Body Wave Attenuation Structure in Southern Mexico

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Abstract

Velocity spectra from moderate-sized earthquakes are used to investigate the body-wave attenuation structure in southern Mexico. In particular, we include local events with magnitudes in the range 4.0 < M < 6.2 and depths larger than 50 km recorded from July 2007 to June 2008 on the VEOX array, which consists of 47 broadband sensors from Pacific Coast to Gulf of Mexico, cross Oaxaca and Veracruz states in southern Mexico. By assuming a Brune-type source, a path-averaged frequency-independent Q is obtained for each seismogram in the frequency band 2 to 30 Hz, depending on the signal quality. P wave analyses show that waves generally attenuate more in the back arc than in the fore arc. 1D inversion results show that the Q value decreases from about 800 at 25 km inland from the coast to about 400 at 175 km inland from the coast. This indicates that the mantle wedge in this region is probably characterized by high attenuation. Preliminary 2D inversion results show that the high-attenuation mantle wedge lies above the slab and between the depths of about 60 km and 120 km.

Introduction

The Veracruz-Oaxaca Seismic Line (VEOX), as a follow of the Meso American Subduction Experiment (MASE), provides us a good opportunity to study the attenuation of southern Mexico carefully.

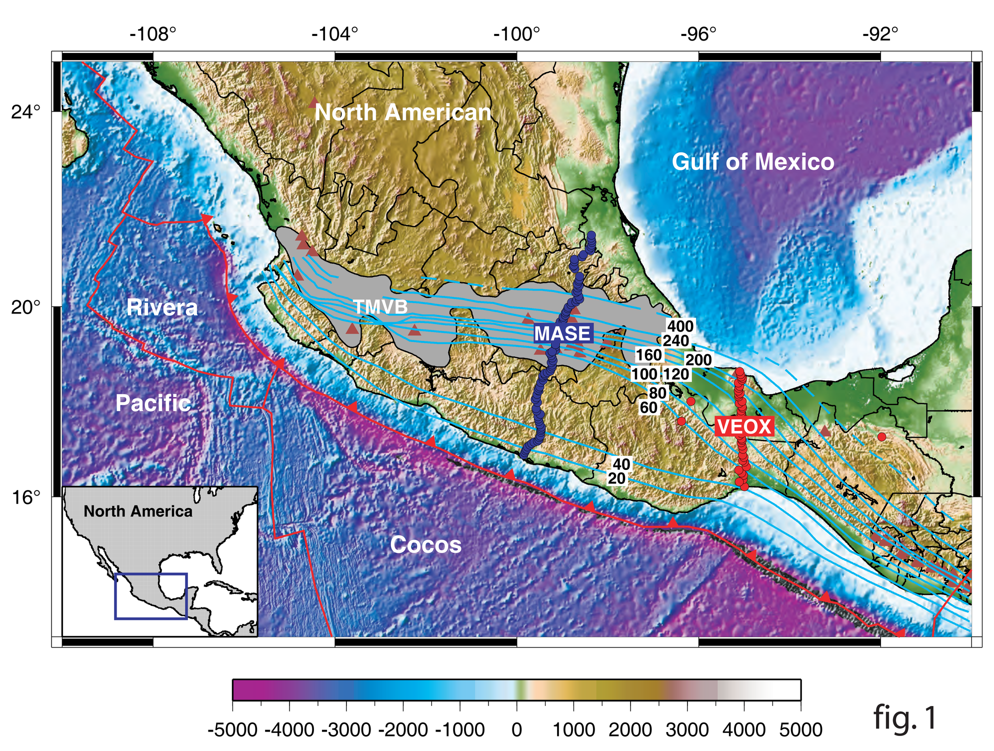

fig. 1

VEOX line consists of 47 broadband sensors.

The slab contours are determined based on the combination of seismicity, velocity tomography and receiver functions.

Volcanos are shown as brown triangles. TMVB stands for Trans-Mexican Volcanic Belt.

