Linkages of fracture network geometry and hydro-mechanical properties to spatio-temporal variations of seismicity in Koyna-Warna Seismic Zone

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*Valentine O Mikhailov[1], Kusumita Arora[2], Alexander Ponomarev[3], D. Gopinadh[2], Vladimir Smirnov[4], Y. Srinu[2], N. Satyavani[2], **Adrien Selles**[5], Rajender Kumar Chadha[2], Srinagesh Davulluri[2] and N Purnachandra Rao[6],*

(1)Schmidt Institute of Physics of the Earth RAS, Lomonosov Moscow state University, Moscow, Russia,
(2)CSIR: National Geophysical Research Institute, Hyderabad, India,
(3)Schmidt Institute of Physics of the Earth RAS, Moscow, Russia,
(4)Lomonosov Moscow state University, Schmidt Institute of Physics of the Earth RAS, Moscow, Russia,
(5)BRGM, D3E/NRE Unit, Indo-French Centre for Groundwater Research, CSIR-NGRI, Hyderabad, India,
(6)National Center for Earth Science Studies, Thiruvananthapuram, India

Abstract :

Well logging data and core samples from the deep boreholes in the Koyna-Warna Seismic Zone (KWSZ) provided a glimpse of the 3-D fracture network responsible for triggered earthquakes in the region. The space-time pattern of earthquakes during the last five decades show strong linkage of favourably oriented fractures system deciphered from airborne LiDAR and borehole structural logging to the seismicity. We used SAR interferometry data on surface displacements to estimate activity of the inferred faults. The failure in rocks at depths is largely governed by overlying lithostatic and pore fluid pressure in the rock matrix which are subject to change in space and time. While lithostatic pressure tends to increase with depth pore pressure is prone to fluctuations due to any change in the hydrological regime. Based on the earthquake catalogue data, the seasonal variations in seismic activity associated with annual fluctuations in the reservoir water level were analyzed over the time span of the entire history of seismological observations in this region. The regularities in the time changes in the structure of seasonal variations are revealed. An increase in pore fluid pressure can result in rock fracture and oscillating pore fluid pressures due to a reservoir loading and unloading cycles can cause iterative and cumulative damage, ultimately resulting in brittle failure under relatively low effective mean stress conditions. These regularities were verified by laboratory physical modeling. Based on our observations of main trends of spatio-temporal variations in seismicity as well as the spatial distribution of fracture network a conceptual model is presented to explain the triggered earthquakes in the KWSZ.

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