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Mapping of the active fault signatures in MBT-MBF zone in Dehradun - Multichannel Analysis of Surface Waves (MASW) approach

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ABSTRACT

In the western part of Dehradun, the young active fault is deforming the Main Boundary Thrust (MBT) - Main Boundary Fault (MBF) zone and also displacing the younger terraces in strike slip manner along the Tons river section. We conducted Multichannel Analysis of Surface Waves (MASW) survey across the identified geologic and geomorphic expression, to map the litho-tectonic disposition across the active fault in the shallow subsurface, using shear wave velocity of the litho-units. It is inferred from the MASW profile sections that a high angle fault displaces the younger and older terraces with the Lower Tertiary rocks, with high shear wave velocities, abut against the Siwalik sandstone and thicker terrace deposits with lower shear wave velocities on the the other side. The presence of steeply dipping fault displacing younger terrace, is a unique observation in the MBF zone and the MASW technique has been successful in mapping the concealed fault.

Keywords: Himalayan belt, Main Boundary Thrust (MBT), Main Boundary Fault (MBF), Nahan salient, Dehradun, Multichannel Analysis of Surface Waves (MASW)

INTRODUCTION

In the seismically active Himalayan belt, the Main Boundary Thrust (MBT) separates the Lower Tertiary or Siwalik sequence of Sub Himalaya from the Pre-Tertiary Lesser Himalaya whereas, the Main Boundary Fault (MBF) separates the Lower Tertiary from the Siwaliks within the Sub Himalaya (Figure 1). In the western part of Dehradun valley in NW Sub Himalaya, MBT with Siwaliks in direct contact with the Lesser Himalayan rocks, lost its identity as a terrain-defining boundary fault and the MBF become prominent (Valdiya, 1980; Thakur et al., 2007; Figure 1). To the east of Nahan salient, the MBT-MBF lies at a close proximity and become ambiguous in geologic and geomorphic signatures (Nakata, 1972; Oatney, 2001; Thakur et al., 2007; Sivasankar et al., 2024). In the region around the confluence of Tons and Yamuna rivers, the narrow MBT-MBF zone is displaced by younger active faults, which cut across both the litho-tectonic units and have produced distinct geomorphic expression by displacing the strath terraces of the Tons River as well (Figure 2). We carried out shallow subsurface mapping of this active fault in the MBT- MBF zone (Figure 2) using Multichannel Analysis of Surface Waves (MASW) survey, to map the subsurface signature of the fault at shallow depths. The MASW is a seismic technique that helps in characterising shallow subsurface in terms of shear wave velocity up to a depth of about 30 to 40 m (Park et al., 1999, 2007; Park and Miller, 2008; Park, 2013; Xia, 2014). The MASW technique is successfully utilised to characterise the subsurface at identified lineament/fault/thrust locations and estimate the average shear wave velocity (Vs^{30}), stiffness, N-value, Predominant frequency (Pf), Average Horizontal Spectrum Amplification (AHSA) and Liquefaction potential (Fs) of the subsurface soils, which are essential for geotechnical studies. (Trupti et al., 2012; Duffy et al., 2014; Karabulut, 2018; Zhao et al., 2019; Suresh et al., 2021; Wang et al., 2023; Sivasankar et al., 2024, Ahmed et al., 2024).

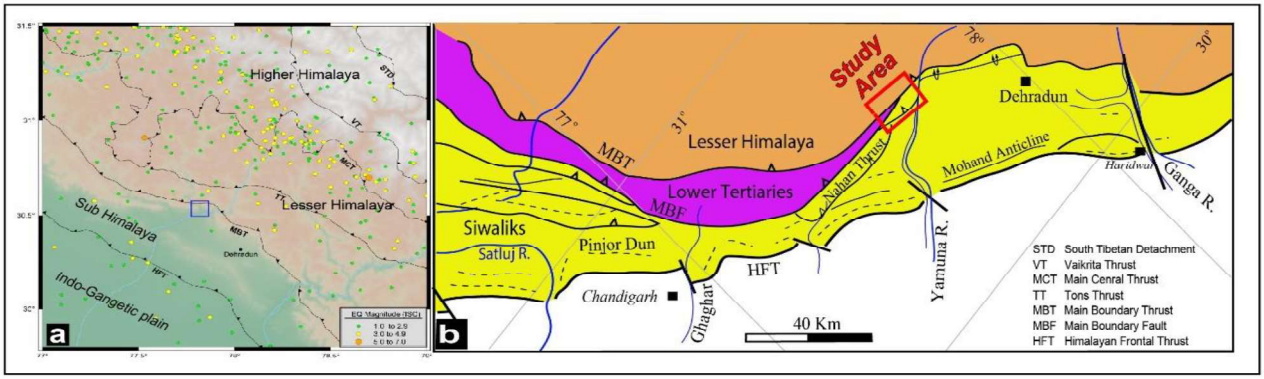

Figure 1. **(a)** SRTM map of Garhwal Himalaya showing the study area, recoded earthquake events (source: International Seismological Centre). **(b)** Geological sketch map of the Himalaya showing different intra-crustal thrusts (MBT, MBF, HFT etc.,) (Modified after Thakur et al., 2007).