# British Columbia OGRIS Local-Seismic-2025-04 – Final Report

## 30-Nov-2025

PRESSURE DIAGNOSTICS

**Executive Summary**

Pressure Diagnostics Ltd. was engaged to test the hypothesis, "*Does pressure depletion due to hydrocarbon production reduce Induced Seismicity (IS) in the Montney of NE BC?*".

Data requirements and specific analysis workflows were identified. Data for 3 pads in NE BC in proximity, known to have significant IS activity were volunteered by an Operator. The 3 pads of wells were drilled, completed, and put on production in 3 separate occasions spanning May-2022 to Jul-2024.

A preliminary review of the data resulted in the conclusion that there was no evidence for depletion, so the testing of the hypothesis was not achieved with this data set.

However, the preliminary review process was deemed to be an efficient method to test the hypothesis on future data sets if they are made available.

**Project Novelty & Rationale**

Induced Seismicity (IS) due to hydraulic fracturing in certain settings, such as portions of the NE BC Montney, presents a risk to oilfield operations and public surface infrastructure such as buildings, hydroelectric dams and other structures.

IS is more likely when certain geologic, geomechanical and hydraulic fracturing parameters align. It is hypothesized that IS may be reduced in these areas after production lowers reservoir (pore) pressure (depletion) which correspondingly reduces net stress according to the Mohr failure criteria (https://www.sciencedirect.com/science/article/abs/pii/B9780080430102500071).

Therefore, regions that are identified to have a higher risk of IS during initial development activities (primary, parent well completions) may exhibit less IS upon secondary (child) well developments. Gathering data to support, and possibly quantify, the risk mitigation with depletion was proposed.

Prior work to define geologic and geomechanical factors that contribute to the likelihood of IS includes: ***Pressure, Stress and Fault Slip Risk Mapping, Enlighten Geoscience* –** (https://www.bcogris.ca/projects/pressure-stress-and-fault-slip-risk-mapping-in-the-ksmma/)

No prior work has been conducted in BC to correlate or quantify the impact of pressure depletion on IS.

**Project Timeline**

| | |
|---|---|
| 14-Jan-2025 | Contract signed |
| 30-Apr-2025 | Original Report Date |
| Jun/Jul 2025 | Data received |
| 23-Oct-2025 | BC OGRIS Induced Seismicity Research Update Industry Meeting Presentation |
| 30-Nov-2025 | Final Report |

**Workflows Proposed**

Application of advanced analytical workflows using techniques documented in SPE 196194 and 204183 were contemplated for this project as outlined in **Table 1**.

| **Analysis Type** | **Purpose** | **Data Required** |
|---|---|---|
| Diagnostic-Fracture-Injection Test (**DFIT**), DFIT-Flow-Back | Base-line parameters for Initial Reservoir/Geomechanics properties (Fracture Extension Pressure, Min. Stress, Fracture Geometry, Pore Pressure); ID changes from parent to child wells | DFIT pressures / volumes |
| Frac Stage-Fall-Off (**SFO**) PTA | Full-scale frac stage Fracture Extension Pressure, variability along laterals / crossing lithological changes or faults; parent/child changes | >15min fall-off time after frac stg |
| Fracture-Driven-Interaction (**FDI**) Stat's & Modeling | Fracture propagation measurements between wells and layers, identify conforming and abnormal frac growth, quantify fracture dimensions (hf, xf); asymmetric growth to child wells | Synchronized Treating and offset well pressure data / van data |
| Contacted-Hydrocarbon-In-Place (**CHIP**) | Quantify stress reduction (Eaton equation), quantify depletion volume and depletion height (bounded flow) | >6month prod history |

**Table 1: Advanced Analysis Workflows**

The application of these workflows requires higher data fidelity than is often available from routine completion records or public data sources. A preliminary review of the data provided was proposed to determine what level of analysis may be possible.

**Project Data**

<u>Data Requirements</u>

The data to correlate IS activity changes with pore pressure reduction must include an intersection of data that meets all the following criteria and considerations outlined in **Figure 1**:

1. Lists of wells with coincident completion dates to IS activity in the same area (the Study Region).

2. Lists of wells in the Study Region that have been completed at significantly different dates to observe differences in initial pressure between original (primary/parent wells) and newer (secondary/infill/child wells).
3. IS data fidelity that includes incident counts and magnitudes with date-time markers in the Study Region.
4. Accounting for changes to the completion program and execution.

