# 2-D Sn attenuation tomography of Arunachal Himalaya

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**Objective:**

To formulate a 2-D $Q_{Sn}$ tomographic model to investigate the uppermost mantle shear wave Q and its implications on the uppermost mantle's rheology and deformation beneath Arunachal Himalaya.

- Seismically active region
- EHS is a highly deformed region where structural, drainage and tectonic units change from nearly E-W striking to N-S direction.
- There are three major thrust faults (MCT: Main Central Thrust, MBT: Main Boundary Thrust and MFT: Main Frontal Thrust).

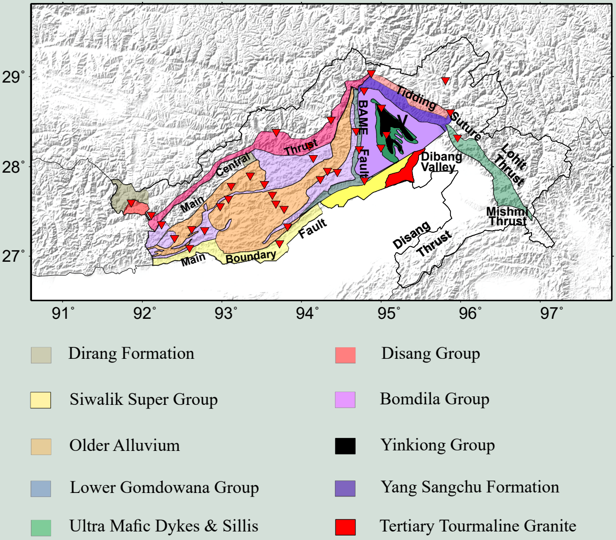



Fig. 1: Topography map of Arunachal Himalaya and surrounding regions. The red inverted triangles denote the location of seismometers.

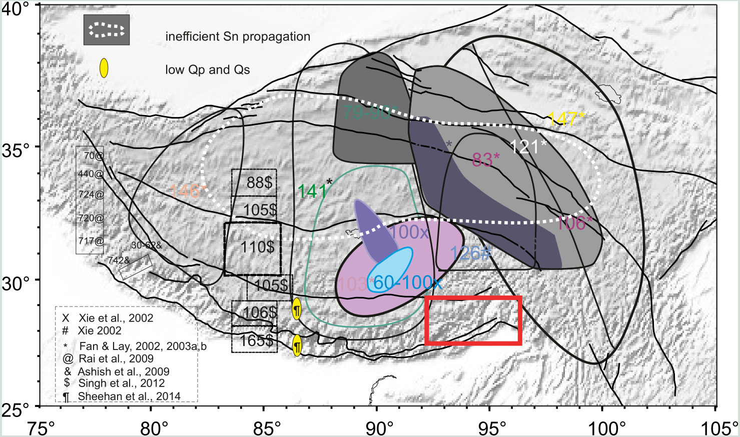



Fig. 2: Previous attenuation study across the Himalaya and Tibet. Low $Q_p$ and $Q_s$ values and Inefficient Sn propagation reported previously in Tibet region.

## $Q_{Sn}$ analysis

**Sn-wave attenuation:**

- Seismic attenuation: dissipation of seismic wave energy as they propagate through the medium
- Attenuation results in amplitude decay of the seismic waves
  - Geometrical spreading
  - Intrinsic attenuation (Anelastic attenuation)
  - Scattering attenuation (Elastic attenuation)
- Attenuation is measured by the quality factor (Q).
- Q is a dimensionless quantity and is defined as,

$$Q = \frac{2\pi E}{\delta E} \quad (1)$$

where E is is the energy of the seismic wave

- Q is inversely related with attenuation strength
  - High attenuation - low Q value
  - Low attenuation - high Q value

**Sn phase:**

- Travels through uppermost mantle above the asthenospheric low-velocity layer
- Travels through both the continental and oceanic paths
- Velocity: 4.1-4.8 km/sec

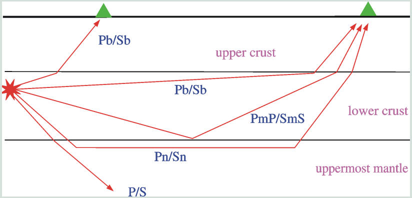



Fig. 3: The cartoon illustrates source-to receiver ray-paths of the Sn and other phases.

