geoconvention
Calgary • Canada • May 12-14 2025

Integrated approach for diagnosing subsurface stress anomalies and their impacts on unconventional resource development

R.J. McGrory[1], J. Seier[1] J.F. Gagnon[1], G. Lee[1], L.M. Akins[1], G. Sharma[1], Z. Esmaeilazadeh[2], Joel Loeffler[3]

1., Veren Inc; 2., ESG Solution Ltd; 3., Ikon Science

Summary

Subsurface stress manifests in many ways and at different scales impacting how unconventional resources are exploited. Diagnosing anomalous stress behavior impacts drill casing design, horizontal drilling orientation and mitigation strategies for fluid induced seismicity - whether from hydraulic fracturing or waste-water injection. Each scale at which stress can be observed and or inferred only gives incomplete information that, on their own, limits our ability to a-priori predict possible hazards associated with different exploitation operations. In this work we elucidate an integrated approach that combine's: geological, geophysical, and geomechanical / engineering datasets representing different scales of stress manifestations using a case study from an over-pressured shale play in the Western Canadian Sedimentary basin. Datasets comprising measurements / inferences from: initial shut-in pressure (ISIP), fluid & proppant injection rates, pore pressure from gauges, DFIT's, elastic velocities from well logs and 3D surface seismic data, and finally, solutions to seismic moment tensor inversion (SMTI) from induced seismic events. When these different scales of measurements of stress are combined into maps & time series, great insights into local stress complexities are achieved and we assert that, if only qualitatively, that it is possible to begin prescribing changes to our operations ahead of the drill bit and mitigate costly delays and problems associated with the development of unconventional resources in the present geological context.