# Spatial variations of attenuation properties beneath western Tibet and its implications to seismotectonics and structural heterogeneity

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**Abstract**

The attenuation characteristics of western Tibet are investigated using high quality data recorded at Y2 network of broadband stations deployed in western Tibet during 2007-2011. The western part of the Tibet is tectonically very complex and seismically very active. The present study aims to provide the spatial variations of attenuation properties in the medium below the study area. Initially, I have estimated the frequency dependent body wave attenuation ($Q_p^{-1}$ and $Q_s^{-1}$), coda wave attenuation ($Q_c^{-1}$) and subsequently relative contribution of scattering ($Q_{sc}^{-1}$) and intrinsic ($Q_i^{-1}$) attenuation have been investigated for each station to explore the dominant factor causing decay of seismic waves beneath western Tibet. Two-dimensional (2-D) attenuation maps are also produced to examine the spatial variations of structural heterogeneities in western Tibet.

The obtained results indicate strong body and coda wave attenuation in the medium. Across the Karakoram fault (KKF), I have subdivided the entire study area into two regions, namely Region 1 and Region 2, to explore the lateral variations of $Q_p^{-1}$ and $Q_s^{-1}$. Region 1 includes the northeastern part whereas Regions 2 covers the southwestern part of the KKF. Both the regions show strong frequency dependent nature of $Q^{-1}$ values with no significant lateral variations. I also find that all the estimated values of $Q_p^{-1}/\ Q_s^{-1}$ ratios are greater than unity at all the frequency ranges which are likely to be associated with both the intrinsic and scattering phenomenon in the crust of western Tibet.

Thereafter, the values of $Q_c^{-1}$ have been calculated as a function of frequency at five different lapse time windows for each station. I have observed that $Q_c^{-1}$ values are decreasing with increasing frequency for all the stations which are also consistent for all the lapse time windows considered in the present analysis. Low $Q_c^{-1}$ values are mostly dominated in Region 2, whereas high $Q_c^{-1}$ values are associated with Region 1 at all the frequencies and lapse time windows (except 12 and 18 Hz at 70 s). Distinct variations in attenuation properties are being observed across the KKF at all the frequencies and lapse time windows. Higher coda wave attenuation is noticed in Region 1 compared to Region 2. Variations of $Q_{0c}^{-1}$ at different lapse time windows and its corresponding apparent depths are also examined. A certain rise in $Q_{0c}^{-1}$ values has been observed at 60 s lapse time window connecting to the depth range varies from 113.87 km to 158.90 km, which may be due to the change in velocities, existing temperature, rock composition variations and strong heterogeneity in the lithospheric mantle.

To know the dominant mechanism causing amplitude decay of seismic wave in the medium, Multiple lapse time window analysis (MLTWA) has been performed for the independent measurements of $Q_{sc}^{-1}$ and $Q_i^{-1}$ for all the stations at five different central frequencies. I find that $Q_i^{-1}$ is predominant over $Q_{sc}^{-1}$ at all the frequency ranges for all stations barring few exceptions (WT03, WT07, and WT13) at 18 Hz. The values of $Q_i^{-1}$ are found to be frequency-dependent and consistent with the local geology and tectonics of the region. Region 1 exhibits higher $Q_i^{-1}$ than Region 2 at lower

frequencies, whereas $Q_i^{-1}$ shows opposite trends at higher frequencies ($>$ 6 Hz) as it shows higher values in Region 2 than Region 1. The frequency dependence nature of $Q_i^{-1}$ may be associated with the composition as well as the distribution of the fluids in the crust. In Region 1, strong $Q_i^{-1}$ may be correlated with the sedimentary deposits whereas presence of fluid filled fractures and/or partial melting causes high attenuation at deeper zones below Region 2. Lateral variations of both the coda wave and intrinsic attenuation distinctly demarcate the regions across the KKF. The results show similar trends of coda wave attenuation and intrinsic attenuation which indicate that the decay of coda wave is primarily due to the intrinsic dissipation in the medium. Finally, all the obtained values of $Q^{-1}$ in this study are in good agreement with other segments of Himalaya and Tibet as well as different tectonic regions in the world.

**Keywords**

Body wave; Coda wave; Intrinsic; Scattering; Seismic attenuation; Crustal structure; Karakoram fault; Western Tibet