**Data**

- 37 seismic stations, AP network, Arunachal Pradesh, 2013 - 2014
- Magnitude ($m_b$) $\geq$4.0
- Epicentral distance $= 2^\circ$ to $15^\circ$ and focal depth $\leq$ 50 km.

**Main Processing Steps:**

- Remove instrument response
- Sn propogation efficiency check
- Bandpass filtering (0.1 - 5 Hz) of vertical component Sn-phases efficient waveforms
- Spectral amplitude calculation of signal (Sn-phase) and noise (pre-Pn phase) through FFT technique with 15% cosine tapering
- Applying Two Station Method approach of Zhao et al. (2015) to compute interstation $Q_{Sn}$ values
- Applying back projection technique for $Q_{Sn}$ tomography.

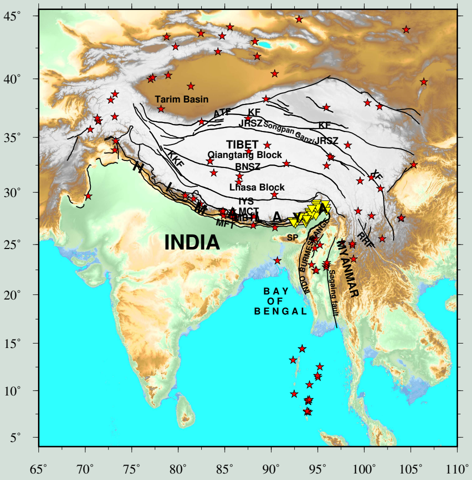
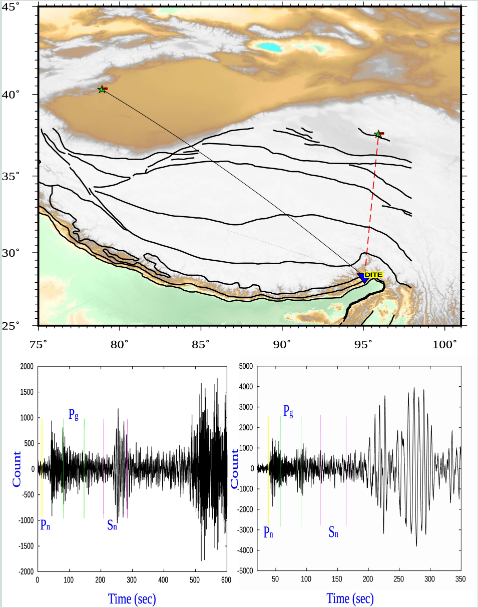



Fig. 4: Map showing events distribution used in this study.

**Velocity window**

- Pn velocity window 8.0 km/s to 7.9 km/s.
- Pg velocity window 6.8 km/s to 5.8 km/s.
- Sn velocity window 4.8 km/s to 4.1 km/s.



