A SEISMOLOGICAL INVESTIGATION OF TIBETAN PLATEAU - ATTENUATION, VELOCITY STRUCTURE, AND SEISMIC SOURCE PROCESS

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Tibet has long been an interesting and important area related to continental collision. The tectonic deformation in the area is profound and complex. In this study, a velocity structure, a Q model, and the seismic source parameters of some Tibetan earthquakes have been determined in order to better our understanding about the tectonic processes of this area.

Fundamental-mode Rayleigh waves generated by twenty-two earthquakes that occurred in the Tibetan Plateau and/or along the Tibetan border were used to obtain a velocity model across Tibet. By a trial-and-error inversion approach and by use of partial derivatives of Rayleigh-wave group velocities, a model with crustal thickness of 70 km, a low-velocity zone at a depth of 20 to 30 km, and a low upper mantle velocity was derived. This model fits our observed data very well and is in general agreement with the TP-4 model developed by Chun and Yoshii (1977).

By employing the equation of Anderson et al. (1965) along with Yacoub and Mitchell's (1977) values of attenuation coefficients, a low-Q_R model for periods between 10 and 50 seconds was generated. Our values are quite low when compared with those of Singh and Gupta (1979) but are close to the values obtained by Feng and He

(1980).

The inversion of Rayleigh-wave attenuation data yielded an internal friction Q_β^{-1} model as a function of depth. A low-Q_β model was derived and compared with the values for the United States (Herrmann and Mitchell, 1975).

The velocity model and Q model for Tibet derived in the study support the conclusion that high temperature and partial melting occur in the area (Anderson et al., 1972; Bird, 1976; Chun and Yoshii, 1977; Chang, 1979).

The source parameters of five Tibetan earthquakes have been studied by comparing the synthetic and the observed far-field P waveforms for the first forty seconds of motion. The source parameters such as focal depth, fault-plane solution, and source-time function for the events have been obtained through both ray theory and a matrix method coupled with a generalized inversion procedure. Results obtained from these two schemes are in good agreement.

The first two events, which are located in northern Tibet, consist of the mainshock and the largest aftershock of an earthquake sequence. The focal mechanisms of these two events are mainly normal faulting, with a considerable amount of strike-slip motion. The third event, very close to the first two, is characterized by normal faulting on a north-south striking fault. For the fourth shock, which occurred in the southern part of Tibet, the fault-plane solution was not well constrained. The fifth event, which was located in eastern Tibet, had a significant amount of strike-slip motion.

Events 2, 3, and 5 are characterized by simple dislocation time histories. On the other hand events 1 and 4, which had larger magnitudes, greater focal depths and larger seismic moments, are multiple shocks as revealed from P waveform modelling.

Synthetic Rayleigh waves were also compared with the observed seismograms recorded at several WWSSN stations near the Tibetan Plateau. The source parameters obtained for the events, as well as the Tibetan velocity model and Q model, were used for computing synthetic seismograms. The fit between synthetics and observations suggests that the velocity structure determined in this study is adequate to represent the Tibetan region, but that the Q model may require revision.

A circular fault model is used for the five Tibetan earthquakes. All the events have low stress drops. Events 1, 3, and 4, considered to be typical of the region, are characterized by large rise times, relatively long corner periods, and large source dimensions. Events 2 and 5, with anomalous $m_b : M_s$ values, were found to have relatively high stress drops and small source dimensions. These probably are related to high stress concentrations or formation of new faults (Molnar and Wyss, 1972; Tatham et al., 1976). The differences in source parameters of the studied events suggest a lateral variation of state of stress and material property in the Tibetan crust. Molnar and Chen (1983) concluded that the dominant stress field in Tibet is east-west tension, giving rise to normal faulting, sometimes with a strike-slip component. They also mentioned that this style of deformation and shallow focal depth (less than 15 km) are similar to those in the Basin and Range province of the western United States.