Application of GIS in Evaluating the Morphometric Characteristics of Basins in Microseismically Active Pangra-Shinde Village of Hingoli District, Maharashtra, India

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The Deccan Volcanic province is one of the largest flood basalt provinces in the world extending upto 500,000 km2 was believed to have been tectonically stable and less vulnerable to earthquakes until 30th September, 1993. On this day devastating earthquake struck and more than 10000 people died. The South East Deccan Volcanic Province (SEDVP) comprises of Killari, Nanded, Hingoli and Kinwat regions of Maharashtra, India. The microseismic activity is observed in Nanded, which is about 180 km NE of Killari in the years 2006, 2008, 2011. These earthquakes occurred periodically and the data generated showed substantial number of micro tremors of magnitudes about 1.0-3.0 magnitude. Studies on micro-earthquake activities around Nanded suggested the occurrence of 'shallow seismic activities' in the heart of the city adjacent to 'Urvashi Ghat' stream which was correlated with geophysical data to be a thrust fault as a cause of microseismic activities in Nanded region (Srinagesh et al, 2012). Later studies carried out in 2017 (Kaplay et al 2017a) provided the field evidence of deformations in the form of faults in basalts around Nanded city, the study also suggested that the basins (sub-basins) North of Godavari river near Nanded, Maharashtra, India, are tectonically more active than the sub-basins towards south of the Godavari river. The study carried out near Kinwat, which is about 240 km NE of Killari, reported physical evidence of deformations with asymmetrical nature of the sub-basin and a recent microseismic event (2015) observed from this region, is also in the close proximity of Kinwat (Kaplay et al 2017b). Recently, in 2017, Pangra-Shinde village, which is located about 40 km NNW of Nanded, has become microseismically active. These earlier studied formed the stimulus to carry out the research around Pangra-Shinde village, which is located in Hingoli district of State of Maharashtra, India (Fig.1). The main objective of the study was to find out if the sub-basins along Kayadhu river, which passes from the study area, are tectonically tilted or not.

FOSS4G has been utilized in this research to plot the streams and demarcate the sub-basin boundaries. The GIS techniques also helped us find out the asymmetric nature of the sub-basins. The natural surface evidence of streams when interpreted using GIS enabled us to understand and identify the nature of sub-basins in terms of their symmetrical nature or otherwise. The concept of application of GIS in morphometric analysis is used in the present study. The anomalous sub-basins are then correlated with the microseismically active region and deformations observed in the region. In the present study we mapped 29 sub-basins along Kayadhu River which is in the proximity to the microseismically active Pangra-Shinde village in Hingoli district. Of the 29 sub-basins plotted along Kayadhu-River, 15 sub-basins show asymmetrical nature. In morphometric studies the asymmetrical basins indicate tilting of the basins/terrain. Tilting of the terrain/basins in turn indicate tectonic activities which may result to microseismic events. All these asymmetrical sub-basins are located nearer to epicentre. The field study carried out by us near Pangra-Shinde village in 2017 reported

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physical evidence of deformations in the form of minor faults and undulations in basaltic terrain near Pangra-Shinde.

The GIS based study also revealed interesting fact that the Kayadhu river is trending NW-SE and has taken knee-bend turn at four locations. The knee-bend turn indicates structural control on the river pattern. The study further revealed the fact that the NW-SE trending Kayadhu river matches the NW-SE trend of Tirna River near seismically active Killari, near Latur, NW-SE trending Urvashi-Ghat lineament in Microseismically active Nanded region and NW-SE trending Kinwat lineament, which is the NW extension of Kaddam-fault lineament, from where also the microseismic event is reported.

Thus present study revealed the fact that the area of seismic activities in South East Deccan Volcanic Province (SEDVP) show asymmetrical nature of basins which in turn indicates tilting of the basins. The present study further reveal the fact that the seismicity/microseismicity activities are not confined to Killari (Latur) only but is observed towards NE direction to Nanded, Pangra-Shinde village in Hingoli district and Kinwat towards eastern boundary of DVP. Thus the extent of seismic/microseismic events in SEDVP is not confined to Killari. It may also be noted that recent studies carried out by group of researchers (Kaplay et al, 2013, Kaplay et al 2017a & b, Babar et al, 2018) reported various faults/deformations from 'Degloor', 'Sagroli', 'Bhaisa', 'Aurangabad' the same is shown in the Fig.1 and the morphometric analysis of Nanded, Kinwat regions show moderately seismically active basins. The extent of microseismic/seismic events with physical evidence of deformations is referred as 'Tectonic Deformation Zone' (Fig.1).

