Seismic attenuation tomography of the North-Western Himalaya using Coda waves

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We use 4695 local waveforms from 1206 earthquakes (epicentral distance < 350 km and 2.0 ≤ Mw ≤ 5.5) recorded by IISER Kolkata network (IK) at 22 stations (32°N to 35°N latitude and 74°E to 77°E longitude), located within the North-Western Himalaya (28°N to 39°N latitude and 68°E to 81°E longitude). We study the coda waves which are generally the tail of a seismogram and arrive after the main seismic waves. We use the temporal decay of coda amplitude to calculate the coda quality factor (Qc) from which we estimate the attenuation (Qc⁻¹). We consider the single back-scattering model (Aki & Chouet, 1975) where both the scattering (Qsc⁻¹) and intrinsic (Qi⁻¹) component of the attenuation are included in the measurement. We use a lapse time of 2τs (τs is the S-wave arrival time) as the starting point of the coda window. Then, we consider multiple forward-scattering model, where the attenuation (Qc⁻¹) is dominantly dependent on the intrinsic (Qi⁻¹) component. In this model we use lapse time greater than 2τs so that the coda waves encounter multiple scatterers and enter the diffusive regime. We calculate the frequency dependent quality factor for each earthquake-receiver path at frequencies 1 to 14 Hz using the linear least squares approach on temporal decay of coda amplitude. We calculate Q₀ (quality factor at a reference frequency f₀ which is chosen to be 1 Hz for the analysis) and its frequency dependence (η) using weighted least squares approach on the power law dependence of Qc on frequency. To see the lateral variation of Q in our study area, we have produced 2-D maps by combining the Qc measurements together in a tomography. For single back-scattering model we use the back-projection algorithm which is based on the calculation of area overlap of ellipses with the gridded region. For multiple forward-scattering model, the same back-projection algorithm is modified to calculate the length overlap of traces with the gridded region. To understand the spatial resolution of the 2-D Qc maps, we use the point spreading function test which quantifies the recovery of Qc perturbation. In addition to this, we also perform a standard checkerboard resolution test to ensure simultaneous recovery of Qc perturbation. We observe low Q in the Kashmir basin and Lesser Himalaya and high Q in surrounding northeastern Higher Himalaya which clearly correspond to the coda wave attenuation signatures in the older Tethyan sedimentary rocks and crystalline igneous rocks in these regions respectively.