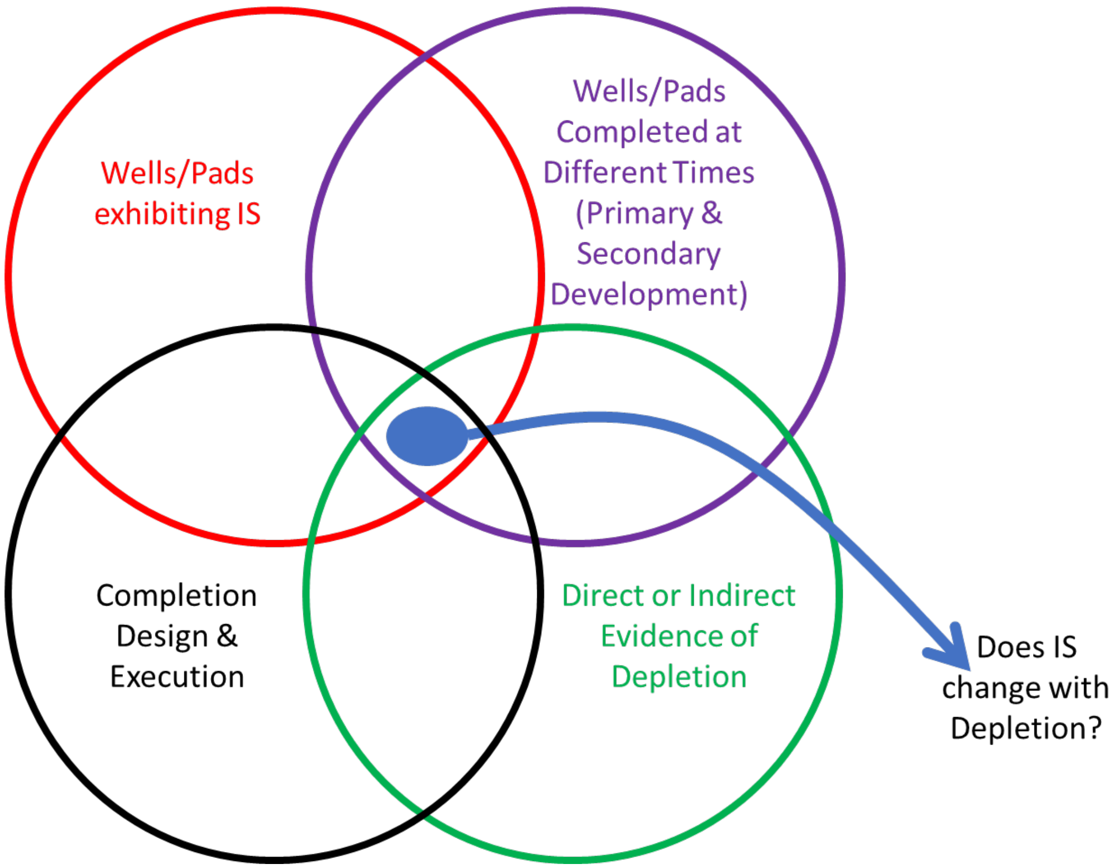


**Figure 1: Intersection of Data to Evaluate IS Reduction with Production Depletion**

<u>How do we observe evidence of depletion?</u>

**"Direct"** evidence of depletion may be measured from pore pressure comparisons between parent and child wells using Diagnostic Fracture Injection Test (DFIT) analysis.

DFIT data required is the .PAS files and operator reports that have been submitted to the BCER and any other volunteered data sets available. The basic requirements for DFIT analysis are:

1. Injection pump rates, volumes, fluid density,
2. Pressure gauge pressure data file(s),
3. Gauge location (surface or TVD),
4. Injection point TVD.

**"Indirect"** evidence of depletion may also be inferred from two sources:

1. Comparison of hydraulic fracturing pressures (Break-down, pumping pressure, ISIP, FFEP) between parent and child wells,
2. Normalized production performance comparisons between parent and child wells.

