The seismotectonics of western Mexico are dominated by subduction of the Rivera and Cocos plates northeastward beneath the western edge of North America (Fig. 1). Subduction of the Rivera plate diminishes rapidly to the northwest along the Mexican coastline (Fig. 2). Variation of the Rivera and Cocos plates northeastward beneath the west coast of Mexico.

1. INTRODUCTION &TECTONIC SETTING

The 22 January 2003 Tecomán subduction earthquake ruptured the Middle America trench subduction interface near Tecomán, Colima, Mexico (Fig. 1). With an estimated magnitude between 7.1 and 7.6, the Tecomán earthquake caused the deaths or injuries of more than 1,000 people and damaged or destroyed more than 40,000 homes and businesses, mostly in and near the inland city of Colima. This area has a history of large earthquakes (1955, 1973, and two in 1992), and the 2003 event is the second to be observed geotectonically. The latest GPS results give insight into the seismic behavior of this region.

1.1 Change in Scale

To the rupture zone. We occupied an additional 19 sites within one km of the rupture zone. The Tecomán earthquake occurred one month after the 2002 Manzanillo earthquake. The Tecomán earthquake caused the deaths or injuries of more than 1,000 people and damaged or destroyed more than 40,000 homes and businesses, mostly in and near the inland city of Colima. This area has a history of large earthquakes (1955, 1973, and two in 1992), and the 2003 event is the second to be observed geotectonically. The latest GPS results give insight into the seismic behavior of this region.

2. DATA

Our GPS network consists of 31 geodetic markers that have been occupied annually since 2003. The Tecomán earthquake occurred one day after we initiated our 2003 occupation. Eight GPS receivers were operating during the earthquake, half at sites located relatively close to the rupture zone. We occupied an additional 19 sites within one week of the earthquake and one to five months after the earthquake. For sites operating during the earthquake, we determined velocity offsets by differencing the locations from the day before the earthquake and the 22 h following the earthquake. For the other sites (hereafter called "quasi-coseismic"), we extrapolate the pre-earthquake location and difference it with the first post-earthquake position observed (Fig. 2).

3. METHODS

Fig. 2. GPS coordinate time series used to find the 19 quasi-coseismic offsets. The linear regression used to determine preearthquake slip motion is shown by the medium-thickness lines. Thick vertical lines represent the quasi-coseismic offsets. Horizontal medium-thickness lines after the earthquake illustrate how postearthquake site position is computed from the first available GPS solution. Time scale differs before and after the earthquake.

We use the commercially available finite element package ABAQUS to model the region. Our 3D FEM mesh (Fig. 3) is designed to approximate the geometrical characteristics of the northern Middle America subduction zone. The modeling and material properties share many similarities to those employed by Masterlock et al. (2003). To perform inversions with the FEM, we construct a linear system of the 3D surface deformations that result from slip on each pair of nodes (one oceanic and one continental) on the subduction interface. We allow for oblique slip, though all nodes must slip in the same direction. Finally, we impose a dip-slip constraint.

4. RESULTS

The GPS-derived slip distribution is located offshore from the Colima Graben (Fig. 4). The rupture is focused on the earthquake epicenter found by the local seismic network (Schimdt et al., 2004). Moment release: 6.3 x 10^17 N m (M = 7.3)

5. DISCUSSION

5.1 Comparison to seismological solution

Only one seismological slip distribution has been published (Yagi et al., 2004), based on a joint inversion of local and teleseismic data. The chief difference between the seismological and geodetic slip distributions is that the former extends to great depths. We tested the seismological slip distribution in our FEM (Fig. 5) and found that it produced large misfits of the vertical deformations, particularly at sites sensitive to deeper slip. Consequently, we contend that rupture did not extend as deep as the seismological model suggests.

5.2 Comparison to 1995 earthquake

The 1995 and 2003 earthquakes rupture different parts of the subduction interface, and only slightly overlap at the northwest edge of the Manzanillo Trough. Modeling of genetic thrust faults indicates that the high-Coulomb stress changes occur along strike immediately at the edge of a rupture (Lin and Stein, 2004). This suggests that the 2003 Tecomán earthquake resulted from stress transfer from the adjacent 1995 event and its postseismic effects.

Both the up-dip and down-dip limits of the 2003 rupture are deeper than those of the 1995 earthquake. This may suggest:

(A) A fundamental change along the strike of the depth of seismogenetic causality, possibly caused by differences in the rates and angles of Rivera and Cocos plate subduction, or

(B) The presence of lower strength rock to greater depths, consistent with Bandy et al. (1995).

5.3 Comparison to 1932 earthquakes

The 1932 earthquakes share attributes with the 1995 and 2003 earthquakes that suggest possible triggering relationship for earthquakes along this part of the subduction interface. Singh et al. (1985) approximate the 1932 aftershock distribution (Figs. 6 and 7) with the 1995 and 1999 earthquakes. Both the up-dip and down-dip limits of the 1995 earthquake (Fig. 6) are shallower than those of the 1995 earthquake. This may suggest:

(A) A fundamental change along the strike of the depth of seismogenetic causality, possibly caused by differences in the rates and angles of Rivera and Cocos plate subduction, or

(B) The presence of lower strength rock to greater depths, consistent with Bandy et al. (1995).