A DIPPING GRADIENT LAYER VELOCITY MODEL FOR SOUTHERN MEXICO

D. J. S. DROWLEY**
K. C. McNALLY***
LUIS GONZÁLEZ****

RESUMEN *

Datos de tiempos de viaje de ondas sísmicas fueron utilizadas para estimar un modelo de velocidades para la parte sur de México, en las vecindades de Oaxaca. El 29 de noviembre de 1978, ocurrió un fuerte temblor ($M_S = 7.8$) aproximadamente a 140 km al sur de Oaxaca, en la interfase de subducción de la placa de Cocos y la placa de Norteamérica. La red de estaciones permanentes operada por la UNAM y una red local de estaciones operada conjuntamente por la UNAM y CALTECH, registró la secuencia de precursores, el temblor principal y las réplicas. Este conjunto importante de datos ofrece una excelente oportunidad para estudiar las distribuciones espacial y temporal de la sismicidad antes y después de un gran temblor. Sin embargo, antes de realizar cualquier estudio detallado, se requiere un adecuado modelo de velocidades para una capa buzante que asegure una localización confiable de los eventos. Los tiempos de viaje de varios precursores y réplicas bien registrados fueron usados en un proceso de inversión, utilizando un algoritmo no lineal de mínimos cuadrados; se estimó un modelo de velocidades para una capa buzante con gradiente de velocidades sobre un semiespacio de velocidad constante. Resultados preliminares indican un buzamiento de la interfase de la corteza y el manto de 7° en la dirección N20° E; la profundidad de esta interfase en las cercanías de la costa es de 25 km con una velocidad de 8.186 ± .048 en el manto.

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** *Seismographic Station, Department of Geology and Geophysics, University of California, Berkeley, California 94720, USA.*
*** *Seismological Laboratory, California Institute of Technology, Pasadena, California, 91125, USA.*
**** *Instituto de Geofísica, UNAM, México.*

The November 29, 1978 Oaxaca earthquake ($M_S = 7.8$) and its foreshock and aftershock sequences were well recorded by a permanent network of stations operated by the University of Mexico and by a local array of stations operated jointly by the California Institute of Technology and the University of Mexico. The substantial data set provides an apportunity to study spatial-temporal patterns of seismicity before and after a large earthquake and new good quality information on velocities and crustal structure at the subduction boundary between the Americas and Cocos plates.

In this study, travel time data from well recorded aftershocks were inverted to estimate a velocity model for both P and S waves for the area so that later all events may be relocated and the seismicity patterns analyzed.

The preliminary locations for the aftershocks were based on a flat layered constant velocity model. We examined the preliminary locations in detail by analyzing the residuals for each station and the overall solution quality for each event. Seven well recorded aftershocks with duration magnitudes ranging from 3.7 to 4.9 were selected for the P model inversion, and four well recorded aftershocks ranging in magnitude from 3.0 to 4.3 were selected for the S model inversion.

Sixty-eight P travel times were inverted using the Levenberg-Marquardt monlinear least squares algorithm (Levenberg, 1944; Marquardt, 1963) to obtain a dipping gradient layer over a constant velocity half-space. Once the P velocities and structure had been estimated, nineteen S travel times were inverted to obtain the S velocities. The velocity results are shown in Figure 1. The structure obtained is a crust-mantle interface dipping approximately 7° to the northeast (Figure 2). These results are compatible with the preliminary results of a refraction survey in 1974 (Mooney, personal communication, 1979).

Our objective is to relocate all events and examine the spatial-temporal seismicity patterns. Preliminary relocations of a few aftershocks using the gradient model indicate that a dipping gradient layer model is an improvement over a flat constant velocity layer model.