Hydraulic fracturing pressure data summary files are preferred.

Production data should include all gas, water, oil/condensate history. Ideally flowing pressure data would also be available. Depending upon the volume of data to review, an analytics software solution may also be employed.

A 3-pad NE BC Montney data set was provided by an Operator in June and July of 2025. The information received was organized and previewed to validate that all necessary components were available.

Data received and sourced included:

1. Well completion summaries; NOTE: original (May-2022) pad had significant casing deformation leading to completion issues and off-plan execution,
2. Frac 'Van' data (no independent pressure gauge data),
3. Original pad DFITs,
4. Production Data (public),
5. Well Surveys,
6. Seismicity Magnitude & Location (Proprietary and BCER arrays).

**Figure 2** shows the map view of the 3-pad data set. The deeper stratigraphic Sexsmith (SXSM) wells are noted due to the expectation and observations that these wells are more prone to IS activity.

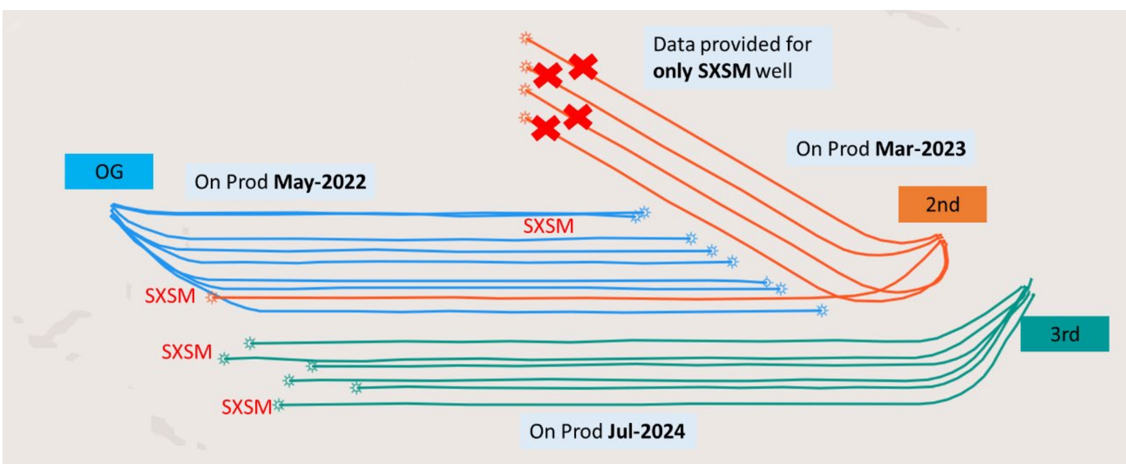


**Figure 2: 3-Pad Montney Data Set with Sexsmith (SXSM) Wells Highlighted**

### Preliminary Review Workflow

A high-level review of the data was completed prior to engaging in the advanced workflows listed in Table 1. This preliminary work was conducted to seek evidence that an intersection of the requirements shown in **Figure 1** existed in the provided data set and to check if sufficient data was available for Advanced Analysis.

**Preliminary Findings**

IS location data was plotted on the 3-pad map (**Figure 3**). This data supported the expectation that the SXSM wells are more seismically active than shallower Montney horizons, at least in this area.

