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Data Managers Society

Presentation will begin at 1:00pm MT

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Why Is Public Geomechanical Data So Hard to Find in AB and BC?

Amy Fox, Enlighten Geoscience Ltd.

May 13, 2020

Me in 2011, upon arriving in Calgary from the U.S. and hearing about public oil and gas data

My Houston-based bosses in 2011

Let's Define "Public"

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- Operators have to submit certain types of data to the Alberta and BC regulators, the act of which makes the data "public"
- This doesn't mean we can necessarily access the data for free, or even at all
- In some cases, databases can be obtained, or purchased, from the regulator and then have value added through corrections, registrations, organizing, mining, etc., then commercialized and made available via purchase/subscription – *is this still "public?"*
- How is the change from a knowledge-hoarding to a knowledge-sharing economy changing our expectations?

Outline for Today's Presentation

Quick Introduction to Geomechanics

Pore Pressure and Minimum Stress Data

Rock Mechanics Data

Data for Maximum Horizontal Stress

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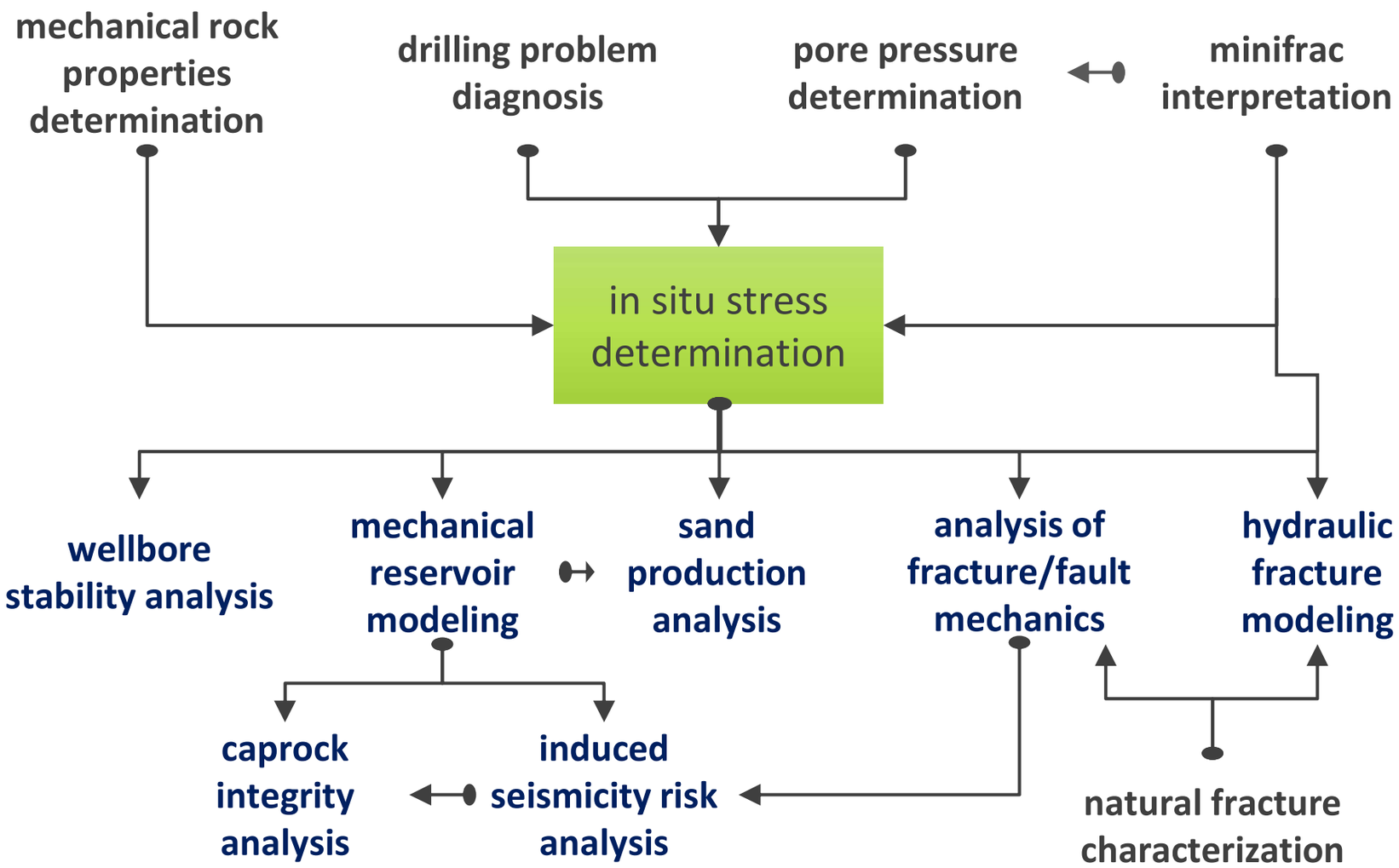
Quick Introduction to Geomechanics


mechanical rock properties determination
drilling problem diagnosis
pore pressure determination
minifrac interpretation
in situ stress determination
wellbore stability analysis
mechanical reservoir modeling
sand production analysis
analysis of fracture/fault mechanics
hydraulic fracture modeling
caprock integrity analysis
induced seismicity risk analysis
natural fracture characterization

Key Components of a Geomechanical Model

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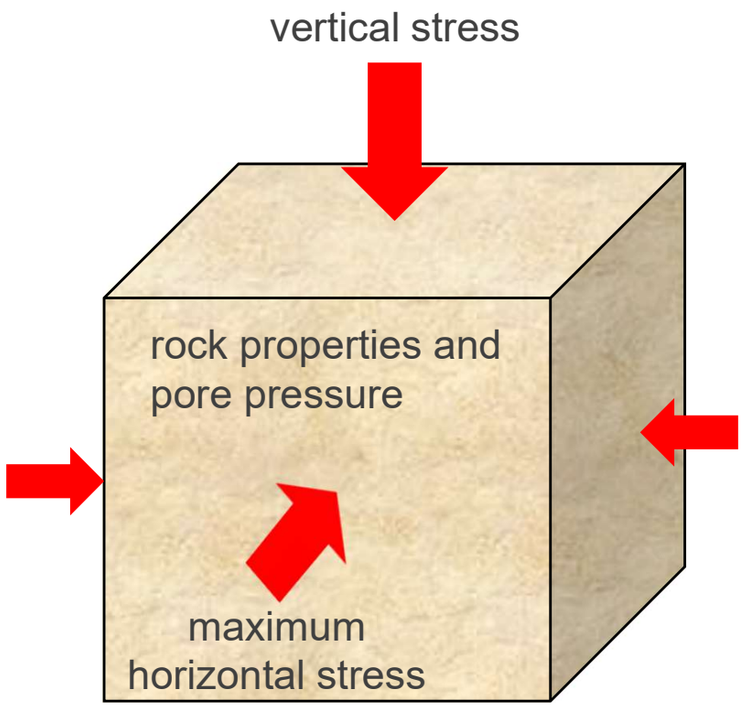
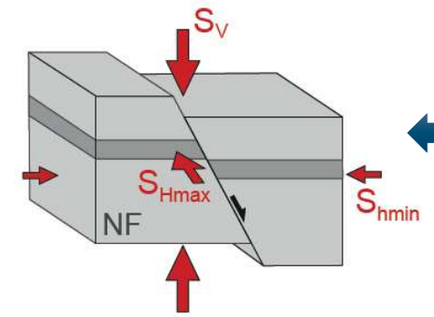
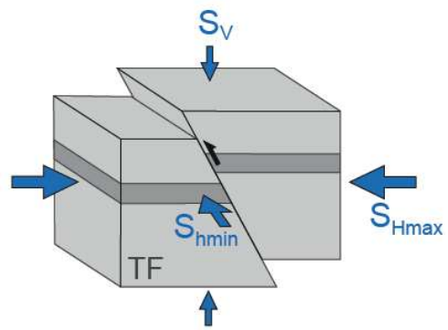


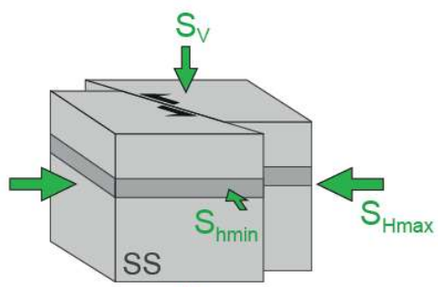


normal faulting
$S_V > S_{Hmax} > S_{hmin}$

non-tectonic, “passive” basins, can calculate stress and pressure from logs like sonic



thrust faulting
$S_{Hmax} > S_{hmin} > S_V$



strike-slip faulting
$S_{Hmax} > S_V > S_{hmin}$

tectonic basins
(*ahem* – the WCSB!)

