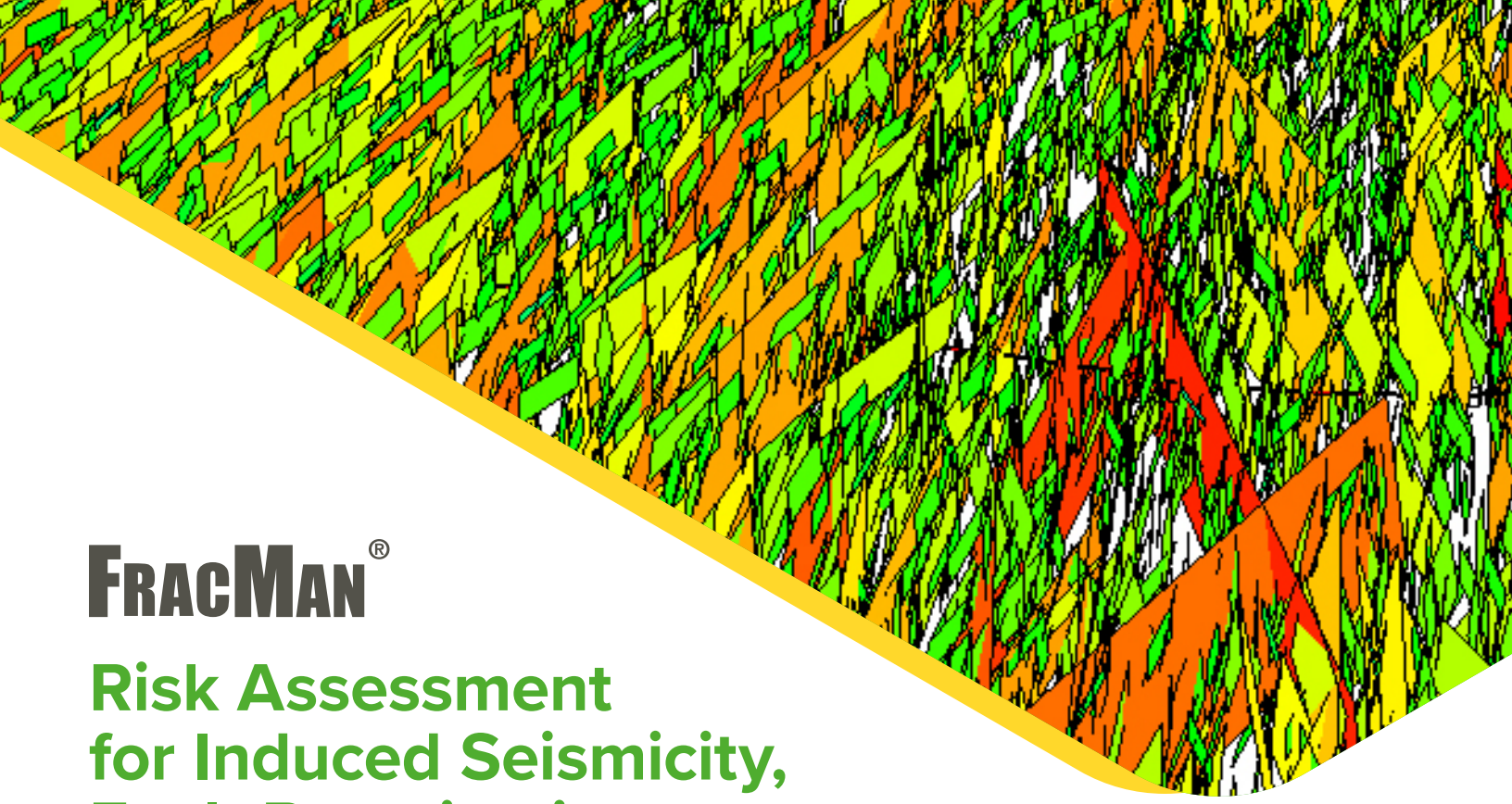


FracMan®

Risk Assessment for Induced Seismicity, Fault Reactivation, and Structural Stability

Induced Seismicity and Fault Reactivation

Induced seismicity has become an important topic of political and scientific discussion, owing to the concern that these events may be responsible for widespread damage and an overall increase in seismicity. Induced seismicity is simply a release of stored elastic strain energy when a fault slips. A fault will remain locked as long as the applied shear stress is less than the strength of the contact. The stress condition on such structures evolves as the subsurface is developed.

Assessment of seismic potential can help support design and interaction with subsurface features. Prediction of microseismic and seismic activity and risk is a tractable problem that can be assessed by Golder.