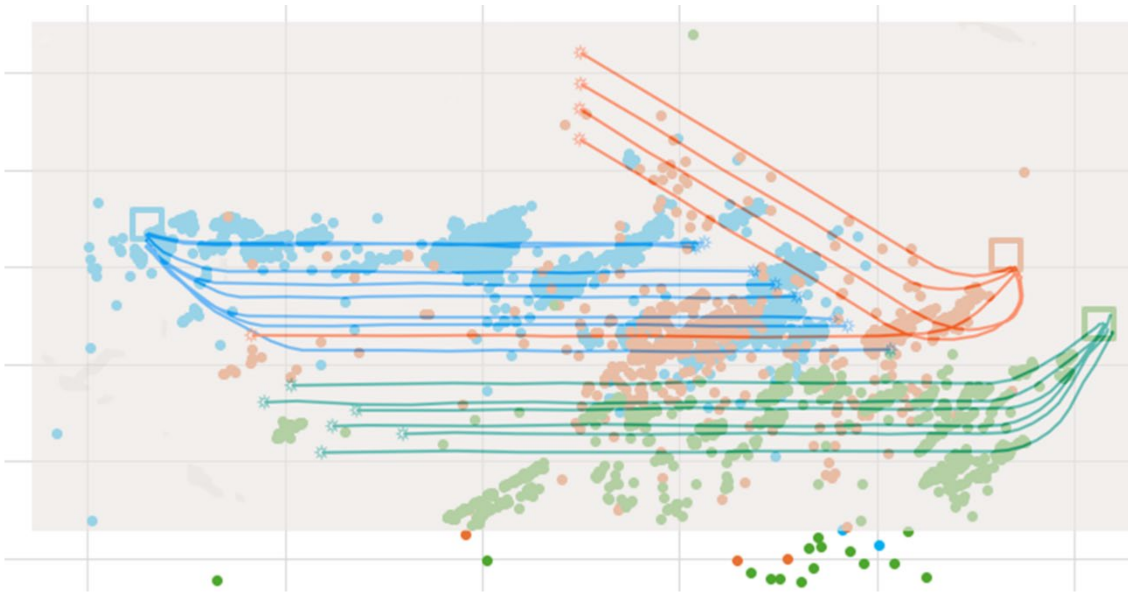

**Figure 3: IS Location Map for 3-Pads**

IS magnitude was filtered to the values >=1.5 and plotted against the date-time of occurrence to illustrate if magnitude may have changed with subsequent completion occupations. **Figure 4** shows that no apparent reduction in IS magnitude occurred. Perhaps a slight increase may have occurred with the 3rd (newest child) occupation.