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Pore Pressure and Minimum Stress Data

Pore Pressure Data Sources

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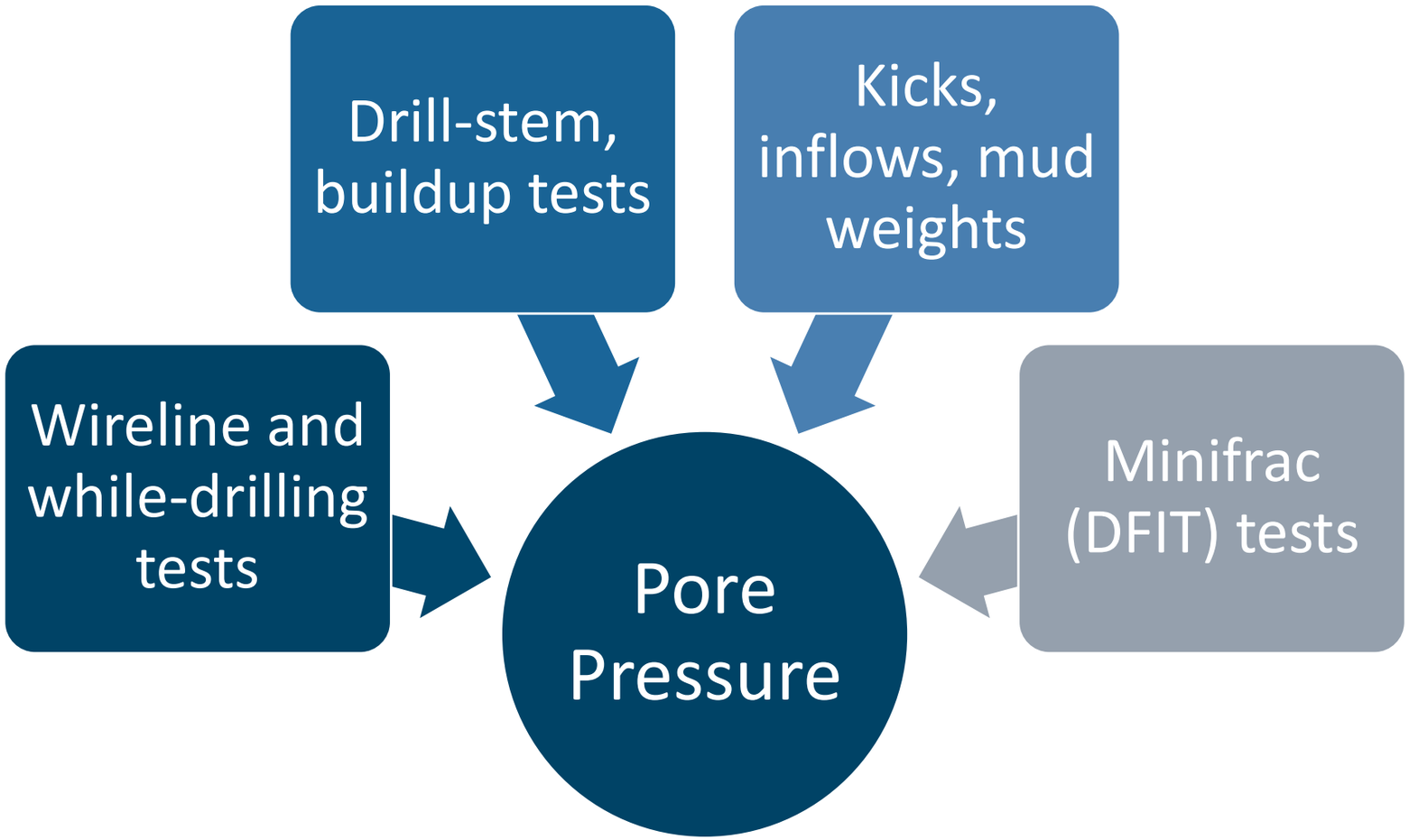

Minimum Stress Data Sources

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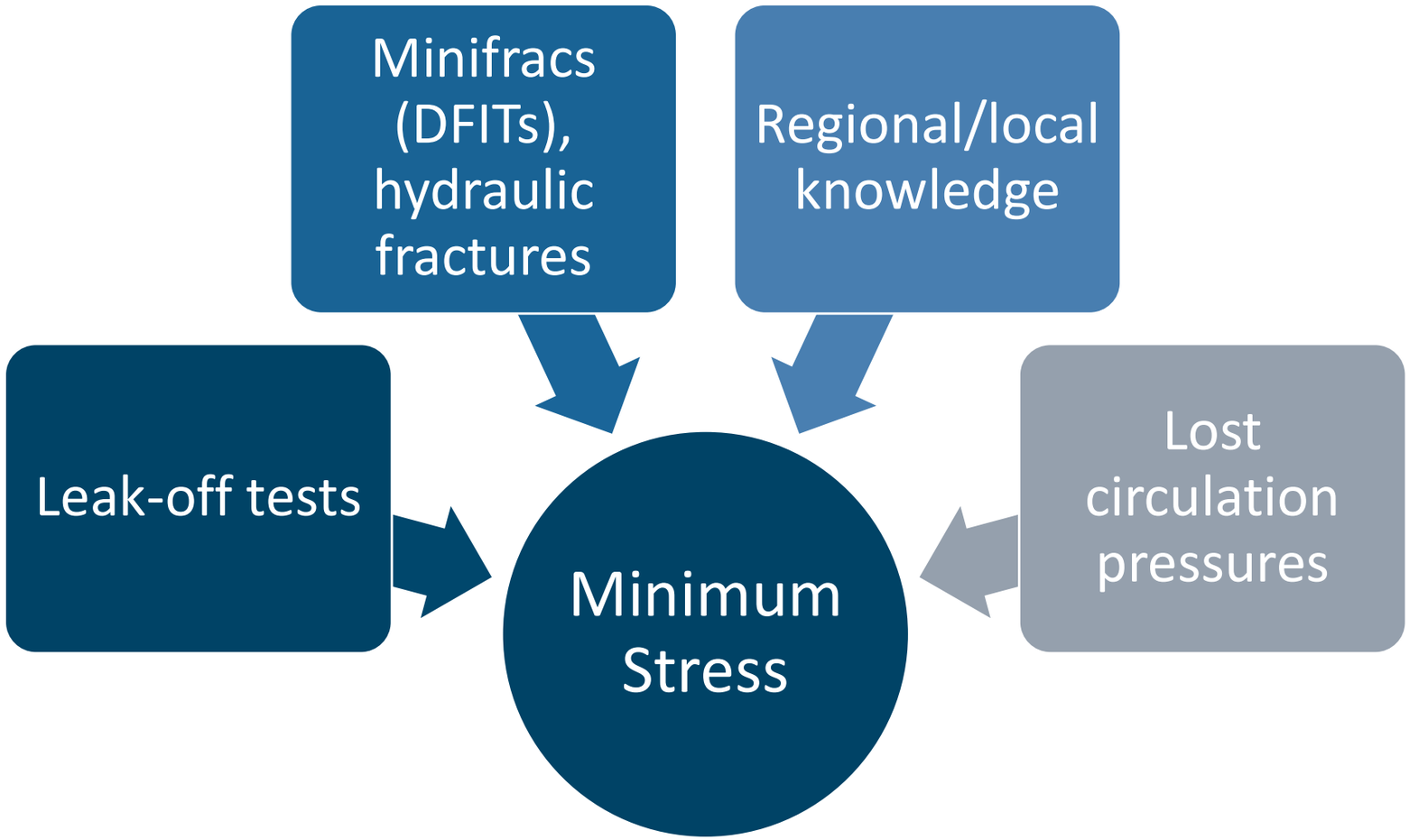

Formation Tests for Pore Pressure

- Wireline testers
  - Push a probe into/against the formation and allow formation fluid to flow in; measures pressure and sometimes sometimes captures a fluid sample
  - E.g., RFT (Repeat Formation Tester), MDT (Modular Dynamic Tester)
- Drill-stem tests
  - Run on drill pipe as a separate run (not while drilling)
  - Seals off a section of the well and allows formation pressure to build up in the sealed off section

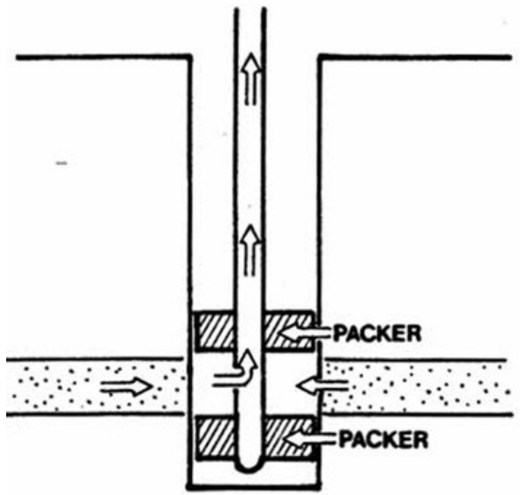

Figure 18-2 A drill stem test.

