THE OAXACA, MEXICO, EARTHQUAKE OF 29 NOVEMBER 1978: A PRELIMINARY REPORT ON AFTERSHOCKS

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RESUMEN

El área de réplicas del período del 1o. al 12 de diciembre de 1978 para el temblor de Oaxaca (29 de noviembre, 1978; $M_S = 7.8$) se estima en 6000 km^2. El temblor parece llenar el tramo de quietud sísmico entre los temblores de 1965 ($M_S = 7.6$) y 1968 ($M_S = 7.5$) sólo parcialmente.

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Based on observed seismic quiescence beginning 1973 for shallow earthquakes (depth < 60 km) with magnitude ⩾ 4 and noting a similar quiescence before the earthquakes of 1965 (M_S = 7.6) and 1968 (M_S = 7.5) in Oaxaca, Ohtake *et al.* (1977) forecasted a large earthquake ($M_S = 7\frac{1}{2} \pm 1/4$) in the area with probable epicenter as 16.5° ± .5°N, 96.5° ± .5°W. The forecast caused considerable controversy in the scientific community (Garza and Lomnitz, 1978). Fig. 1 shows the epicenters of aftershocks (1 to 12 Dec., 1978) located by an array of 15 portable smoked-paper seismographs. The magnitudes were determined from coda durations using a relation given by Lee *et al.* (1972); events shown in Fig. 1 have approximate magnitudes greater than 2.7. The aftershock area obtained from the location of these events and shown in Fig. 1 by broken line is about 6000 km^2. The area is well defined by the activity of 1 Dec. to 3 Dec. and does not appear to grow with time. Locations of the mainshock and 17 aftershocks (upto 8 Dec. 1978) given by the Preliminary Determination of Epicenters (PDE) published by the U. S. Geological Survey are also shown in Fig. 1. This aftershock area is about 1.3 times larger and more elongated in the N-S direction than the area determined from our field array data. Eight of the 17 PDE aftershocks occurred after 1 Dec. Seven of these events are shown in Fig. 1 with their corresponding locations obtained from our field array data (one lies outside the area). PDE locations differ from our locations by 35 to 60 km; all PDE locations lie to the west, with 4 displaced to the north and 3 to the south. This probably explains the N-S elongation of the PDE aftershock area. Assuming 15° as the dip of the subducting Cocos plate, the area of rupture is obtained as 6200 km^2.

The seismic moment M_0 determined from surface waves has been reported as 3.2×10^{27}, $2-3 \times 10^{27}$, and 2×10^{27} dyne-cm by Stewart and Chael (1979), Masters *et al.* (1978), and Reichle *et al.* (1978), respectively. Taking 2.6×10^{27} dyne-cm as the average value of M_0 and a rectangular rupture area of 90 km x 70 km, the average displacement $\overline{D}$ on the fault and stress drop $\Delta\sigma$ are obtained as:

$$\overline{D} = \frac{M_0}{\mu A} = 1.4 \text{ meters}$$

$$\Delta\sigma = \frac{8}{3\pi} \mu \frac{\overline{D}}{W} = 5 \text{ bars}$$

where μ = rigidity = 3×10^{11} dyne/cm^2, A = rupture area, and W = fault width. The moment, stress drop, rupture area, and average displacement of this earthquake are very similar to the Colima earthquake of 1973, $M_S = 7.5$ (Reyes *et al.*, 1979).

Fig. 2 shows all shallow (depth $\leq$ 60 km) seismic activity of the region (listed by PDE) for the period Jan. 1966 to Dec. 1978. This figure also shows (shaded) aftershock areas of earthquakes of 23 Aug. 1965 (right) and 2 Aug. 1968 (left). The rectangle shown by broken line is the area identified by Ohtake *et al.* (1977) which was seismically quiet from 1973 to 1978. Note that part of the "gap" for large earthquakes bounded by the 1965 and 1968 rupture zones was seismically quiet since 1966 (solid outline. The lateral dimension and location of this quiet zone is equivalent to the aftershock zone determined from our field array data (shaded area in center). However, the aftershock area defined by PDE locations (open circle, Fig. 2) for the 1968 sequence is concentrated along the eastern boundary of the unbroken area. This leads to the question of whether the gap is entirely broken at present since it is defined relative to PDE data. It is possible (i) that the remaining area might rupture or (ii) that the area bounded by the solid outline may be a "permanent gap".

Oaxaca experience suggests that monitoring of seismicity patterns from world-wide stations is a useful tool for identifying "special study" areas of potential large earthquakes.

