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An integrated approach to subsurface stress analysis by FE method for the M_w 7.6 Bhuj earthquake, India

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January 26, 2001, M_w 7.6 Bhuj earthquake a high stress drop event, highlights the anomalous subsurface stress localization in the Kachchh rift basin, comparable to those at plate margins; it may not be reasonable to relate this due to plate activity in the absence of any conspicuous seismogenic lineament connecting Kachchh rift basin with the nearest plate boundary viz. Chaman fault-Owen fracture zone-Murray ridge-Makran thrust, and regarded largely as intraplate event; however recently, Kachchh is otherwise postulated to be diffused and undergoing deformation. Further, Bhuj earthquake's nucleation in the middle-lower crust in a paleo-rift environ, offer difficulty in evaluating the major tectonic cause for anomalous stress concentration in the Kachchh rift basin. Results from different geophysical investigations are integrated in this study to draw plausible causes for the anomalous stress distribution in the realm of Kachchh geological setting. Causative factor is analyzed through 2-D finite element stress modeling constraining with the seismicity, shallow to deep crustal heterogeneity (inferred from magneto-telluric, gravity-magnetic and seismic studies in the epicentral region) and ambient tectonic forces leading to N-S compression of the Kachchh rift basin. A doughnut seismicity pattern in an area ~1250 km^2 indicates continuing seismicity in the Kachchh region. Moderate strain rate, high Poisson's ratio ~0.27 and high Pore fluid pressure ~343 MPa indicates the presence of serpentinite in the lower crust, whose dehydration caused embrittlement and release of fluids prompted potential rock failure condition in Kachchh rift basin.

Keywords: Bhuj earthquake, Stress concentration, Crustal heterogeneity, Doughnut seismicity, Strain rate, Serpentinite, Pore fluid pressure