Spectral Analysis Method

The Fourier velocity spectral amplitude of a body wave from event *j*, recorded at station *i*, can be written as [e.g. Garcia *et al.*, 2004]

$$A_{ij}(f) = CS_j(f)I_i(f)\exp(-\pi f t^*_{ij}) \quad (1)$$

where *S(f)* is the source spectra, *I(f)* is the instrument response, *C* is the frequency-independent amplitude term. The exponential term describes the attenuation effect. $t^* = t/Q$, where *t* is the travel time, and *Q* is the quality factor.

Assuming a Brune-type source [Brune,1970], the source velocity spectrum of event *j*, can be written as

$$S_j(f) = \frac{fM_{0j}}{1+(f/f_c)^2} \quad (2)$$

where M_{0j} is the signal moment, and f_c is the corner frequency.

t^* for each seismogram and a common corner frequency for each event are obtained applying the techniques from *Eberhart-Phillips* and *Chadwick* (2002).

Data and Analysis

We used 124 events in total as showed in fig. 2. Here we show an example of attenuation difference between the P wave going through forearc region and the P wave through backarc region. The two waves are from the same event, and have about equal raypath length. It is clear from the spectra that the wave going through backarc regioin attenuates more than the other one.

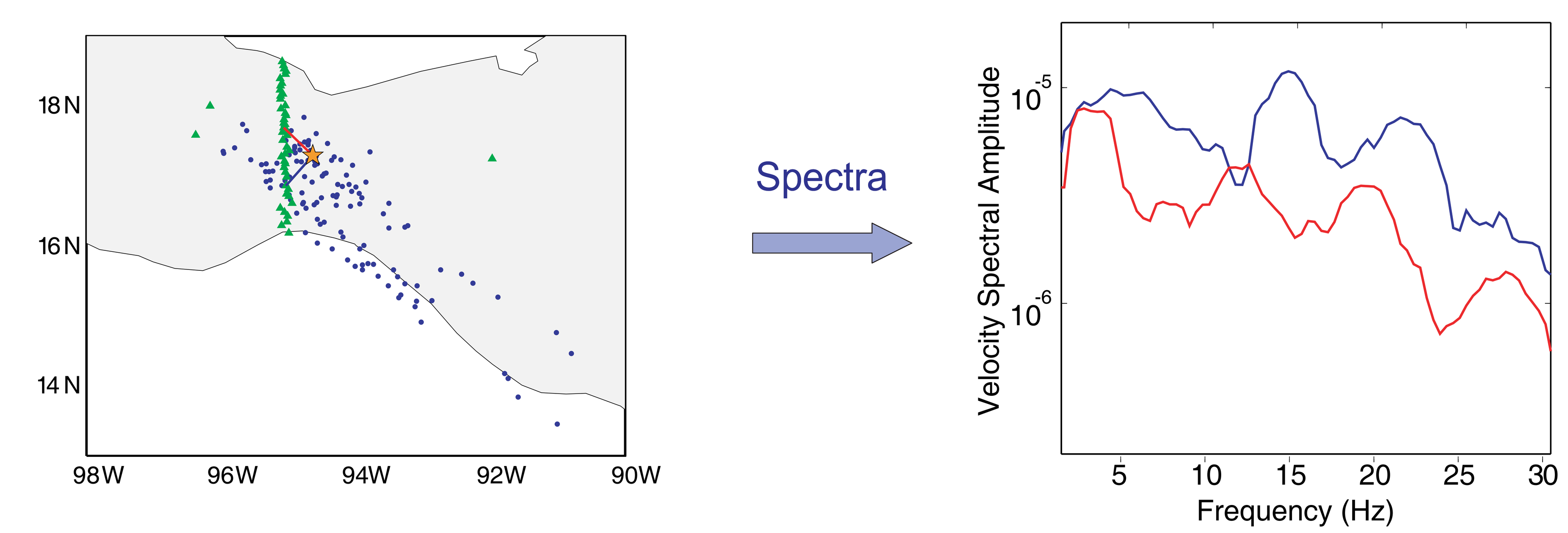

fig. 2

Example of signals, noises, and fittings for some seismograms.