Leak-off Tests and XLOTs for Minimum Stress

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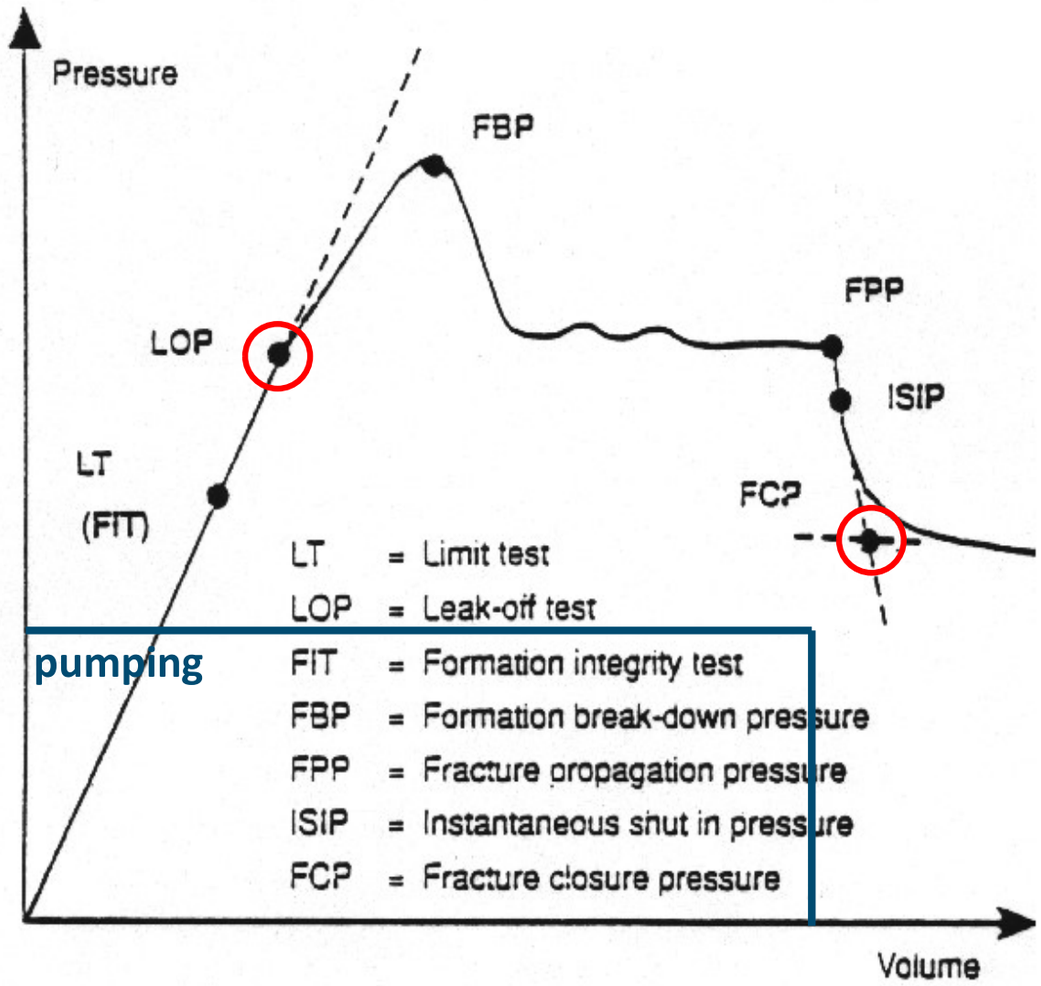

Finding Legacy Data

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- DSTs and AOFs
  - AER:
    - Oil pressure txt file is free
    - Can get total catalog of DST and AOF tests by buying recent (1999+) catalog (only $21K) and/or historical data (1962-1999 for $107.5K)
    - Can subscribe to a 3rd party software/database
  - BC: Can build a database by going through well files or subscribe to a 3rd party software/database
- Leak-off Tests
  - Usually buried in daily drilling reports – more on that in a bit

What About Current Data?

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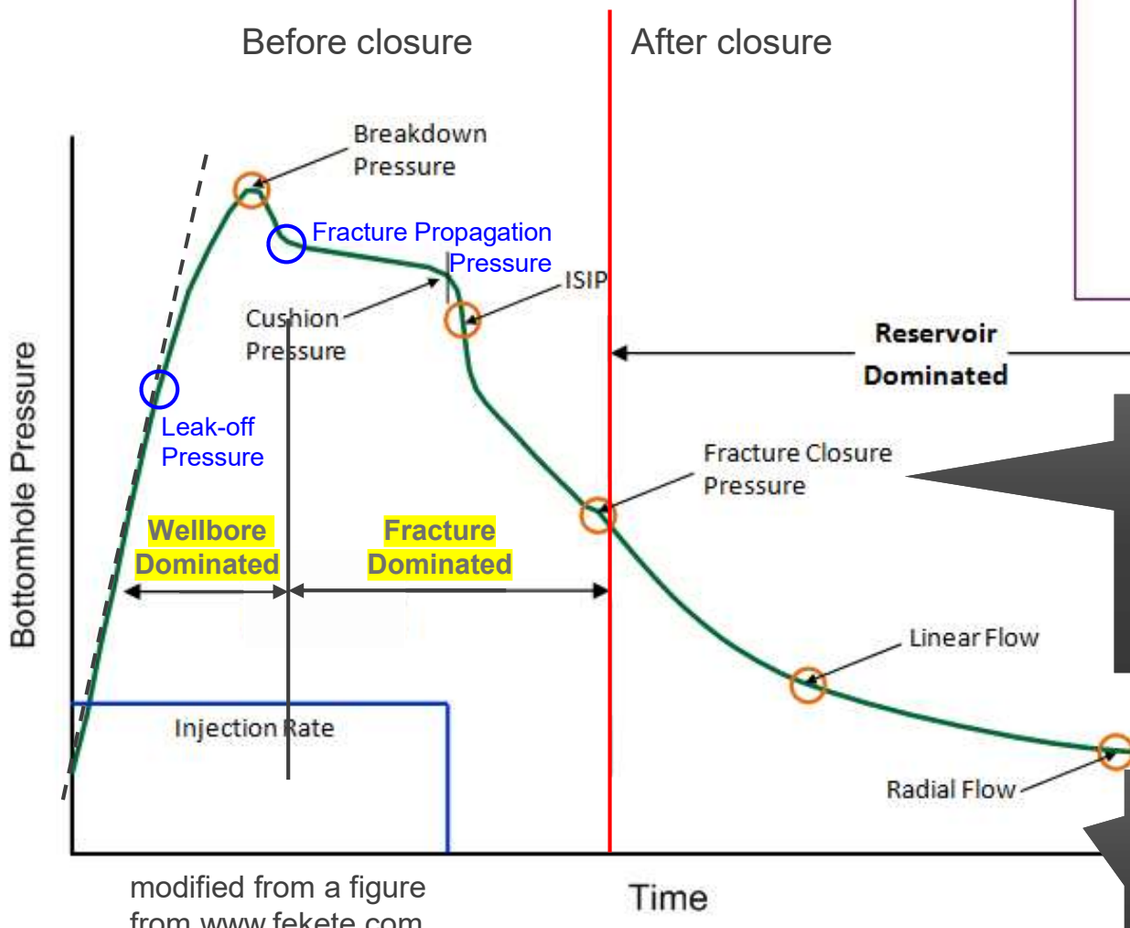
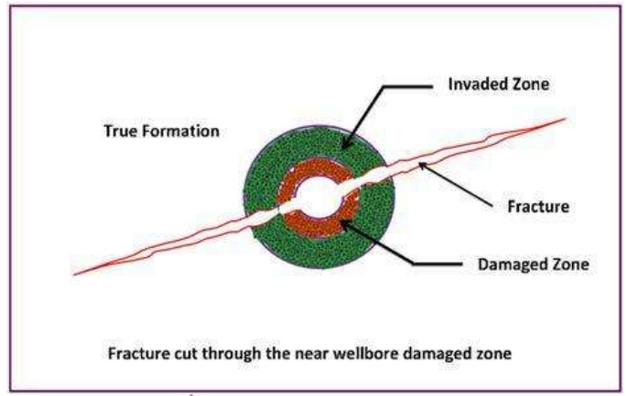
- Wells and reservoirs have changed! And with them, preferred data types…
- Reservoirs are too tight for traditional wireline and downhole pressure tests
- LOT's just aren't done anymore (*in Western Canada*)
- Everybody's talkin' 'bout DFITs!

Minifrac/DFIT Tests

- Typically done at the toe prior to stimulating a horizontal well
- Provide minimum stress and pore pressure **interpretations**



modified from a figure from www.fekete.com



With DFIT's, closure is usually identified on a variety of specialized plots rather than from the pressure-time curve

After-closure analysis requires adequate data (flowback time) and careful interpretation

