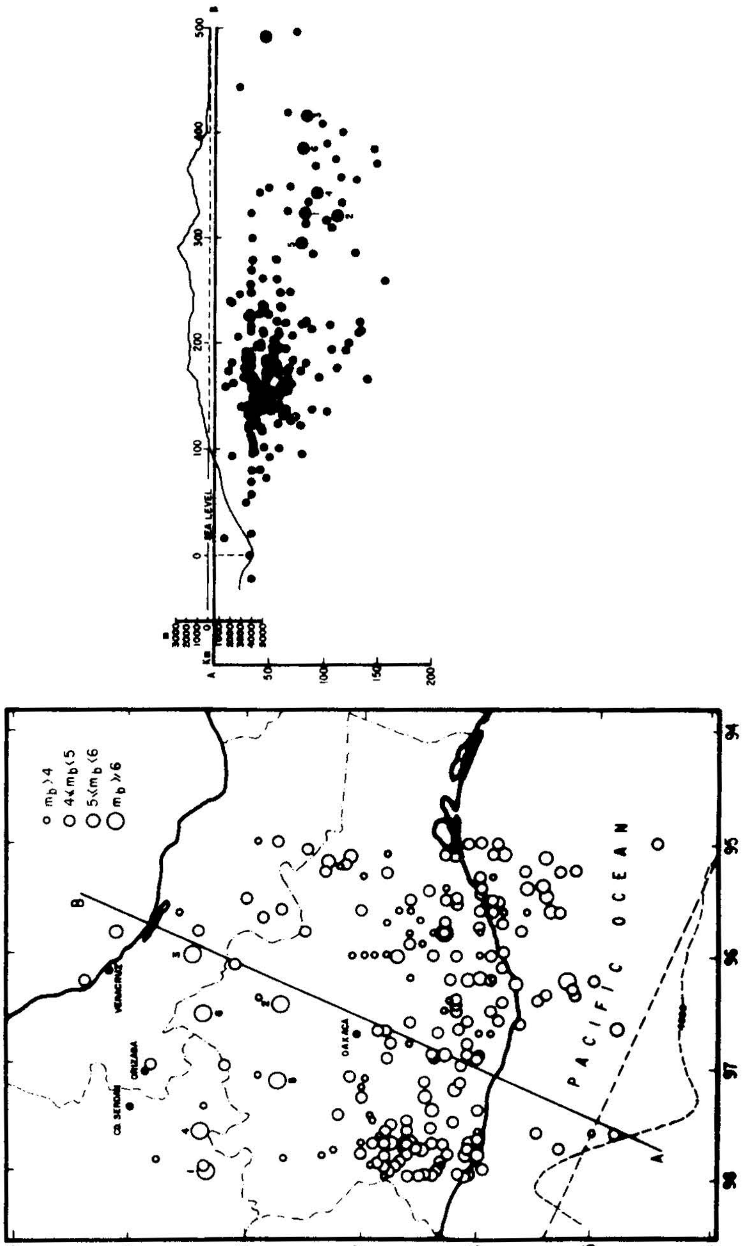

Figure 1. Seismicity from January 1, 1962 to December 31, 1974 for the region of Oaxaca, Mexico (between 14°N to 20°N and 95°W to 98°W). The depth profile AB is shown in right hand side. The event studies are numbered of 1 to 6.

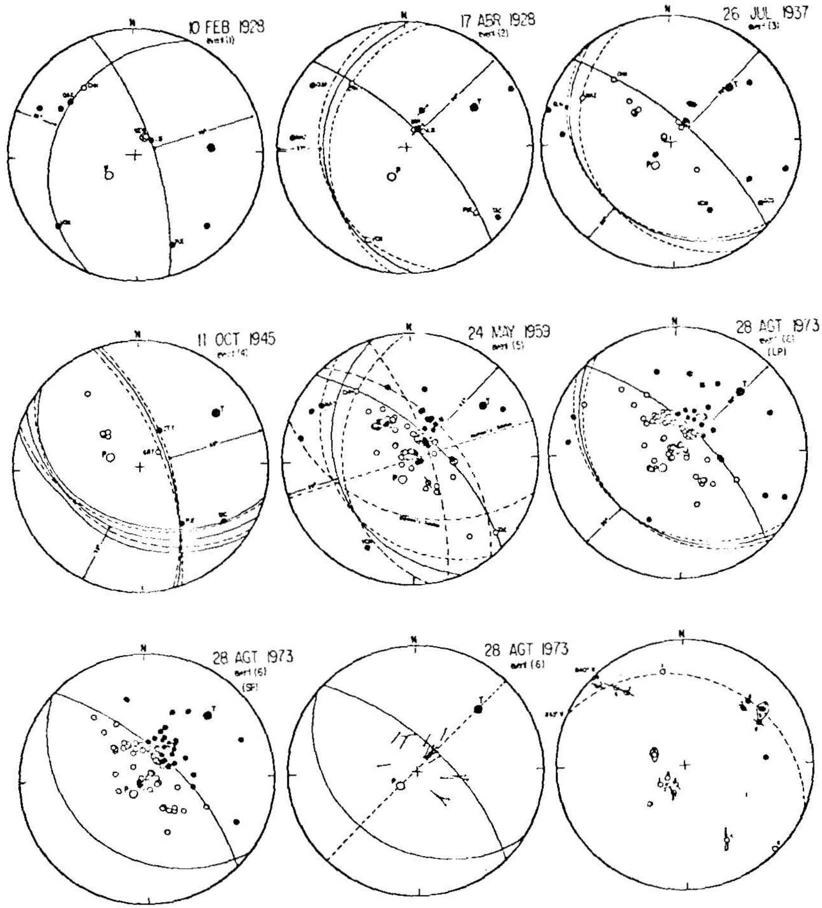

Figure 2. Data projected on the lower focal hemisphere using the Wulff net. Small circles represents first motion polarity of P waves (open circles are dilatation, filled circles are compression). Large circles represents the principal axis of stress (open circles are pressure axis (P), closed circles are tension (T)). The S-waves polarization vectors are plotted by arrows. For event 6 the long and short period waves and S-polarization are shown. The remaining plot show the projection of the principal axis of stress for all events (lower hemisphere of the Wulff net).

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