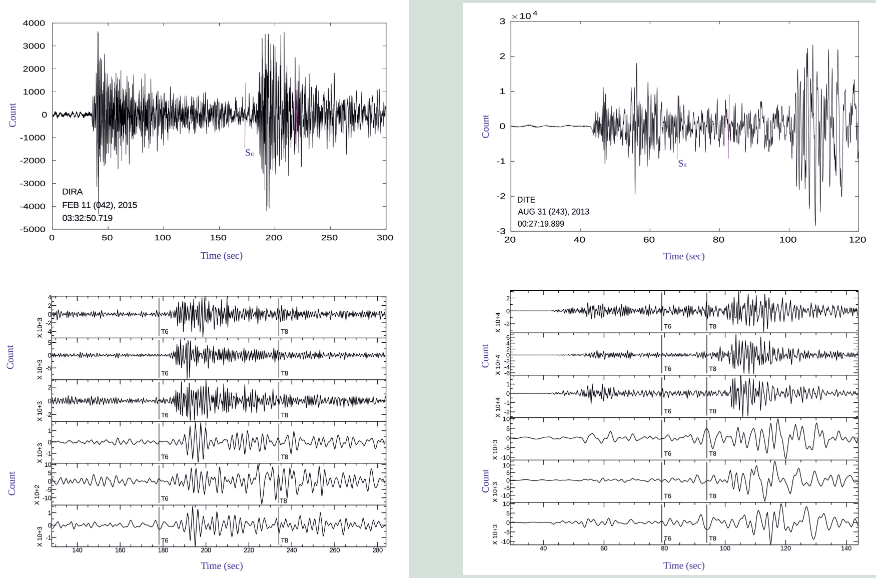
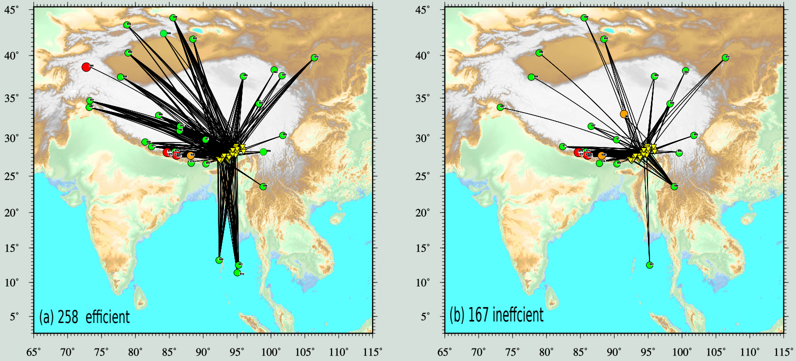



Fig. 5: Efficient and Blocked seismograms inspected at: Band (0.5 - 5 Hz), High (0.5 - 2 Hz) and low (0.1 - 0.5 Hz) pass filter.

## *Sn*: Efficient, Inefficient, and Blocked Raypaths



- Bandpass filtering (0.1 - 5 Hz) of the vertical component Sn-phases efficient waveforms
- Geometrical spreading correction
- Signal (Sn-phase) and equal time noise window (pre-Pn waveform) amplitude spectra are computed through FFT with 15% cosine tapering
- Station pairing corresponding to one event
- Interstation distance $\geq$150 km
- Angle between source and two station$<15^\circ$
- SNR$\geq$2
- The inter-station uppermost mantle Q value for the near station *S1* to far station *S2* for an event *E* is

$$\int_{R1}^{R2} \frac{d\Delta}{Q(f)} = \frac{v}{-\pi f} ln\left[\frac{A_{S2}(f)}{A_{S1}(f)} * \frac{G(\Delta_{S1}, f)}{G(\Delta_{S2}, f}\right] \quad (2)$$

$$Q(f) = Q_0 f^{\eta} \quad (3)$$

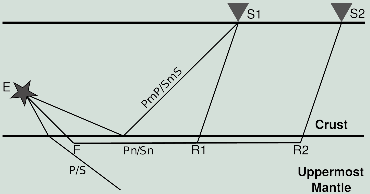
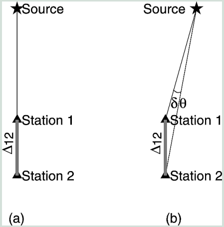



Fig. 6: The cartoon illustrates the simplified concept of the Two Station Method along with source-to-receiver ray-paths of the Sn and other phases.