Finding DFIT Data – KSMMA Example

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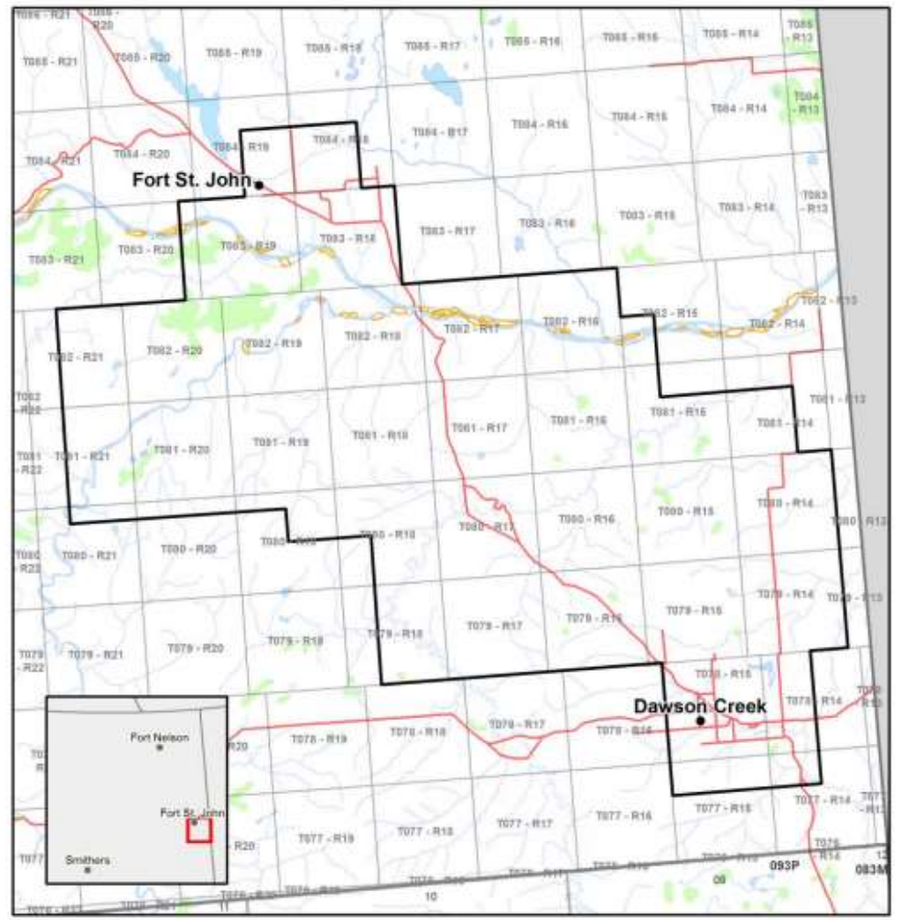
- Our client provided a list of 627 DFITs identified as having been run in the Lower Montney in KSMMA since 2009
- Had complete data sets, suitable for re-interpretation, for 40 (6.4%)
  - Some were available in the OGC records
  - Most were kindly provided by operators when we asked



Legend:

Kiskatinaw Seismic Monitoring and Mitigation Area (KSMMA)

KSMMA DFIT Study

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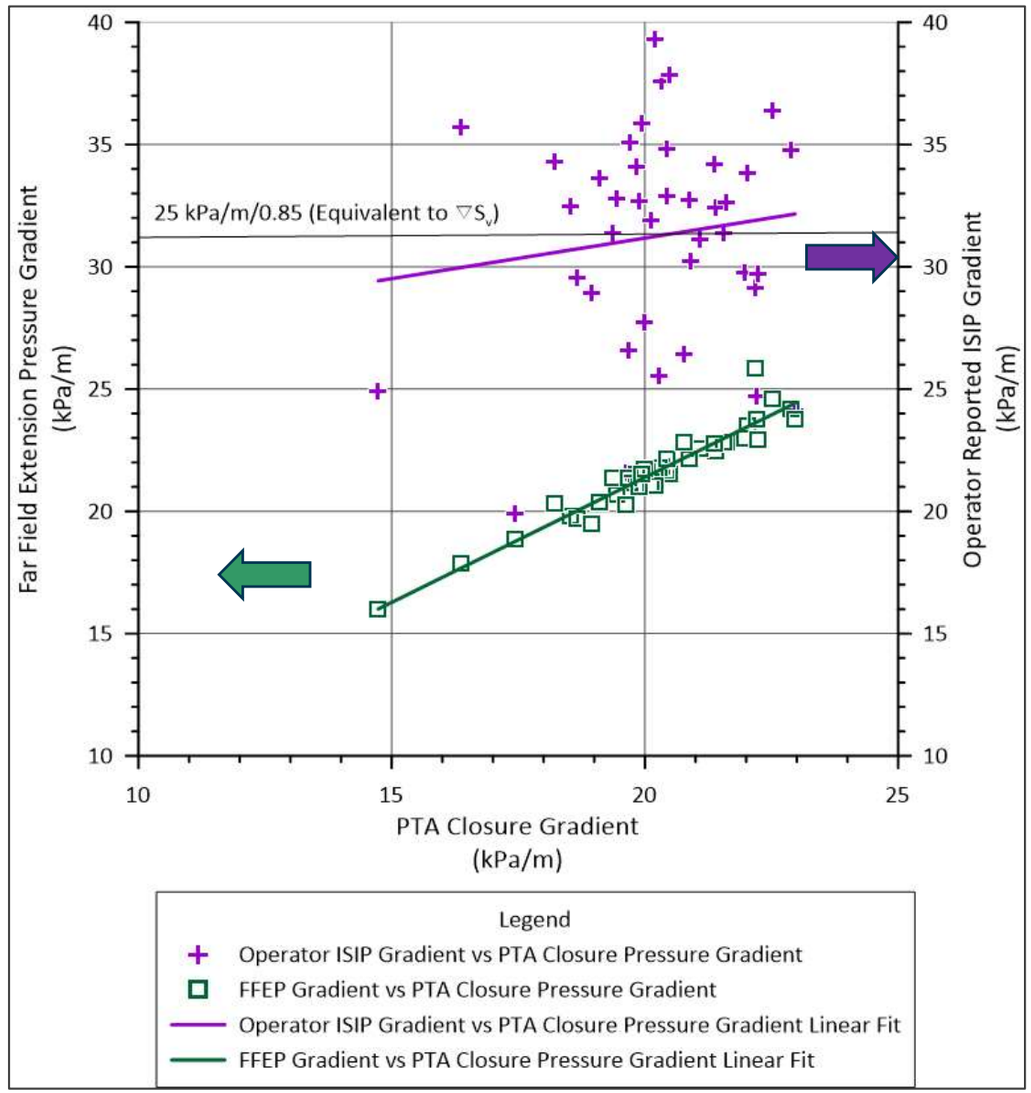
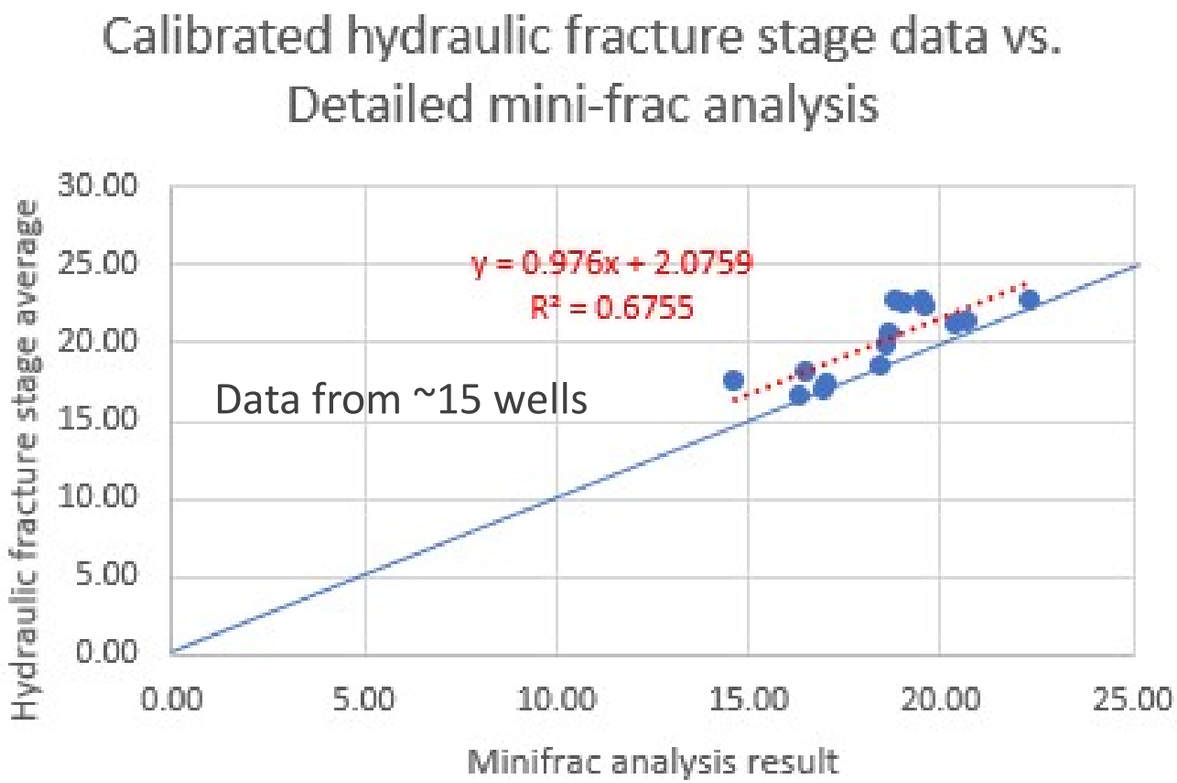
- Why did we need to reinterpret?

What about using ISIPs from actual hydraulic fracture stages?



Minimum Stress from Hydraulic Fracture Stage Data

- Some people use “calibrated” (e.g. 0.85 x) ISIPs from hydraulic fracture stage data
- Tricky, because ISIP is subjective and hydraulic fractures are big, complicated operations
- With a large enough data set, sometimes can get a good estimate from the average



Lost Circulation, Kicks, Inflows, Shows, etc.