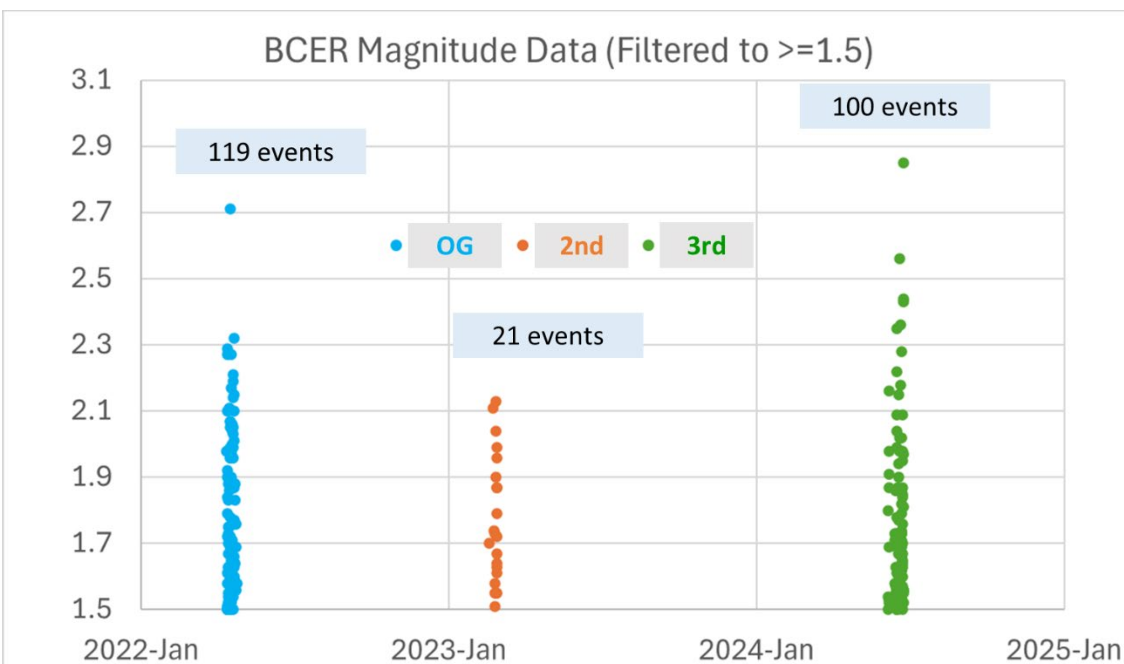


**Figure 4: IS Count and Magnitude Plotted for 3 Pads**



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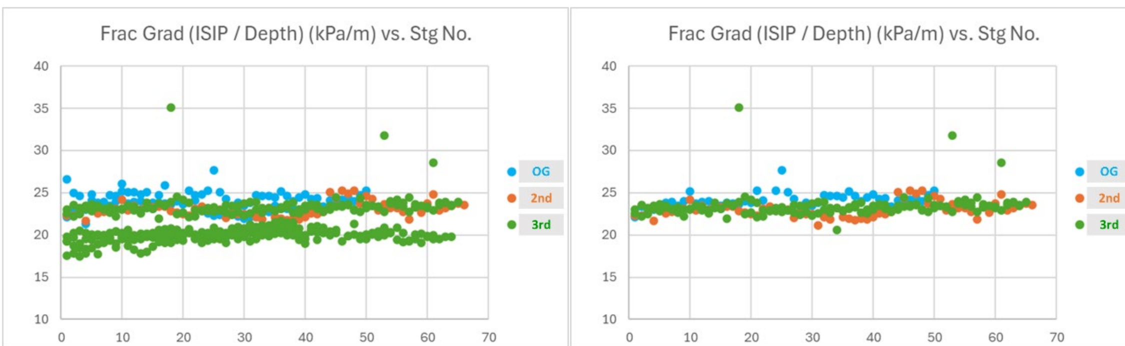
No DFIT data was collected on the 2nd or 3rd occupation (child well) pads so Direct evidence of depletion was not available in this data set.

Without DFIT data spanning the 3 pads, Indirect indicators for depletion such as hydraulic fracturing pressures and production performance were reviewed.

Frac stage pressure data was available for only a portion of the wells; partly due to substantial completion execution problems (reported casing deformation) experienced on the first (OG) occupation. Only the SXSM completion data on the 3rd occupation was supplied.

We prefer to use PTA-derived Farfield Fracture Extension Pressure to better represent hydraulic fracture pressure but this level and quality of data was not available.

**Figure 5** shows the available Operator-picked Instantaneous Shut-In Pressure (ISIP) for the 3 pads. The equal-basis comparison of the 4 SXSM wells is shown in **Figure 5 (b)**. Note that there is no apparent difference between the 3 occupations for the ISIP on the SXSM wells. No depletion is evident from this data.




**(a)** **(b)**

**Figure 5: Operator-Picked ISIP Gradient for: (a) All Wells (b) SXSM Wells**

Production data was obtained from the public record to compare performance between the 3 pads. With pressure depletion, initial production performance would be expected to be less.

**Figure 6** shows the lateral-length-normalized production rates versus time for the 3 pads. The OG wells have a very wide range of initial rates due to the reported completion issues and casing deformation. The 2nd and 3rd occupation wells have similar production profiles.

**Figure 7** shows the same production rates for the 4 SXSM wells. Most indicative are the 2 SXSM wells on the 3rd occupation having nearly identical performance despite a large difference in the proximity to prior pad (parent wells). No Indirect evidence of depletion is apparent.