Two station geometry

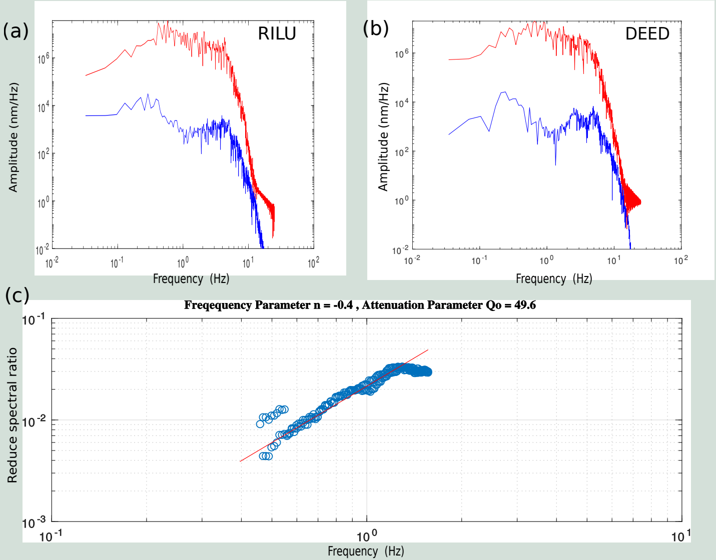



Fig. 7: Example of $Q_{Sn}$ estimation using the Two Station Methodology (TSM) of Sn wave for station pair RILU—DEED for an event6 (origin time: 22/11/2014 08:55:26.6, latitude: $+30.34^{\circ}$, longitude: $+101.74^{\circ}$, magnitude: 5.4).

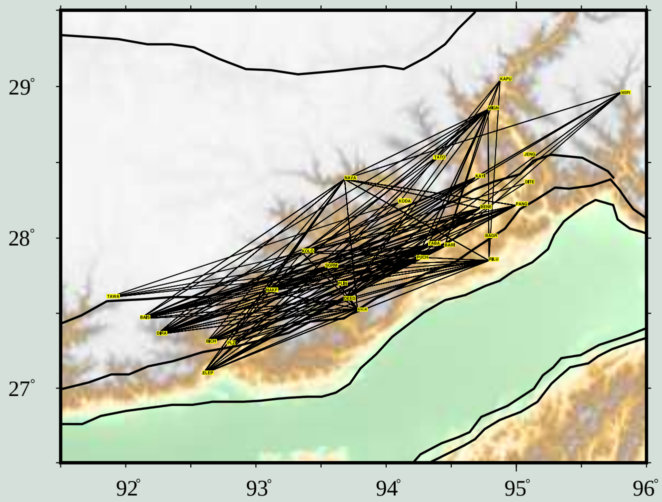



Fig. 8: The figure shows the inter-station raypaths coverage map of the study area. We have 425 inter-station raypaths after the TSM analysis.

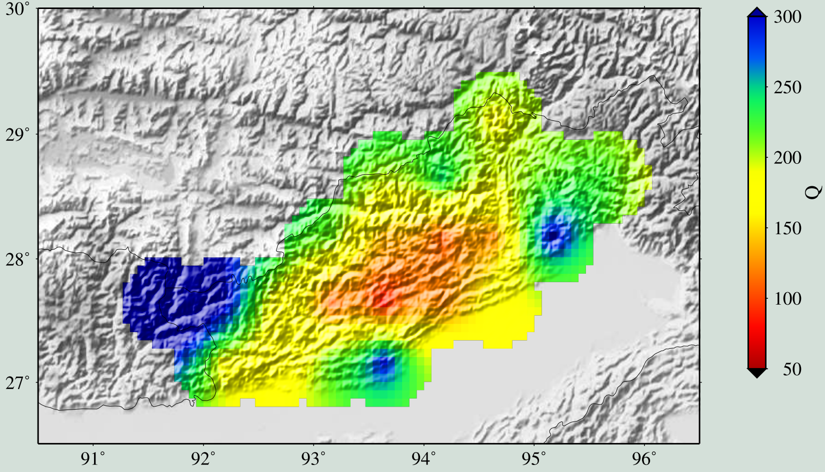



Fig. 9: The map shows the two-dimensional Sn attenuation tomography of the region. The model is obtained at 1 Hz reference frequency with a cell size of $1^{\circ} x 1^{\circ}$.

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