SEISMIC ANISOTROPY WITHIN THE TIBETAN CRUST

Overview

Tibet is one of the most actively deforming areas in the world, as demonstrated by its surface topography, faulting, and seismicity. This deformation results in the development of finite strain within the Tibetan crust that produces seismic anisotropy. We isolate the distribution of seismic anisotropy within the Tibetan crust by using short- and the intermediate-period surface waves and crustal reverberations of teleseismic body waves.

Anisotropy into the crust. Acceptable fits are obtained with the parameterization allowing radial anisotropy in the middle crust (Table 1). The mid-crustal radial anisotropy maximized in the western part of the plateau as shown in Figure 5.

Intermediate-period Rayleigh-Love discrepancy can be resolved by introducing radial anisotropy between 15 and 35 s while the Love-wave dispersion is normal at those periods.

Figure 3a shows the observed surface-wave dispersion curves for teleseismic sources. The 20 s and 50 s Rayleigh-wave group velocities are calculated from these observations using the method of Park and Levin (2002).

Table 2 gives the observed and calculated group velocities for 20 s Rayleigh-wave group velocities. The 50 s Rayleigh wave group velocity is calculated from the observed 20 s Rayleigh-wave group velocity.

Table 2. Observed and calculated Rayleigh wave group velocities.

<table>
<thead>
<tr>
<th>Distance (km)</th>
<th>20 s Observed</th>
<th>20 s Calculated</th>
<th>50 s Calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>4.07</td>
<td>4.07</td>
<td>2.10</td>
</tr>
<tr>
<td>300</td>
<td>4.00</td>
<td>4.00</td>
<td>2.03</td>
</tr>
<tr>
<td>400</td>
<td>4.07</td>
<td>4.07</td>
<td>1.98</td>
</tr>
<tr>
<td>500</td>
<td>4.00</td>
<td>4.00</td>
<td>1.94</td>
</tr>
</tbody>
</table>

Finite strain within the Tibetan crust

The interpretation of the observed anisotropy in the crust is more complicated than interpreting mantle mantle anisotropy (mostly produced by olivine) because different physical mechanisms can produce crustal anisotropy in finite strain. Preferential orientation of mica may play the most important role in mid-lower crustal anisotropy, with larger shear modulus parallel to the plane of oriented mica crystals than perpendicular to it (e.g., Wieland et al., 1999; Goforth et al., 2003; N. Christie, unpublihed results).

Strong radial anisotropy in the Tibetan crust may be caused by radial flow of the weak mid-crustal layer in response to vertical gravitational flattening (Figure 12a) that would result in preferential horizontal orientation of the mica crystals. The mid-lower crustal anisotropy in Northern Tibet may be caused by large-scale faults oriented east-west. Another interpretation of these anisotropy may be the preferential east-west direction of crustal viscous flow (Figure 12d).

Conclusions

Our results indicate that: (1) the Tibetan crust is characterized by strong radial anisotropy that maximizes in the western part of the plateau, (2) the strength of surface-wave azimuthal anisotropy appears to be correlated with that of the radial anisotropy, and (3) surface-wave fast axis directions rotate from north-south to east-west across Tibet as surface wave velocities move from the upper to the mid-crust.

We isolate P-to-S converted waves at three Tibetan stations from earthquakes shown in Figure 8 with the multi-dimensional backazimuthal range between 100° and 150° SE is used. Scale of T component suffers a change in polarity. Shaded bar denotes time gathers shown in Figure 10.

Development of finite strain within Tibet

Isotropic gravitational flattening

Gravitational flattening with preferential east-west extension

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