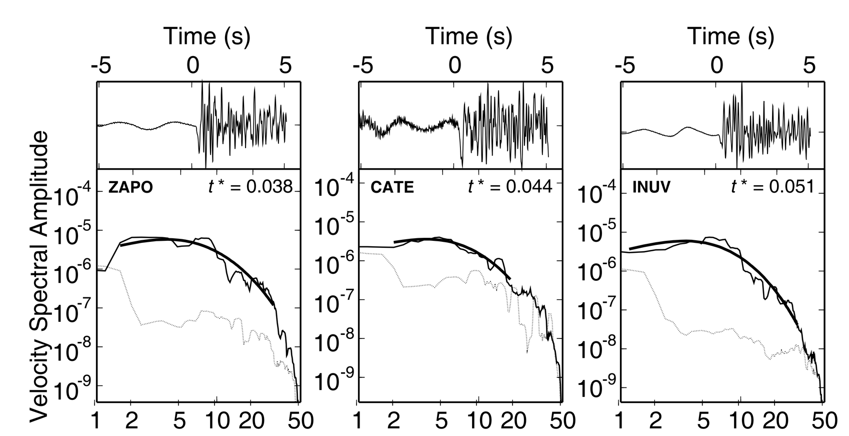

fig. 3

Example of path-averaged attenuation results (1000 *t**/*t*) at each staion along the array for the same event as in fig. 2.