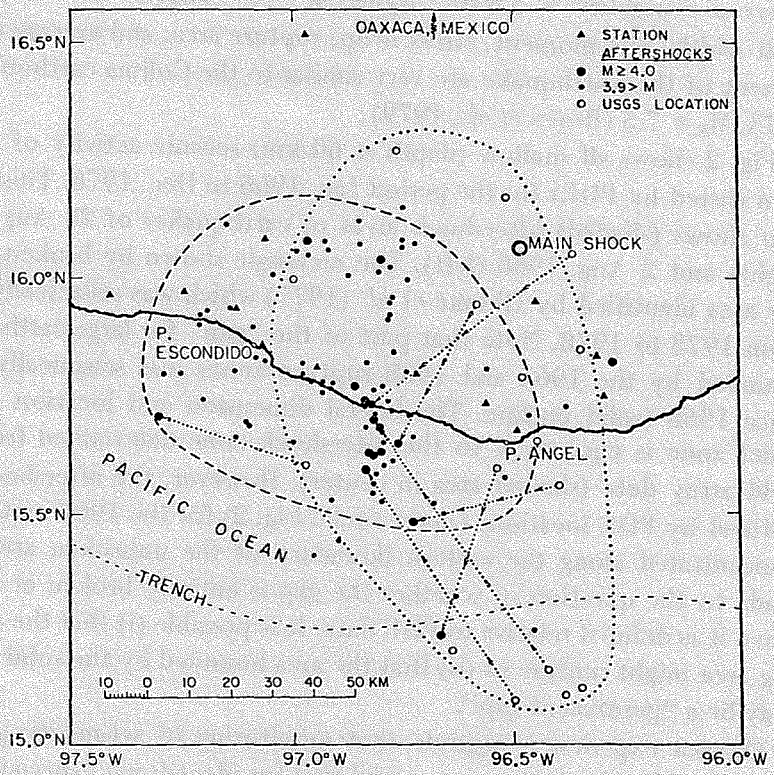

Fig.1 Aftershocks located by (i) the field seismograph array (1 to 12 Dec. 1978) and (ii) the U. S. Geological Survey (29 Nov. to 8 Dec. 1978) from world-wide stations. Dashed arrows indicate U.S.G.S. mislocations of same events. The aftershock areas from U.S.G.S. data (dotted) and field array data (dashed) are outlined for comparison.

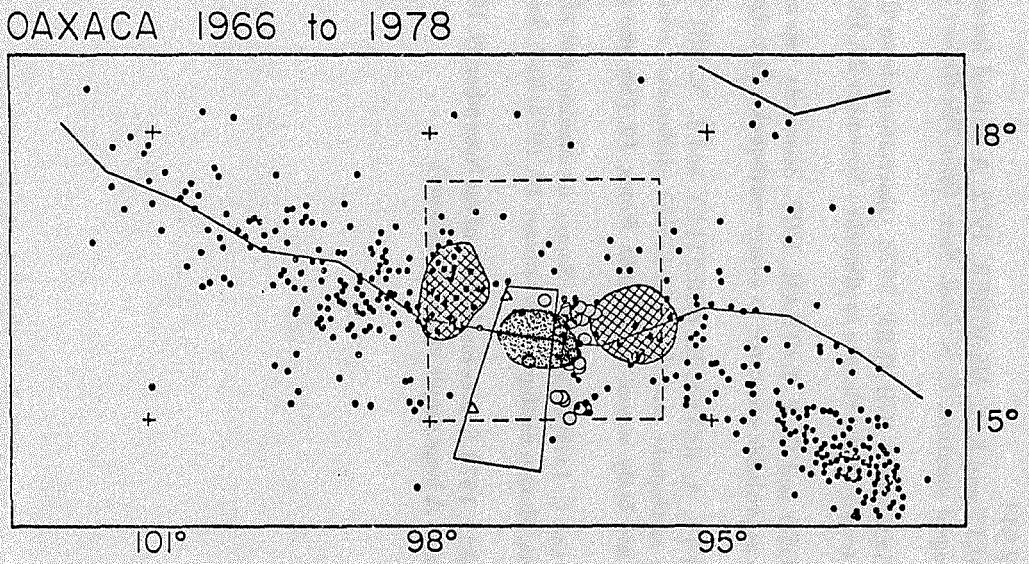

Fig.2 All shallow (depth $\leq$ 60 km) seismic activity located by the U.S.G.S. for the Oaxaca region from 1966 to 1978. The 1965 and 1968 aftershock areas are shaded; open circles are the 1978 Oaxaca mainshock and aftershocks through Dec. 1978. The area of aftershocks located by the field seismograph array is shown by the dotted area (center). The areas which are quiet since 1966 (solid outline) and since 1973 (dotted rectangle) are also shown. Triangles indicate earthquakes in large quiet area preceding the 1978 mainshock.

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