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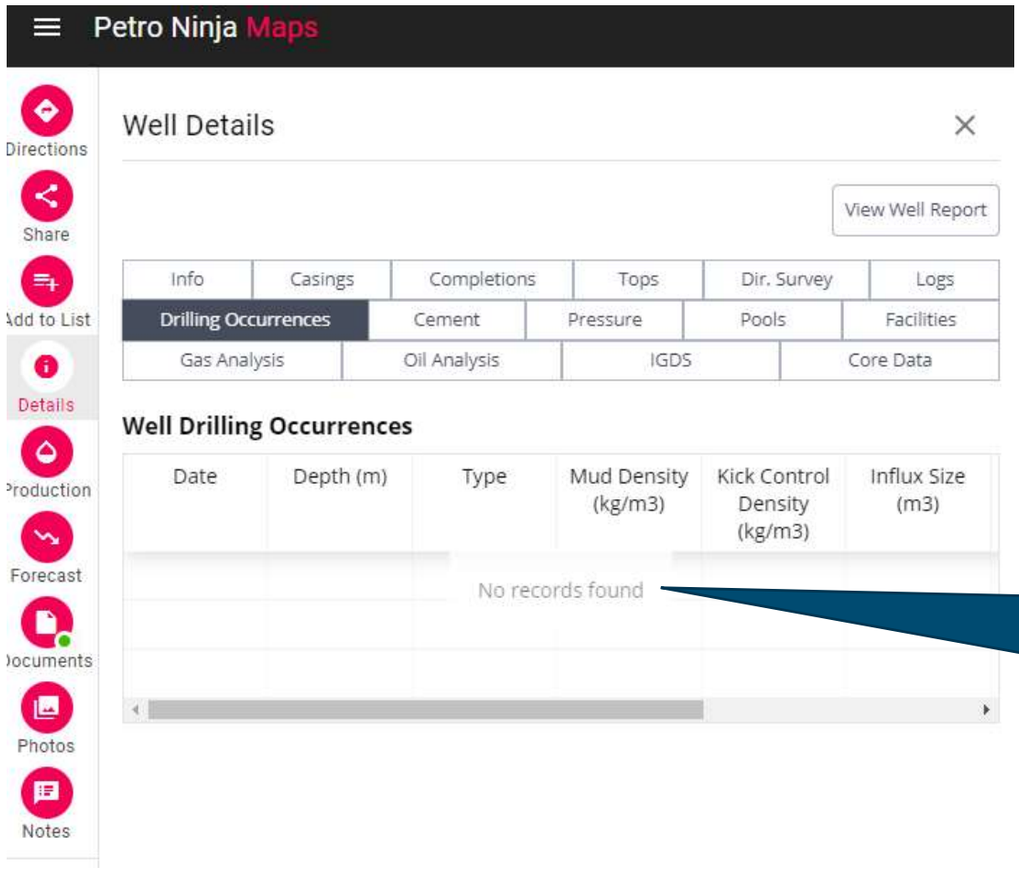
- Not reported unless severe, and sometimes not even then



I've seen this in wells that had blowouts or total lost circulation that lasted for days

Lost Circulation, Kicks, Inflows, Shows, etc.

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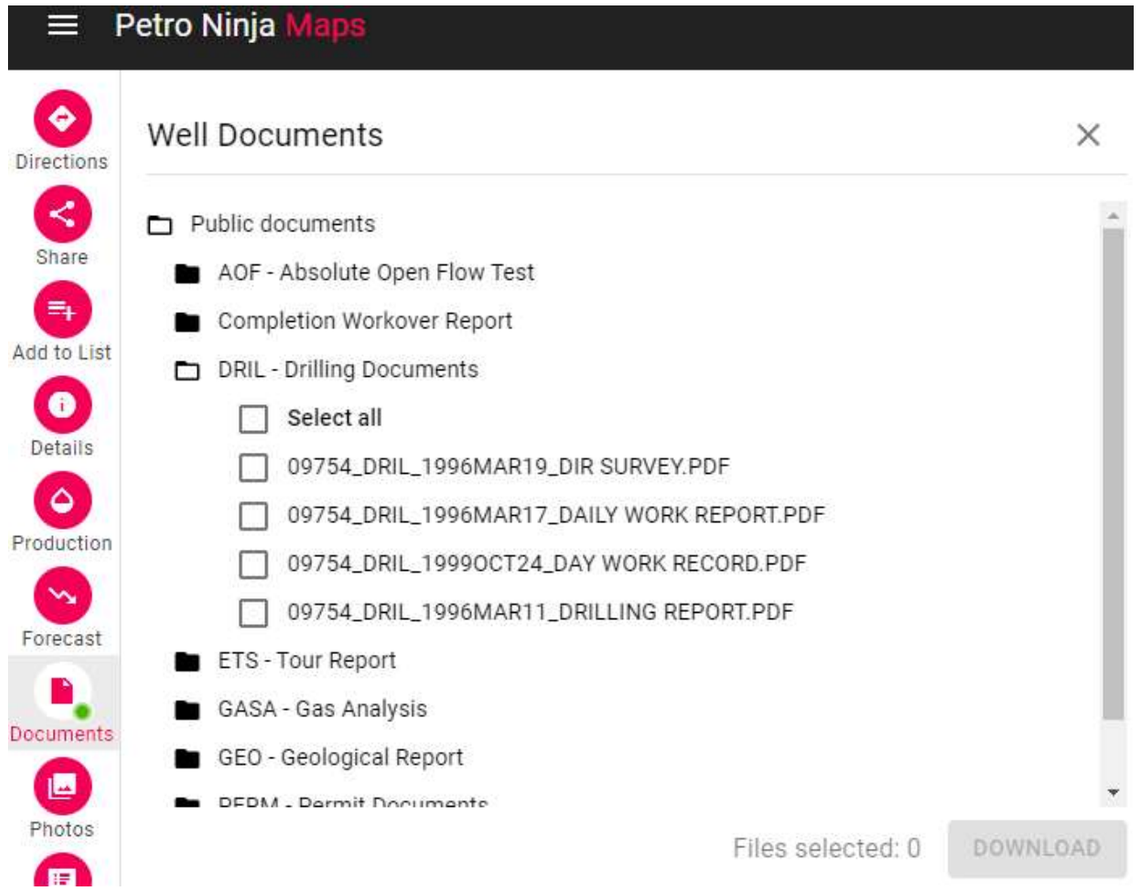
- Have to dig through details of daily drilling reports / drilling tour sheets
- How to find:
  - Look for in well documents in software of choice and/or OGC e-Library
  - In BC, 5459 wells have either drilling reports or tour sheets
  - In Alberta, order from AER for any well for $11/well



Lost Circulation, Kicks, Inflows, Shows, etc.

Once found, mine for data page by page (same goes for mud weight data)

Status of well at rig release (as reported by operator)..... Gr.

Date	Status	Depth	Remarks (D.S.T. Information, Geological Markers)	K.B.
	DRLG	882	Conductor barrel became washed out when drilling surface hole @ 136m, continued to drill ahead using one rig pump instead of 2, plan to drill to surf csg depth 280 to 285m	
			- Remote sump located approx. 15 km away on "Roddy Ross's surf. land near Cecil Lake.	
			While drlg w/ mud wt 1015 kg/m³ (water) got kick @ 882m (Suspect in base of Cadomin zone) max SIDPP 1100 kPa SICP 1100 kPa, influx 1.5m³, 90 1227 mixing mud to increase density. When circd out kick had 2m lazy gas flare.	
			800 ½°	

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Rock Mechanics Data

Which Rock Properties?

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- STRENGTH properties
  - Compressive strength, tensile strength, friction angle, cohesion
  - These must be measured in a lab

- I really don't care about Young's modulus and Poisson's ratio
- For anyone who doesn't realize it, mechanical property "logs" (or derived from seismic) are NOT measured values; they are calculations based primarily on density and sonic velocities

Alberta REPS Database and GOS-REPS Index

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- Cost: Can subscribe to monthly updates for $1240/yr, buy entire REPS for ~$2,420, or get individual reports for $11 each
- Index (free) is a spreadsheet with 125,000 rows

1	Report No.	UWI	Licence Number
124175	R_11315	00/04-34-077-23W5/0	042994
124176	R_11316	00/09-06-076-23W5/0	044723
124177	R_11317	00/02-17-066-21W5/0	047550
124178	R_11318	00/11-18-072-17W5/0	001183
124179	R_11319	00/12-01-057-03W5/0	B00020
124180	R_11320	00/10-08-046-22W4/0	001728
124181	R_11321	03/08-12-039-05W5/0	046294

D	E
ANALYSIS TEST TYPE REPS	
Analysis Description	**Abbreviation**
Absolute Permeability	AK
Absorption Analysis	AbA
Academic Studies	AS
Acid Compatibility	AC
Acid Sensitivity	ASEN
Acid Solubility	ACS
Acid Stimulation	ASTIM
Acoustic Velocity	ACV
Adsorption Analysis	AA
Air Permeability	APERM
Alkali Surfactant Polymer Flood	ASPF
Alkaline Polymer Flooding	APF
American Petroleum Institute Gravity	API
Anion Exchange Capacity	AEC
Aromatic GC-MS Biomarkers	AGCMSB
Ash Analysis	ASHA
Asphaltene Precipitation	AP
Bitumen content (DEL)	BITC
Brazil Tension	BT
Brine Compatibility	BC
Brine Composition	BRC

ysis Date	Analysis Test Type	Material Type
2018-12-14	CP(HG)	
2018-12-18	GRI, KAIR, GS, SO, SW, EP, TP, K, CP	
2017-12-17	CP(HG)	
2018-12-20	CP(HG), GRI, TP, K, EP, GAD, SO, SW, GS	
2018-12-17	CP(HG)	
2018-12-18	CP(HG), GRI, SO, GS, SW, TP, EP, KAIR, GAD	
2018-12-18	G), GRI, TP, EP, K, SO, GS, SW, GAD	

codes refer to test/analysis type – 12 of which might contain useful geomechanics information