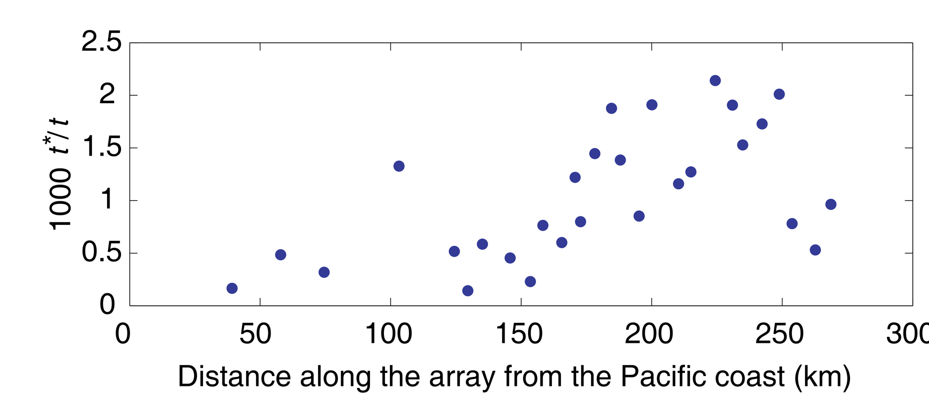

fig.4

1D Tomographic Geometry

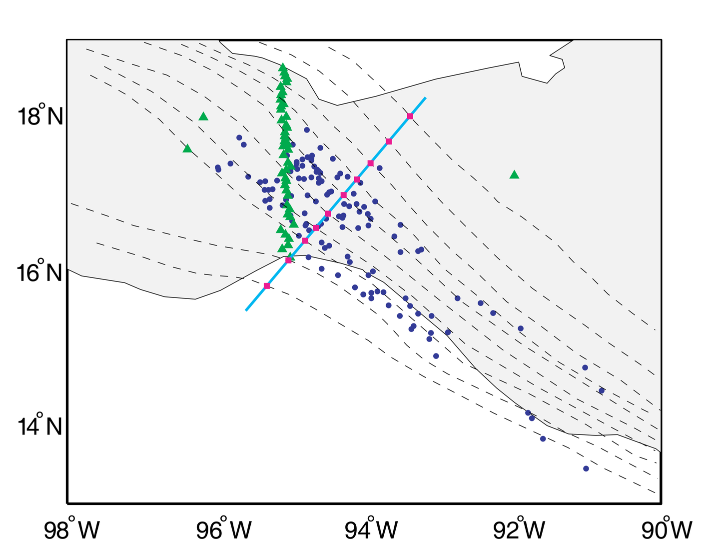

fig. 5

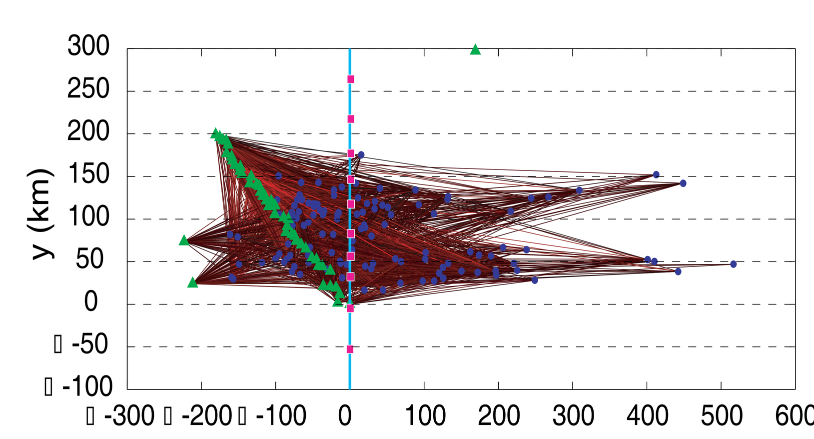

fig. 6

1D tomographic inversion assumes that attenuation only varies along the direction perpendicular to the slab isodepths (dashed lines in fig. 5). Fig. 6 rotates counterclockwise relative to fig. 5, showing inversion blocks in y axis. Raypaths are colored by the average attenuation values. Red means higher attenuation, and black means lower attenuation.

1D Inversion Results

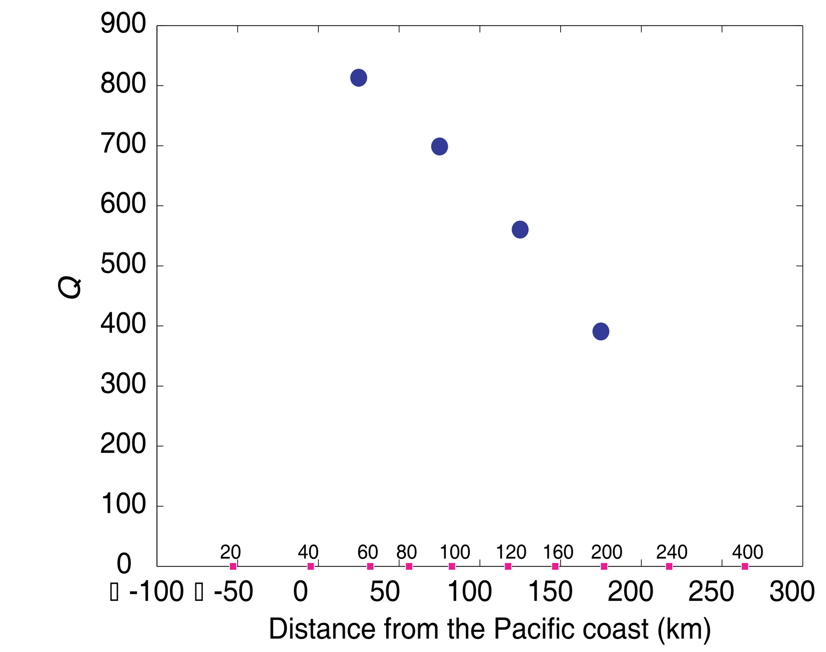

fig. 7

The x axis of fig. 7 is the same as y axis of fig. 6. Each blue dot shows the 1D inversion result for the corresponding block in fig. 6. Small magenta squares and the texts above indicate the locations of slab isodepths.

