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Seismic Attributes as Indicators for Inferring Tectonic and Deformation Processes: An example from Aravalli-Delhi fold belt, NW India

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The 700 km long Proterozoic Aravalli-Delhi Fold Belt (ADFB) in the NW India is investigate through a multidisciplinary study using seismic reflection , gravity, magnetic, magnetotelluric methods from 1991-93 under the deep continental studies program. The ADFB, which has distorted hour-glass structure, sandwiched between Mesoproterozoic Vindhyan and Neoproterozoic Marwar basins. Geologically, it is probably one of the best studied regions in the Indian shield with a tectonic history from Archean times. Deep crustal seismic reflection and a limited refraction studies over the 400 km long Nagaur-Jhalawar transect provided a wealth of data to understand the structure and tectonic evolution of the region. Deep seismic reflection profile runs across all the major tectonic features of the region for better delineation of structure. The data set was revisited a number of times with different objectives. A major thrust fault with a north-westerly dip of 30^0 (Jahazpur thrust) originating from the top of the reflection Moho near Nandsi and surfacing near Jahazpur is the most important tectonic feature delineated from deep seismic reflection study. The second most important feature is the convex upward reflection associated with Bouguer gravity high of 80 mGal, interpreted as high density high velocity body located at mid crustal level. The third feature being the Vindhyan basin it self manifested as a series of sub-parallel reflections deepening towards south east with a thickness of 4-5km at the end of the transect. These compelling evidences confirm the operation of plate tectonic processes during Proterozoic.

The objective of the present study is to search for the independent signatures of tectonics in the seismic attributes in the seismic stack sections or in the shot domain data. The seismic traces in stack sections did reflect the signatures of tectonics, but in a gross manner. The most obvious reason being, the "smearing / homogenising effect" the stacking process introduces. Hence we studied the shot gathers. As the data is huge, evenly spaced shots with reasonable signal to noise ratio are chosen for the study. The study over the Jahazpur thrust fault region reveals that major tectonic and lithological boundaries are associated with large variation in the spectral peak predominant seismic frequencies. Interactive spectral analysis of every 5^{th} record is performed. The study brings out three predominant spectral peak frequencies (F1, F2 & F3) approximately correlatable to lower, mid and upper crustal levels. In a similar fashion corresponding peak spectral amplitudes (A1, A2 & A3) are also studied. The study reveals while the predominant spectral peak frequencies are lower by 20-30 % over the Jahazpur thrust region, the corresponding spectral peak amplitudes display a broad high of similar order over the Jahazpur Thrust region. Large variations at shallow level in the Spectral Peak Frequencies / Amplitudes, over the Vindhyan Basin is correlatable with the minor faults and within the basin.

Key Words: Seismic Attributes**,** Aravalli-Delhi Fold Belt, Spectral Peak Frequencies/Amplitudes, Tectonic Processes