Using PowerBI to Search the AB Index

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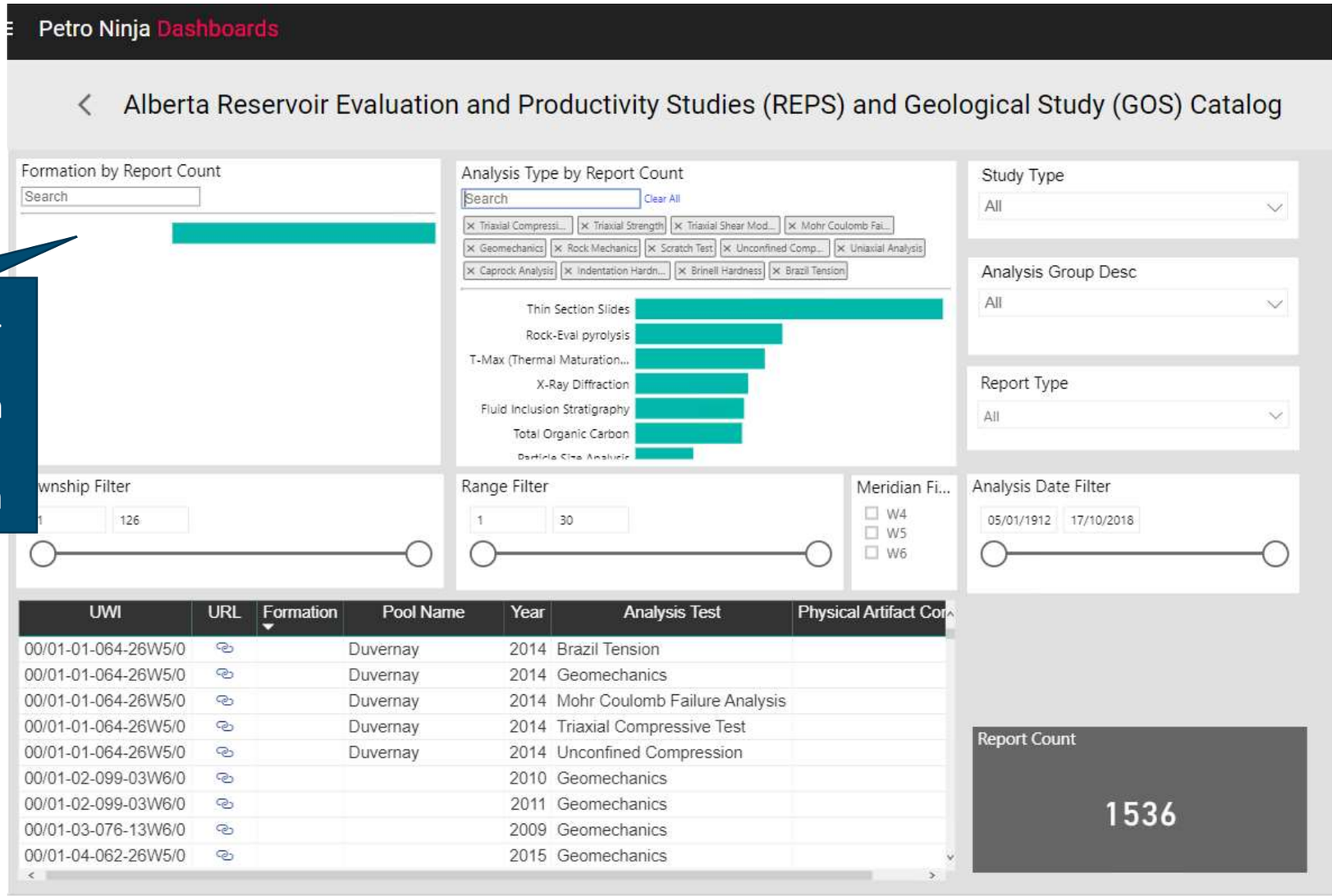
Note that not 1 of 1536 wells indicates which formation the test was run on



BC Energy Documents

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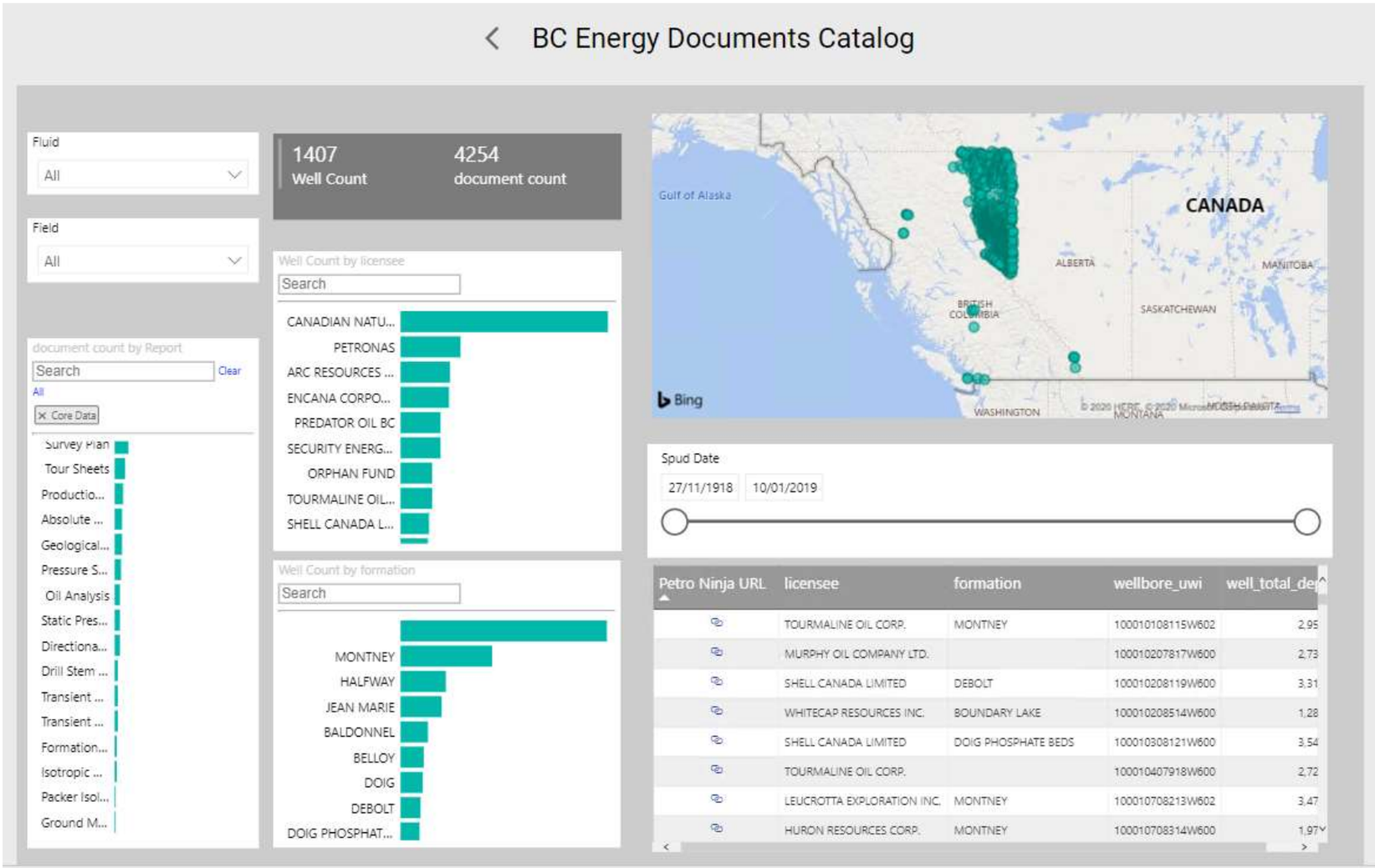
- Free but relatively unsearchable



Even if We Find the Files

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- What's in them is all over the place – a full report, a single spreadsheet, raw data, plots/no plots, photos/no photos
- Have to confirm formation using tops
- Test often not designed to capture the needed (by me) properties
- Widespread misunderstanding of "triaxial" testing – what it's for, how it's done, sample requirements

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Data for Maximum Horizontal Stress