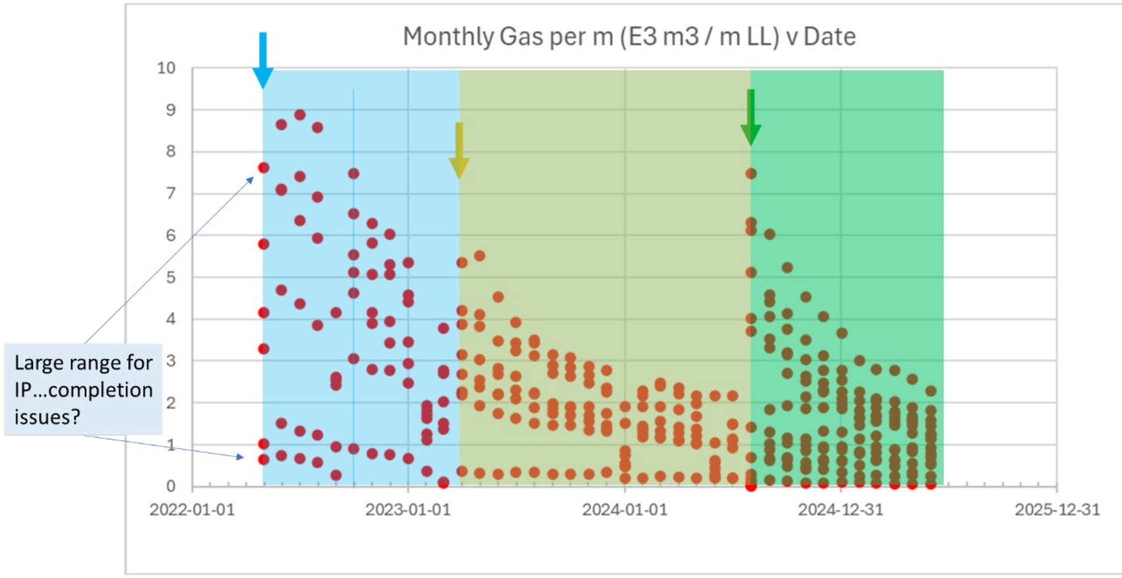



**Figure 6: Normalized (by lat-length) Production Comparison for 3 Pads**

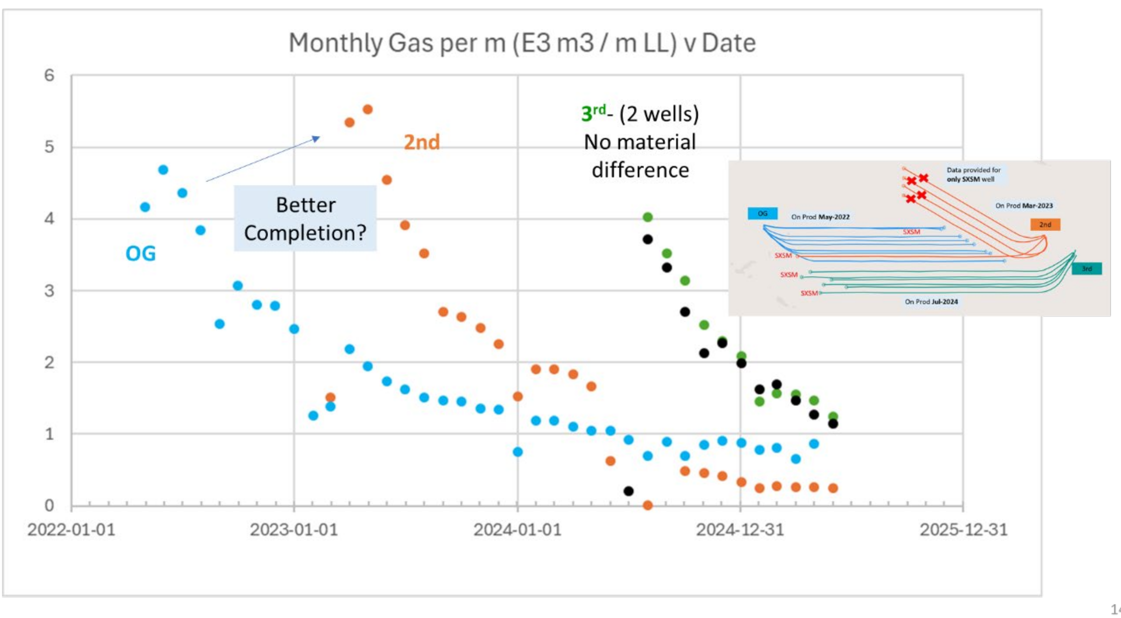



**Figure 7: Normalized (by lat-length) Production Comparison for 4 SXSM Wells**

### Conclusions

The preliminary review of the provided data resulted in the conclusion that there was no evidence of depletion. With no depletion there was no valid testing of the hypothesis that depletion may reduce IS activity. No further Advanced Analysis workflows were applied.

However, the preliminary review workflow demonstrated an efficient method to check if the data needed to assess IS vs. depletion is sufficient. We recommend this screening process for subsequent similar investigations into IS and depletion.