The decrease of *Q* from coast to inland indicates that the mantle wedge is probably charaterized by high attenuation. To determine the depth of this high-attenuation region, we need 2D tomography.

2D Tomography

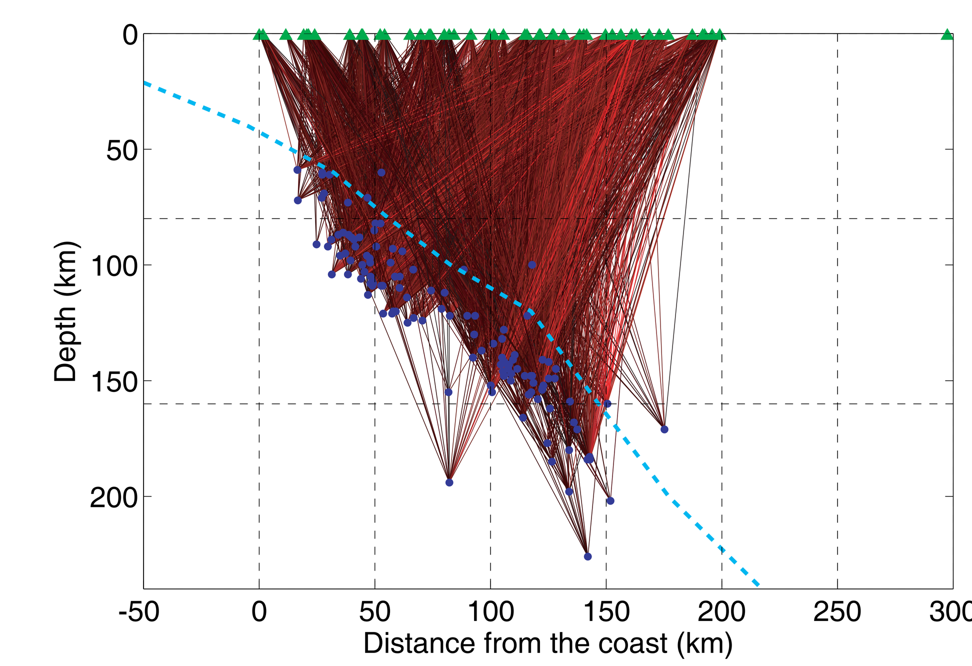

fig. 8

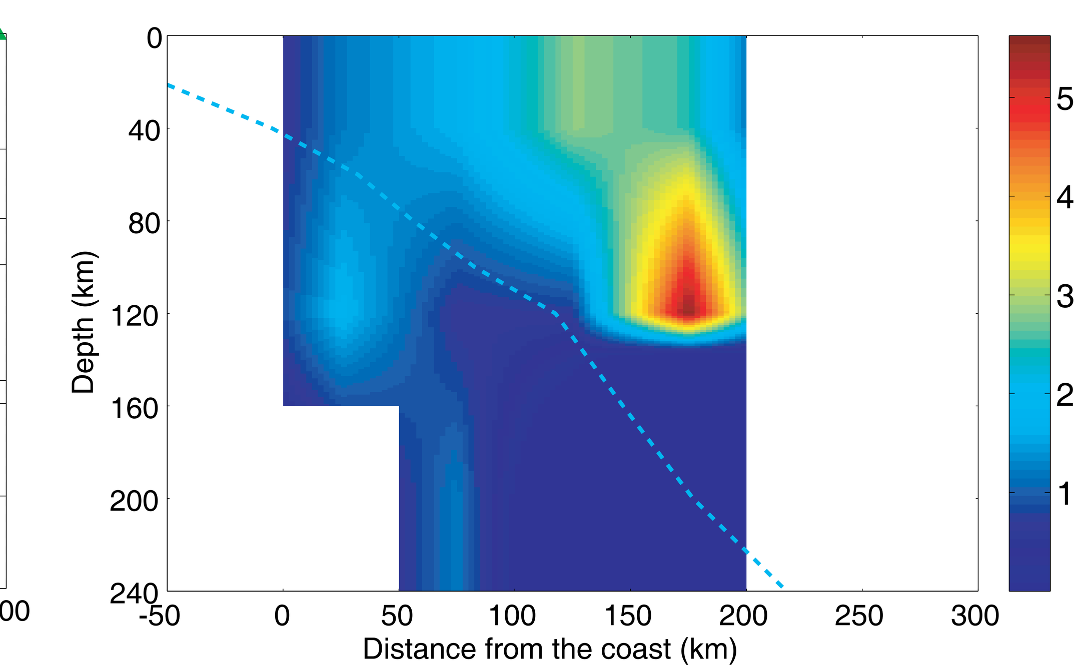

fig. 9