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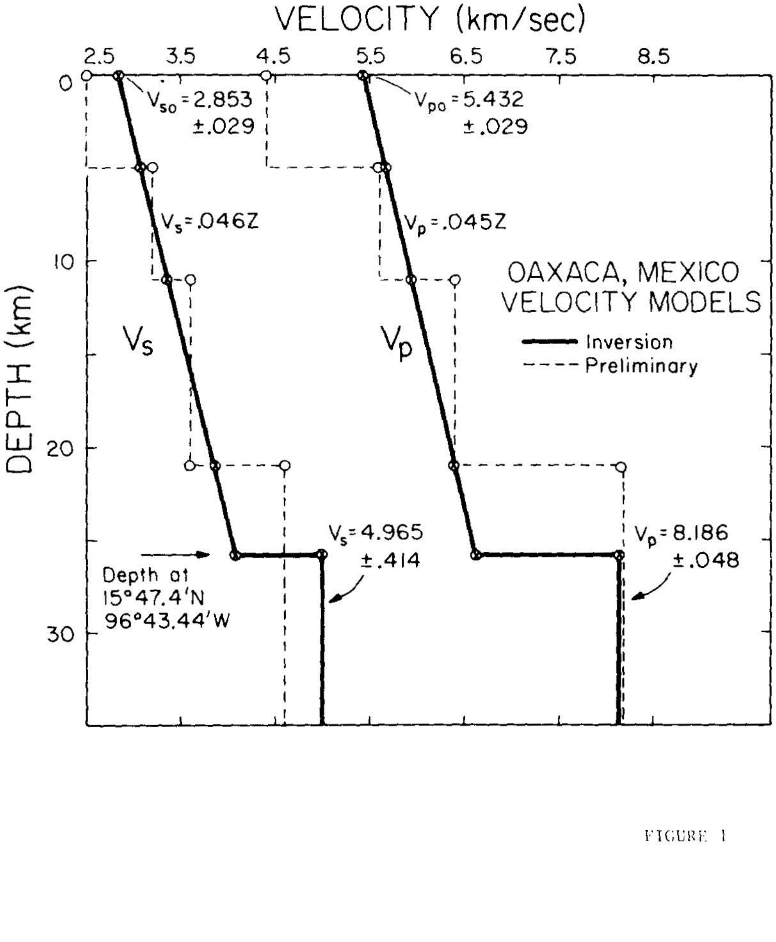

FIGURE 1

Figure 1. P and S velocities obtained in our travel time inversion compared to the initial flat constant velocity layer model. The depth of the crust-mantle interface shown is the depth at the reference station PGO.

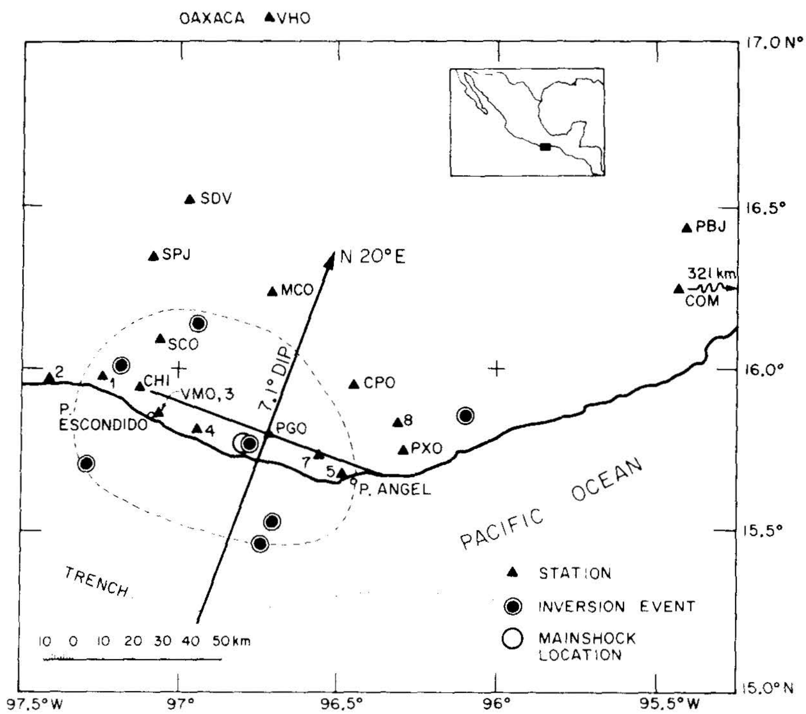

FIGURE 2

Figure 2. Map showing the events used in the P travel time inversion and the structure obtained relative to the reference station PGO.

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