The buildings constructed in microseismically active Nanded City and Pangra-Shinde village are constructed without keeping the seismic hazard in mind. Many of the houses, nearer to 'Epicentre', are of 'load bearing type 'and thus are not safe. Keeping in view the probabilistic future danger in the wake of 'micro-seismic activities' it is advisable to change the design and selection of building materials for construction of houses. The present findings are also of great significance to the scientific community as the India's first LIGO (Laser Interferometer Gravitational-Wave Observatory) laboratory will be set up in Aundha in Hingoli district. The site of LIGO project is hardly 30 km from the present study area.

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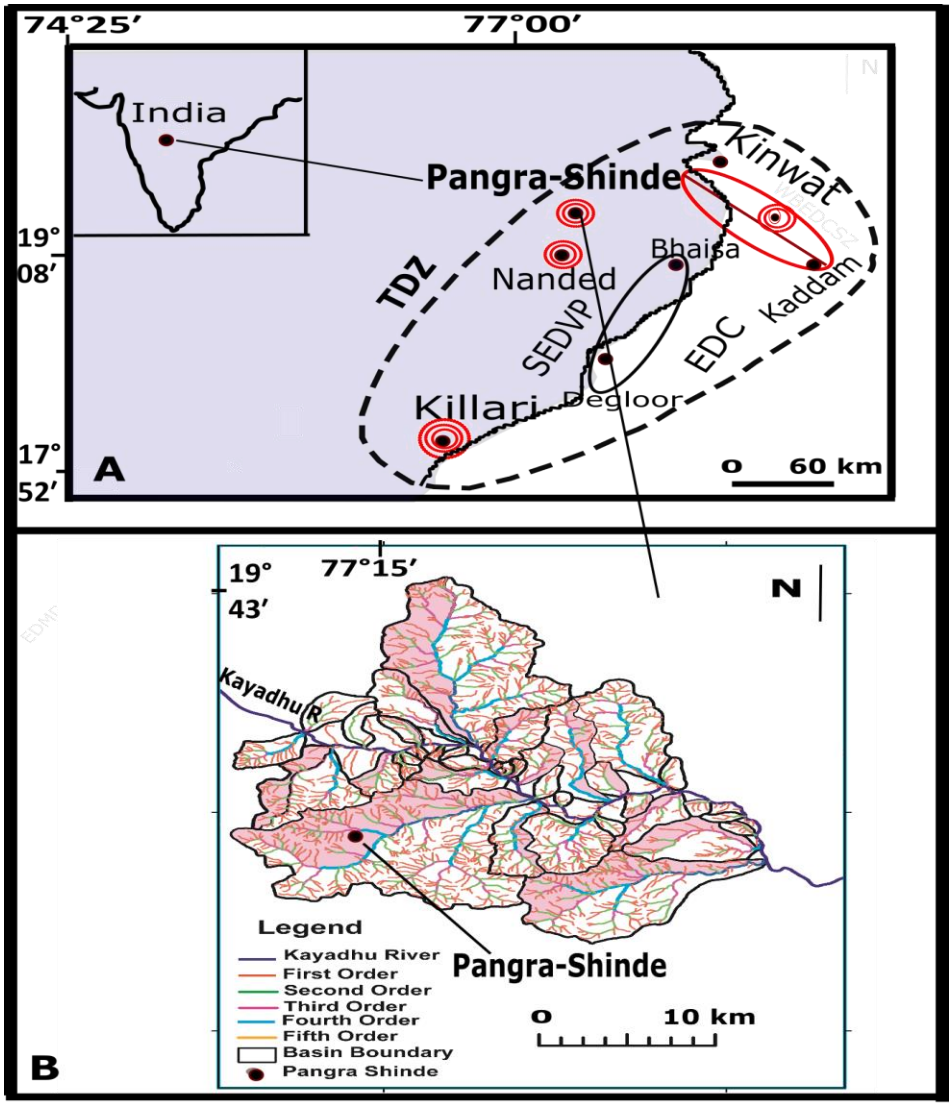

Fig.1A. Figure showing the extent of seismic/Microseismically active area. Dashed line indicates 'TDZ' ('Tectonic Deformation Zone') in South East Deccan Volcanic Province (SEDVP). EDC – East Dharwar Craton, Red ellipse indicates the 'Western Boundary East Dharwar Craton Shear Zone' (Kaplay et al, 2017b). Solid Black ellipse indicates 'Western Boundary East Dharwar Craton Deformation Zone' (Md.Babar et al, 2018). The areas of Seismicity/Microseismicity are shown with the multiple red circles. Fig.1B. Figure shows 29 sub-basins along the Kayadhu River. Of these 29 sub-basins, 19 are asymmetrical, which indicates tilting of the basins. Pangra-Shinde sub-basin also shows tilting.