2D tomography considers a cross section perpendicular to the slab isodepths (as the cyne line in fig. 5). Preliminary results show that the high-attenuation region lies above the slab (dashed line in fig. 8 and fig. 9).

Comparison with Attenuation Structure in Central Mexico

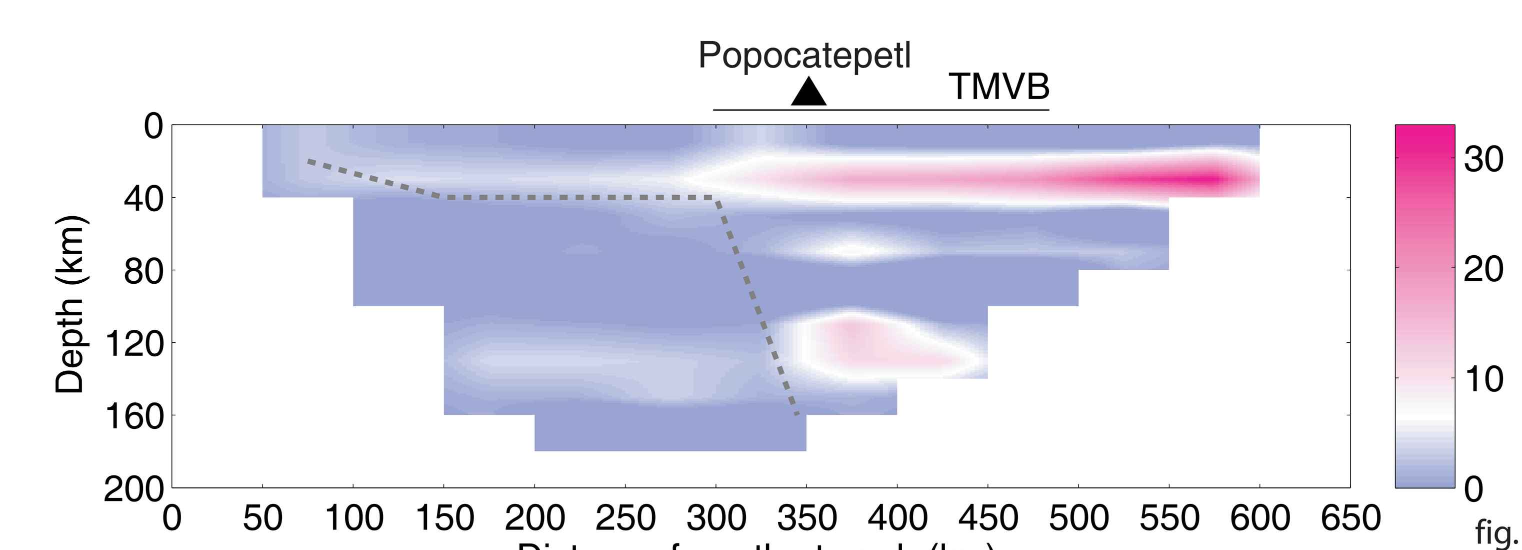

fig. 10

The attenuation structure along the MASE line.