

# Seismic wave attenuation in and around Hyderabad granitic region, south Indian shield

M. Srikanth<sup>1\*</sup>, K. Sivaram<sup>1,2</sup> and V. Pavan Kumar<sup>1,2</sup>

<sup>1</sup>CSIR-National Geophysical Research Institute, Uppal road, Hyderabad 500007.

<sup>2</sup>AcSIR-Academy of Scientific and Innovative Research, Ghaziabad, India.

\* Corresponding author: srikanth.geo123@gmail.com

## ABSTRACT

We investigate the attenuation characteristics of seismic body waves in the Hyderabad Granitic region (HGR), located in Eastern Dharwar Craton, southern Indian shield, using the coda-normalization method. The analysis is carried out using local earthquake data, recorded by a broadband seismic network of ten stations, installed in and around the HGR. The dataset consists of 30 local earthquakes with magnitudes ranging from 1.4 to 3.9, recorded during the year 2020-2021. Analysis is carried out at five central frequencies 1.5, 3, 6, 12 and 24 Hz for the lapse time window of 40s, to estimate the attenuation parameters for P-waves ( $Q_p$ )<sup>-1</sup> and S-waves ( $Q_s$ )<sup>-1</sup>. In this frequency range, the estimated  $Q_p$  and  $Q_s$  values seem to indicate power-law dependence ( $Q \sim Q_0 f^n$ ), where  $Q_0$  is  $Q$  at 1 Hz, and  $n$  is the frequency dependence parameter.  $Q_p$  values vary from  $35 \pm 15$  to  $200 \pm 80$ , while  $Q_s$  from  $60 \pm 10$  to  $300 \pm 150$ , while 'n' shows minor variations for both P and S waves. The ratios  $Q_s/Q_p$  varying from 0.78 to 2.50, indicate variations in crustal properties, including heterogeneity and fracture characteristics. Our study would be of use in the investigation of the regional seismic hazard, seismic wave propagation and crustal heterogeneity.

**Keywords:** Quality factor  $Q_p$  and  $Q_s$ , Seismic attenuation, Scattering, Intrinsic absorption, Hyderabad Granitic Region (HGR), Eastern Dharwar Craton, South Indian Shield

## INTRODUCTION

The study region of HGR is located in the Eastern Dharwar Craton (EDC) of the southern Indian peninsular shield. According to the seismic zonation map of India (BIS, 2016), this region lies between the seismic zones II and III with low to moderate intraplate seismic activity. Small earthquakes and microtremors associated with the hydrological processes and crustal heterogeneities, have been reported in the numerous recent studies. The HGR is also characterized by active neotectonic processes, with evidence of ongoing uplift at a rate of  $\sim 12$  mm/year (Catherine and Pandey, 2005), indicating continued crustal deformation. The recent installation of broadband seismic networks, has significantly improved the seismic monitoring, enabling a more comprehensive characterization of regional seismicity (Srinagesh et al., 2015). Shallow microtremors in the Hyderabad region, have often been linked to seasonal groundwater recharge following heavy monsoon rainfall, indicating the influence of hydrological processes on local seismicity (Parvin et al., 2021). Most of the seismic events, occur at shallow crustal depths and are often associated with pre-existing fractures and structural discontinuities.

Over the years, various geophysical investigations have been carried out to understand the crustal structure and seismic characteristics of this region. Receiver function modelling studies across the Deccan Volcanic Province and the Eastern Dharwar Craton, have revealed significant variations in crustal thickness and seismic velocity structure within the south Indian shield (Kumar et al., 2020). An earlier seismic attenuation study of  $Q_p$  and  $Q_s$  was carried out by Baruah et al. (2007) specifically around Jubilee Hills region of the

Hyderabad (Telangana, India). Recently, a broadband seismic network consisting of ten stations was deployed by the CSIR-National Geophysical Research Institute, Hyderabad to monitor regional seismicity and investigate crustal structure. Using the acquired data from this network, Mandal et al. (2022) analyzed the moment tensor and source parameters of a rare lower-crustal earthquake (Mw 3.9) that occurred on 25 July 2021 beneath this region. Their results suggest presence of lower crustal attenuation and intraplate deformation. Several significant crustal and mantle discontinuities as well as mantle transition zone discontinuities beneath the HGR have also been discovered by further research using receiver function analysis (Mandal et al., 2024). The performance of broadband seismic stations and the noise levels in the EDC have been assessed by ambient noise analysis (Saha et al., 2024). Shallow shear-wave velocity structure and site response characteristics over this region have been revealed further by site characterisation studies employing Horizontal-to-Vertical Spectral Ratio (HVSR) analysis (Sivaram et al., 2024). Despite these studies, investigations focusing on seismic wave attenuation in the HGR, remain limited. Understanding the attenuation characteristics of seismic waves are directly related to crustal heterogeneities, lithological variations and tectonic features. The current study uses local earthquake data captured by the broadband seismic network to examine the nature of frequency-dependent attenuation properties of seismic body waves in the HGR.

## REGIONAL GEOLOGY

The HGR symbolizes the northeastern extension of EDC, which primarily consists of granites and gneisses, together