OBSERVATIONS FROM THE IDA NETWORK OF THE MOMENT TENSOR OF THE OAXACA EARTHQUAKE, NOVEMBER 29, 1978

T. G. MASTERS**
J. BERGER**
and F. GILBERT**

RESUMEN*

Para determinar el mecanismo focal del temblor de Oaxaca del 29 de noviembre de 1978 se usan datos de 8 estaciones de IDA. Asumiendo que la función de tiempo tiene la forma de un escalón, se calcula la función de Green para cada estación mediante la superposición de 1,117 modos para el modelo 1066 A (períodos mayores de 80 seg). El tensor de momentos se obtiene por medio de un análisis en el dominio del tiempo utilizando el método de mínimos cuadrados y la descomposición en valores singulares. Resultados muy preliminares indican un momento escalar de aproximadamente 2-3 x 10^{20} N. M. (2-3 x 10^{27} dinas -cm).

** Traducido y adaptado del resumen en inglés publicado en* Earthquake Notes, 49, *4, p. 46, 1978. (Nota del Editor).*

***Institute of Geophysics and Planetary Physics
Scripps Institution of Oceanography University of California, San Diego, La Jolla, California 92093, USA.*

The Oaxaca earthquake was well recorded by eight IDA (International Deployment of Accelerometers) stations and these quality long period digital records have been used to determine the source mechanism.

The theoretical development of Gilbert and Dziewonski (1975) is followed and we quote only the result that the response for a point source and a step time function is given by

$$\underline{a}\,(\underline{r}_a, t) = \underline{\underline{G}}\,(\underline{r}_a, r_0, t) \cdot \underline{f}\,(t) \tag{1}$$

$\underline{r}_a$ is the radius of the Earth, r_0 is the source depth and G is a Green's function computed by summing 1117 modes (period greater than 80s.). $\underline{f}$ is a linear vector of the six components of the moment rate tensor. The data and Green's functions were low-period pass filtered (filter corner at 160 secs falling off at 36 db per octave) and decimated by 2. Equation (1) was solved by singular value decomposition in both the time and frequency domain and it was found that it was not possible to give a satisfactory fit to the amplitudes of all the stations. Numerical experiments have shown that this is not due to a more complex source time history than has been assumed but is probably due to large scale lateral heterogeneity in the vicinity of the source. However the results did indicate that the majority of the radiation pattern could be explained by a double couple source. A search was performed to find the optimum double couple to fit the data. If the strike, dip and slip of the fault plane are specified the $\underline{f}$ vector can be calculated for a normalized double couple source. (A normalization of 10^{20} Nm was chosen.) Performing the dot product in (1) gives

$$\underline{a}\,(t) = M\underline{s}\,(t) \tag{2}$$

where $\underline{s}$ is a synthetic seismogram and M is the moment of the earthquake (in units of 10^{20} Nm). Equation (2) can be used to calculate a moment for each station

$$M_p = \left[\underline{a}_p \cdot \underline{a}_p / \underline{s}_p \cdot \underline{s}_p \right]^{1/2} \qquad (3)$$

where p is the station index.

The optimum double couple is chosen as that which gives the most uniform moment across the stations. The results are summarized in Table 1 and compared with the moments given by the double couple orientation inferred from first motion studies (Reichle, personal communication). The slip direction is measured clockwise from the strike direction in the plane of the fault and 270° slip corresponds to a pure thrust.

Several conclusions can be drawn from this study. The first is that a second order moment tensor description may not be adequate for shallow sources even at the low frequencies considered here (1-6 mHz) and higher order moments may be required to give a good fit to the radiation pattern.

The first motion double couple orientation does not describe the amplitudes seen at the IDA stations at all well. The moments calculated at individual stations vary by as much as 50 percent from the average moment. It should also be noted that the indeterminacy in the depth gives a large variation in moment. The deeper sources have less excited fundamental modes than shallower sources and need a correspondingly larger moment to fit the data. The double couples which give the most uniform fit to the "power" at the IDA stations have similar strike dip and slips although the dips are much steeper than the first motion studies indicate. The minimum variation in moment is 18 percent from the average moment for model 1066B with a source depth of 20 km. Because the IDA instruments are calibrated to an accuracy of 1 percent (Berger *et al.*, 1979), this variation must still be regarded as unacceptable and a more complicated model of the source required.

Model	Depth (km)	Strike(°)	Dip(°)	Slip(°)	Av. Moment ($\times 10^{20}$Nm)	Spread of Moments ($\times 10^{20}$Nm)
1066B	20	290	40	260	1.75	0.64
1066B	40	280	40	270	2.59	1.44
1066A	20	290	50	260	1.98	0.84
1066A	40	280	30	270	2.79	1.42
			First Motion			
1066B	20	300	15	270	3.59	2.71
1066B	40	300	15	270	5.31	4.78
1066A	20	300	15	270	4.24	3.67
1066A	40	300	15	270	4.94	4.09

Table 1. Optimum double couples calculated for depths 20 km and 40 km and Earth models 1066A and 1066B. The spread of the moments ($M_{p\ max} - M_{p\ min}$) has been minimized.

BIBLIOGRAPHY

BERGER, J., D. C. AGNEW, R. L. PARKER and W. E. FARRELL, 1979. Seismic system calibration: 2. Cross-spectral calibration using random binary signals, *Bull. Seismo. Soc. Am.*, *69*, 271-288.

GILBERT, F. and A. DZIEWONSKI, 1975. An application of normal mode theory to the retrieval of structural parameters and source mechanism from seismic spectra, *Phil. Trans. Roy. Soc. London*, *A278*, 187-269.