Stress-induced Borehole Failure

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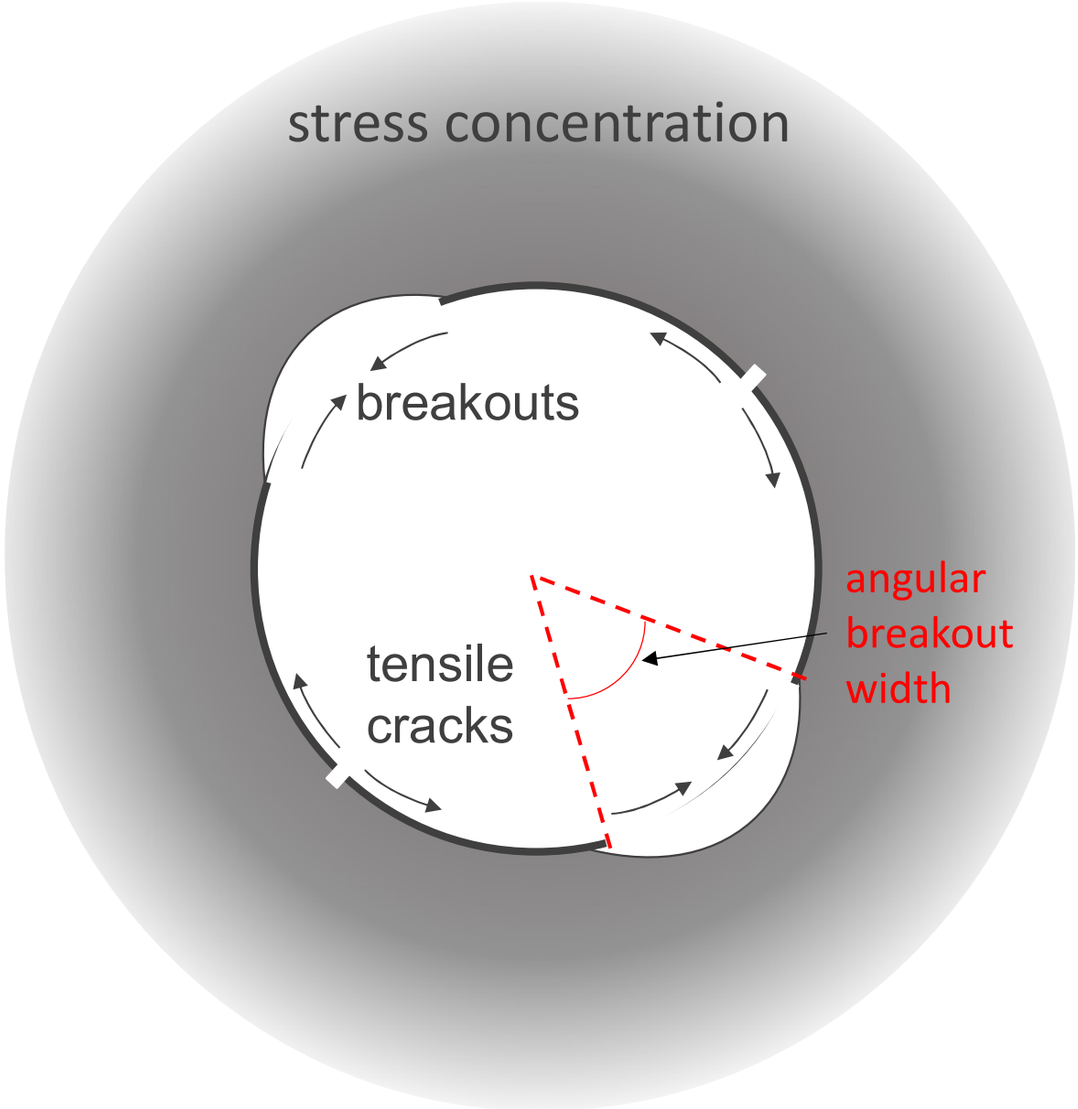
Data for Breakouts:

- Image logs ("FMI")
  - can get orientation and width
- Caliper
  - breakout must be large enough for caliper arm to engage
  - can get a sense of severity (width) from amount of enlargement
  - sometimes oriented
- Drilling problems



Data for Tensile Fractures:

- Image logs
- Lost circulation
  - if caused by exceeding the minimum stress and unintentionally propagating a fracture into the formation

What's an Image Log?

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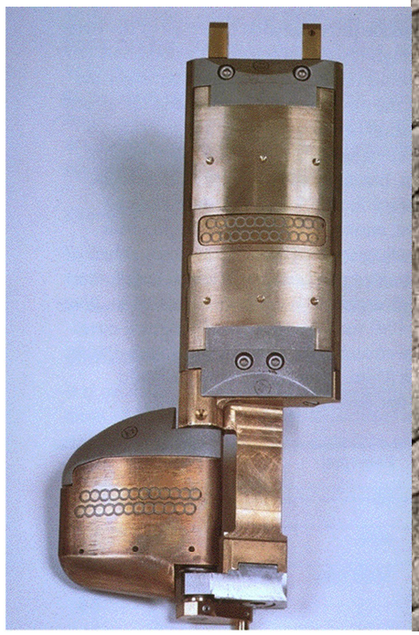
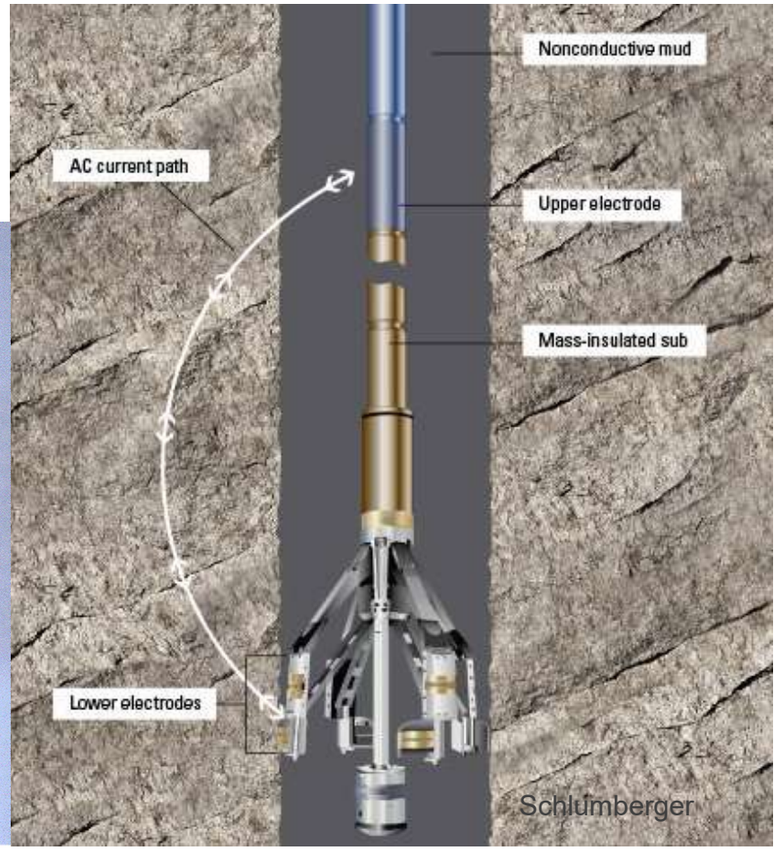
Electrical





Acoustic

What's an Image Log?

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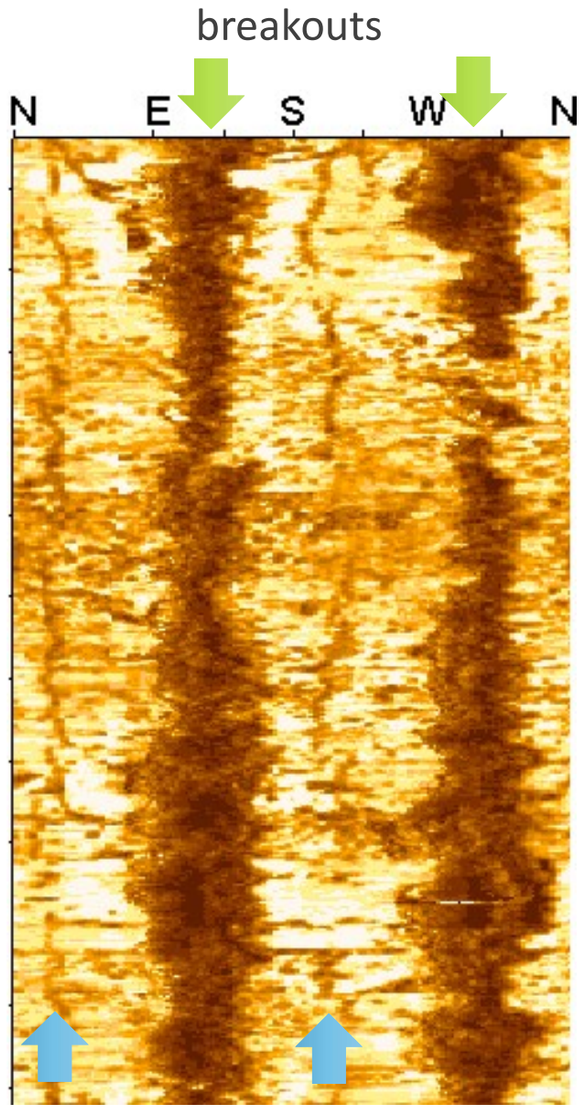
breakouts



tensile cracks

KSMMA Example Again

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- For 2019 study
  - Found 16 public image logs, 12 of which were usable (more on image quality coming up)
  - Operators provided 7 or 8 that we couldn't find in the public data
- For 2020 study
  - Using additional search techniques, found a total of 59 wells in which image logs were collected in or below the Montney in and around KSMMA
  - Of the additional wells found since 2019, we have access to 8 or 9 images
  - Haven't assessed image quality yet

QUICK CALC: 59 wells – 24 available images (40%) – probably only 2/3 of those usable (27%)

