

# ARMA UToronto Student Chapter Seminar Series

NSERC/Energi Simulation Industrial Research  
Chair in Fundamental Rock Physics  
and Rock Mechanics

**Direct Shear Measurements of Bedding Plane  
Strength and Stiffness, Montney and Doig  
Formations, Farrell Creek Gas Field, Northeast  
British Columbia and Its Application to  
Understanding and Mitigating Casing Deformations**


**Pat McLellan, M.Sc., P.Eng.**

President  
McLellan Energy Advisors Inc.



 **Wednesday, March 25th, 2026**

 **11:00 AM - 12:00 PM EDT**

 Online Zoom Meeting  
RSVP by QR Code or link



<https://utoronto.zoom.us/join/register/8tK8ZnKuSV2uZ9aKsq-NpA#/registration>



**energi**  
SIMULATION

**ARMA**  
STUDENT CHAPTER  
**UTORONTO**



Civil & Mineral Engineering  
UNIVERSITY OF TORONTO

## The SPEAKER

Pat McLellan, M.Sc., P.Eng. is a consultant, advisor, and short course instructor who specializes in the application of geomechanics to the energy, mining and environmental sectors. He has a 40+ year history of practical project and research experience gained with multi-national energy firms (Shell, Petro-Canada, Talisman Energy), service companies, and consulting firms he founded. He was previously a director of the Petroleum Technology Alliance of Canada and the Petroleum Society of CIM (now SPE). He has received best paper and service awards from the SPE and was an SPE Distinguished Lecturer. Pat graduated from Queen's University with a B.Sc.(Eng.) in Geological Engineering in 1979 and from the University of Alberta in 1983 with an M.Sc. in Geotechnical Engineering. Pat is the lead author of the In Situ Stress Chapter of the CEGA Geological Atlas of Western Canada, which will be released in the spring of 2027. He is currently consulting part-time for selected organizations, trying to ease into retirement, at least until the phone rings again.

## The TALK

A program of 12 direct shear tests was undertaken in 2012 on parted and intact, dry, bedding planes in vertical core sections of the Montney and Doig Formations from a depth between 2239 and 2482 mKB TVD obtained from the well Talisman Altares 16-17-83-25W6M. This well is located in what was Talisman Energy's Farrell Creek gas field in northeast British Columbia, approximately 75 km west of Ft. St John. The field is now operated by Canadian Natural Resources.

Talisman developed this gas and gas liquids play in the Montney Formation using multiply fractured horizontal wells. The Montney Formation reservoir and overlying Doig Formation consist mainly of fine grained argillaceous siltstones and sandstones with varying amounts of carbonate, quartz and illite clay. Bedding plane-parallel fissility is occasionally well developed in the Montney siltstone, although most of the core tested in this program were obtained from intact core segments not possessing slickensides. TerraTek (now part of Schlumberger) conducted a program of high normal load direct shear tests on cubic samples encased in hydrostone cement. Different bedding plane surfaces were tested – as is and parted; intact with visible parting; and bedding planes that were artificially parted along a notch.

Normal stress levels ranged from 2 to 25 MPa. Peak and residual strength parameters, and shear and normal stiffnesses were measured over a range of relevant in-situ stress levels during loading and unloading conditions. Linear Mohr-Coulomb envelopes give an average peak friction angle of 42° and a peak cohesion of 1.5 MPa. Residual friction angles averaged 28° with an apparent residual cohesion of 1.5 MPa. Linear and non-linear failure criteria were fit to the data, with the non-linear Barton-Bandis criteria giving a slightly better fit. The data collected in this laboratory program were part of a larger geomechanical investigation of well completion and stimulation practices in tight unconventional reservoirs in Western Canada.

This presentation will also briefly highlight the problems Talisman faced with bedding parallel casing deformations induced during hydraulic fracturing operations. Root cause investigations were undertaken with geomechanical lab testing, comprehensive petrophysical logging, multi-finger caliper logging, in-situ stress testing, and wellbore scale and pad scale geomechanical FEM modelling. Important learnings and mitigation measures will be described. Casing deformation problems continue to plague some operators in the Montney Formation of this part of BC.