Our Experience of Induced Seismicity

Golder has worked on many projects in which induced seismicity is identified as a possible but real impact or risk to subsurface development. Golder has been providing induced seismicity expertise for a wide range of subsurface-related activities including:

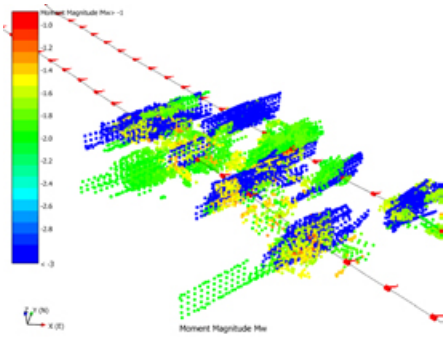
- Hydraulic Fracturing
- Waste Disposal Wells
- Hydrocarbon Extraction and Storage
- Geothermal Energy
- Mining
- Civil Engineering and Infrastructure
- Nuclear Geological Disposal Facility
- Carbon Capture and Storage

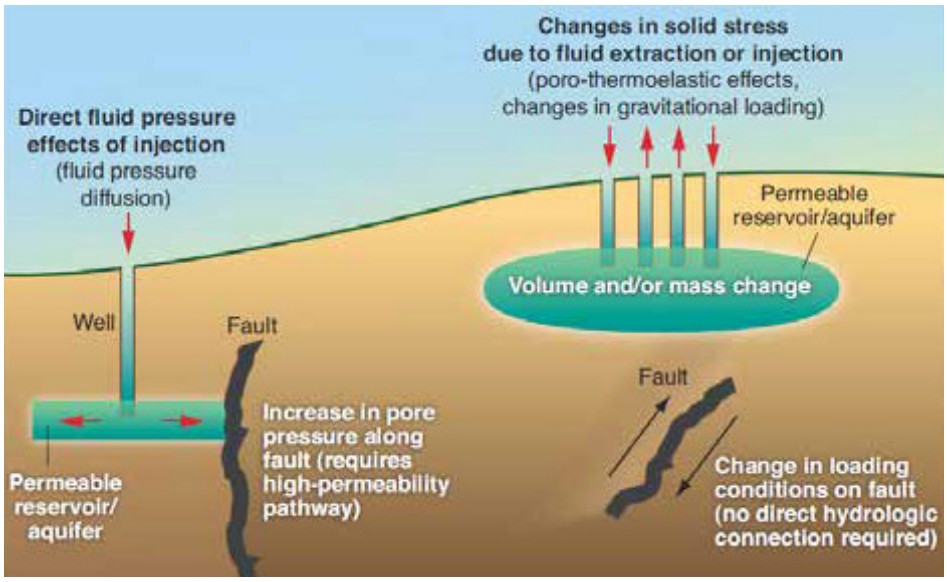
FracMan® Discrete Fracture Network Technology

Central to our induced seismicity experience is the FracMan Discrete Fracture Network (DFN) software tool. FracMan is the only DFN model that can fully capture the anisotropy and connectivity of natural and hydraulically fractured systems, providing a clear advantage over conventional continuum modelling approaches. FracMan is a three-dimensional, total asset tool, scalable to full field applications. Its robust visual capabilities for simulating induced seismicity concerning both reservoir injection and structural integrity analysis have set a standard in the market and have helped our clients cost effectively enhance production as well as manage the associated risk.

Golder's Focus

Our focus is to help clients realize the full potential of their assets – optimization is what it's all about. Golder has extensive experience in hydrocarbon basins, shale plays, and deep mining environments; working with and guiding clients to make better investment decisions throughout the full development life cycle.



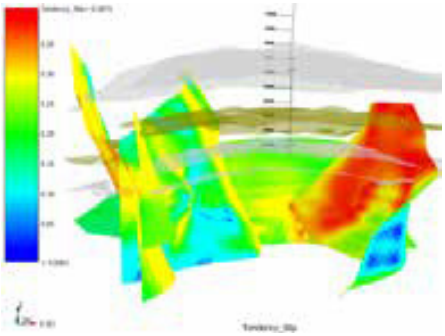


Our in-depth and practical knowledge of the industry and our expertise in development, means we understand the technical and commercial challenges you face when developing your reservoirs. Our integrated approach enables clients to discover the potential of their sites; understand the rock properties; and make faster, more informed decisions as well as improve their return on investment (ROI).

Golder can help solve your problems by:

- Making use of our innovative technologies and services
- Providing deep geoscience characterization
- Developing greater geomechanical insight
- Reducing operational risks from induced seismicity from deep well waste disposal
- Developing better performing hydraulic fracture stimulation strategies
- Providing improved decision making

Golder's multi-disciplined team will use our comprehensive subsurface knowledge to help you maximize your ultimate ROI. Our impartial advice and guidance enables you to make better investment decisions throughout the project life cycle.



Contact us at: fracman@golder.com

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