Image Log Challenges

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- Before computer storage, only paper logs could be submitted – these were, and remain, difficult to reproduce digitally (e.g., scan)
- After computer storage but before good network capability, logs were often delivered on tapes or CDs – some of these can be found in the public raster logs
- Things *are* getting better *slowly*, with good-quality, colour images showing up here and there as PDFs and TIFFs
- Whether or not an operator chooses to report they've collected an image log is still an issue
  - Sometimes operators would (maybe still do) submit images at uninterpretable vertical scale or just the field tests log, and regulators don't know the difference

Image Log Quality

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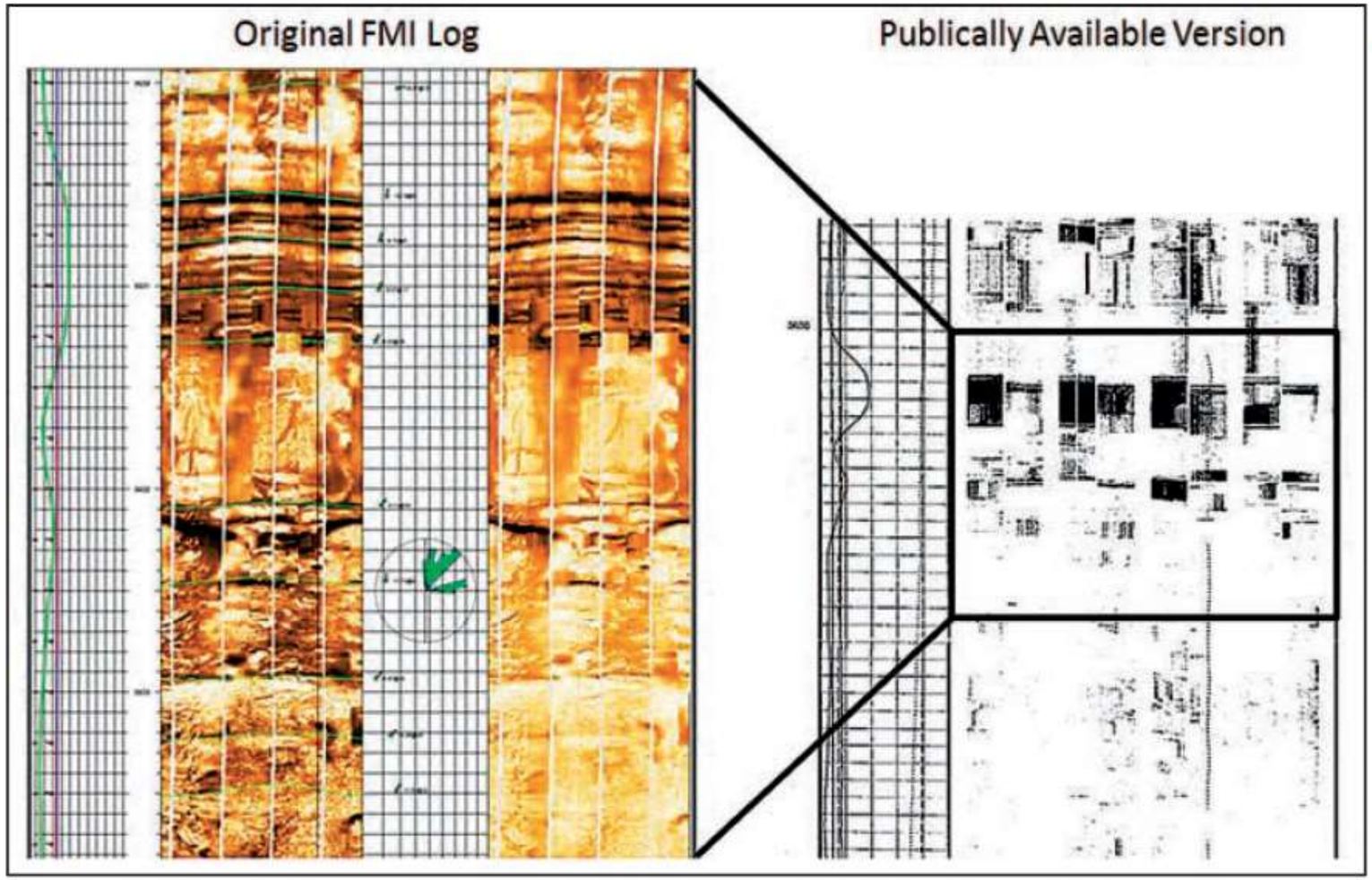

Left: Section of an FMI image in the Duvernay as submitted to the ERCB (Courtesy of HEF Petrophysical). The image shows stress induced wellbore breakouts and tensile cracks as well as significant pre-existing natural fractures. Right: Sample of the same image log in the raster format available to the public.

GEOMECHANICS FOR EVERYONE
Part 2: The Importance of Geomechanical Data – Getting it, Understanding It and Using It Correctly

CSPG Reservoir, October 2013

A story: The great Duvernay FOIP experiment of 2013-2014…

Example: Offset Well Image Log Search

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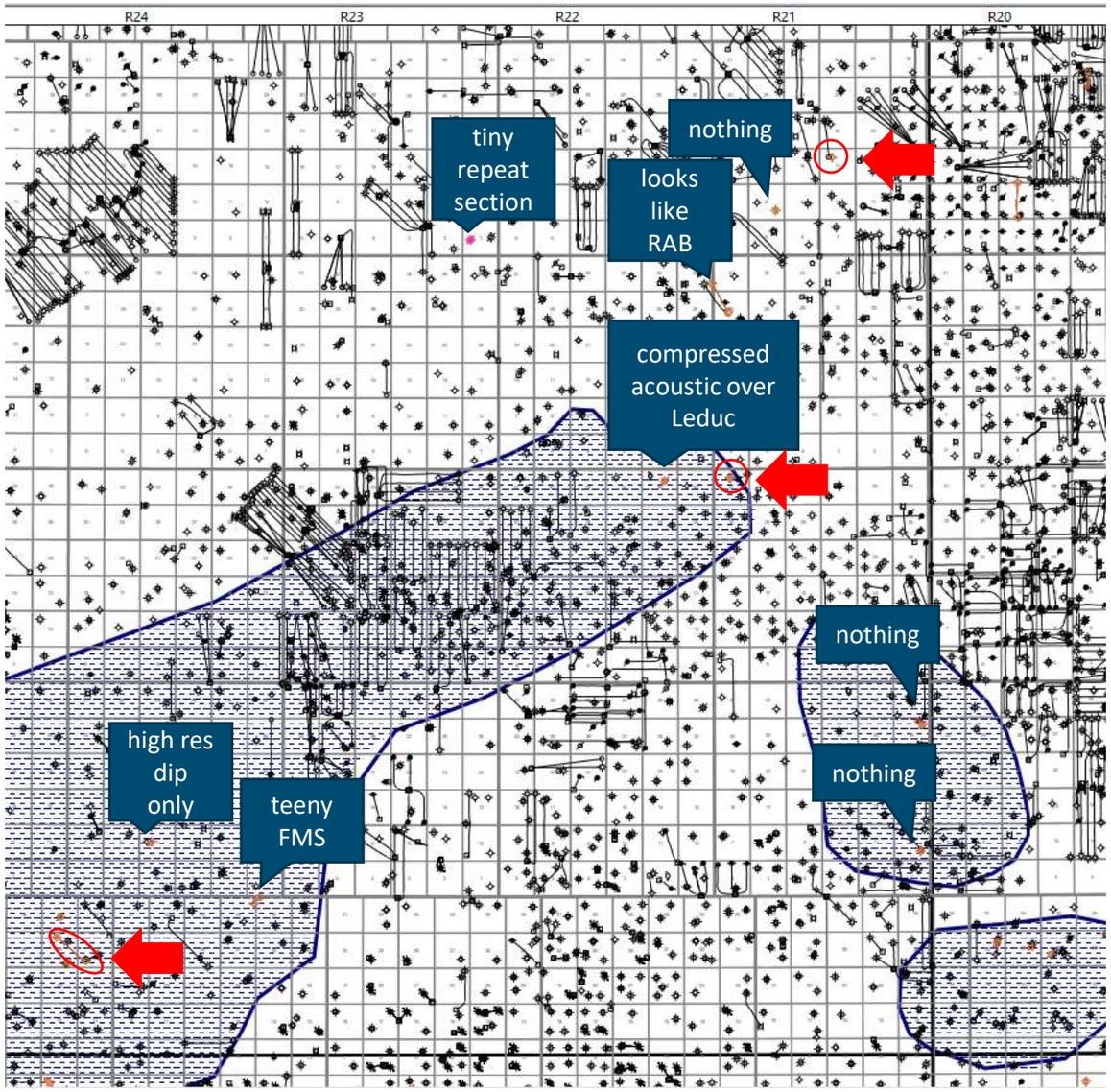
Out of 11 wells, found 3 usable image logs



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Wrap-up

Conclusions/Discussion Points

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- What data have I not talked about?
  - Whole core descriptions and photos
  - Caliper, dipmeter, dipole shear, azimuthal/array sonic
- What am I missing? What solutions have others found?
- After seeing these examples, how public do *you* think public data are?
- How can we engage the regulators to discuss different/new options for data access?
  - Example, through our KSMMA work we seem to have revivied a conversation with the OGC regarding image logs.

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