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Paleostress analysis and Ground Penetrating Radar (GPR) studies along the intra-uplift Vigodi Fault in western part of Kachchh Mainland, Gujarat, western India

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Abstract

Tectonics of western India has been of great academic and industrial interest (e.g., Dasgupta and Mukherjee, 2017; Vanik et al., 2018). The structural grain and geomorphic configuration of the Kachchh basin is controlled by the E-W trending intra-basinal master faults that bound major uplifts exposing Mesozoic rocks in their respective upthrown blocks (Biswas, 1993). All uplift bounding master faults accumulated ~ N-S neotectonic seismic compression (Maurya et al., 2017). However, the role of various intra-uplift faults in absorbing stresses is not well understood, especially as they nearly parallel the master faults.

Here, we present the first results of paleostress analysis carried out along the Vigodi Fault (VF), ~ 30 km long, NW-SE striking intra-uplift fault, located to the south of Kachchh Mainland Fault (KMF) in the western Kachchh Mainland. 407 fault-slip data consisting of fault plane and slickenside attitudes along with other kinematic indicators were collected from 14 stations along the VF. The paleostress inversion of fault-slip data was carried out by applying the open source software Win-Tensor (v.5.8.8) to obtain the reduced stress tensor. Paleostress inversion algorithms e.g., the Right Dihedral method, the PBT module and the rotational optimization were executed to estimate the principal stress axes orientations.

The subsurface geophysical investigations were carried out using Ground Penetrating Radar (GPR) to understand the shallow subsurface geometry and trace the continuity of the VF below patchy alluvial cover. 15-20 m long, high-resolution 2D GPR radargrams were recorded at selected sites across the

fault line using subsurface Interface Radar-20 (SIR-20) GPR system of GSSI Inc., USA along with monostatic antenna (200 MHz frequency). Our studies show that in northwestern extremity, the VF occurs as a reverse fault for ~ 9 km and trends NW. It continues further SE occurring as a scattered surface exposure and changes its geometry to high-angle normal fault for ~ 5 km while crossing the north flowing Nara River. Further, the West Vigodi Fault (WVF) bifurcates from the VF and trends NE.

The results of paleostress analysis show that the contemporaneous stress field exhibits spatial variation in the stress state suggesting multiple reactivation phases of the fault. The changing stress regime index obtained is between 0.25 to 1 and 2.25 to 2.50. This is suggestive of pure extensive to transtensive and pure compressive stress regime (Delvaux et al., 1997) that prevailed in the intra-uplift VF zone during different tectonic deformation episodes in the Cenozoic. Moreover, the maximum horizontal stress (SH_{max}) shows shift from NNW-SSE to NE-SW direction spatially. The GPR data reveals that VF is largely a steep south dipping reverse fault with a small segment in the central part showing high-angle normal fault.

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