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Horizontal Stress Magnitudes Using Poroelastic Model in Upper Assam Basin, India

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Abstract : Upper Assam sedimentary basin is one of the oldest commercially producing basins of India. Being in a tectonically active zone, estimation of tectonic strain and stress magnitudes has vast application in hydrocarbon exploration and exploitation. This East North East –West South West trending shelf-slope basin encompasses the Bramhaputra valley extending from Mikir Hills in the southwest to the Naga foothills in the northeast. Assam Shelf lying between the Main Boundary Thrust (MBT) and Naga Thrust area is comparatively free from thrust tectonics and depicts normal faulting mechanism. The study area is bounded by the MBT and Main Central Thrust in the northwest. The Belt of Schuppen in the southeast, is bordered by Naga and Disang thrust marking the lower limit of the study area. The entire Assam basin shows low-level seismicity compared to other regions of northeast India. Pore pressure (PP), vertical stress magnitude (SV) and horizontal stress magnitudes have been estimated from two wells - N1 and T1 located in Upper Assam. N1 is located in the Assam gap below the Bramhaputra river while T1, lies in the Belt of Schuppen. N1 penetrates geological formations from top Alluvial through Dhekiajuli, Girujan, Tipam, Barail, Kopili, Sylhet and Langpur to the granitic basement while T1 in trusted zone crosses through Girujan Suprathrust, Tipam Suprathrust, Barail Suprathrust to reach Naga Thrust. Normal compaction trend is drawn through shale points through both wells for estimation of PP using the conventional Eaton sonic equation with an exponent of 1.0 which is validated with Modular Dynamic Tester and mud weight. Observed pore pressure gradient ranges from 10.3 MPa/km to 11.1 MPa/km. The SV has a gradient from 22.20 to 23.80 MPa/km. Minimum and maximum horizontal principal stress (Sh and SH) magnitudes under isotropic conditions are determined using poroelastic model. This approach determines biaxial tectonic strain utilizing static Young's Modulus, Poisson's Ratio, SV, PP, leak off test (LOT) and SH derived from breakouts using prior information on unconfined compressive strength. Breakout derived SH information is used for obtaining tectonic strain due to lack of measured SH data from minifrac or hydrofracturing. Tectonic strain varies from 0.00055 to 0.00096 along x direction and from -0.0010 to 0.00042 along y direction. After obtaining tectonic strains at each well, the principal horizontal stress magnitudes are calculated from linear poroelastic model. The magnitude of Sh and SH gradient in normal faulting region are 12.5 and 16.0 MPa/km while in thrust faulted region the gradients are 17.4 and 20.2 MPa/km respectively. Model predicted Sh and SH matches well with the LOT data and breakout derived SH data in both wells. It is observed from this study that the stresses SV>SH>Sh prevailing in the shelf region while near the Naga foothills the regime changes to SH≈SV>Sh area corresponds to normal faulting regime. Hence this model is a reliable tool for predicting stress magnitudes from well logs under active tectonic regime in Upper Assam Basin.

Keywords : Eaton, strain, stress, poroelastic model
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