

Peace Project aquifer study

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Bemex Consulting International

Covers Montney play area north of Fort Saint John – work undertaken to understand potential locations and amount of water available to share between agriculture and fracing

OVERVIEW

Geoscience BC coordinated project – Carlos Salas

Many groups and individuals involved

- Petrel Robertson
- Skytem
- Aarhus Geophysics
- Quaternary Geosciences (Vic Levson)
- Bemex Consulting International (Mel Best)
- SFU (Dianna Allan and her MSc student, Samantha Morgan)

Geoscience BC Reports on the Peace Project

2018-13: Geoscience BC Peace Project: FINAL REPORT By Samantha E. Morgan and Diana M. Allen Simon Fraser University

2018-08: Peace area project — Comparison of resistivity gamma and geological logs with airborne EM inversions by M. Best, Bemex Consulting International, and V. Levson, Quaternary Geosciences Inc

2018-06: Processing and inversion of SkyTEM data leading to a hydrogeological interpretation of the Peace River North Western Area by Aarhus Geophysics and GEUS (the Geological Survey of Denmark and Greenland)

2017-18: Petrophysical Interpretation on Six Shallow Wells in the Peace Region of BC by Yevgen Mykula

2017-17: Summary report of proposed water well locations for Halfway River First Nation area by M. Best M., Bemex Consulting International, and V. Levson, Quaternary Geosciences

Report 2017-16: Northeast BC sonic drilling project: Physical log descriptions and interpretations by M. Best M., Bemex Consulting International, and V. Levson, Quaternary Geosciences

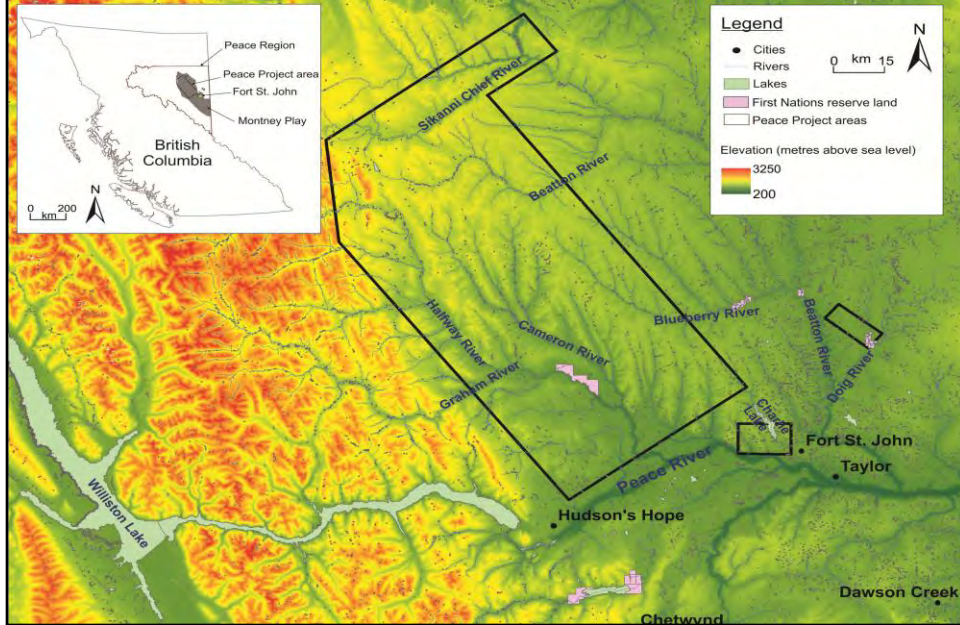
2016-18: Peace Area Project – Well Selection for Testing Geological Model based on Gamma and Airborne Electromagnetic (AEM) Studies by Bemex Consulting International and Quaternary Geosciences Inc.

2016-04: Interpretation of Quaternary Sediments and Depth to Bedrock Through Data Compilation and Correction of Gamma Logs by Petrel Robertson Consulting Ltd.

2016-18: Peace Area Project – Well Selection for Testing Geological Model based on Gamma and Airborne Electromagnetic (AEM) Studies by Bemex Consulting International and Quaternary Geosciences Inc.

2016-09: Processing and Inversion of SkyTEM data by Aarhus Geophysics APS

Location map



Gamma log study

- Legislation in Alberta and BC require all wells collect gamma logs starting at the surface.
- Petrel Robertson awarded contract (with Vic Levson as their Quaternary interpreter).
- Found approximately 1300 wells in area that were suitable for inclusion in the study, i.e. had useable gamma logs starting at the surface.
- Also used water wells where available for depth to bedrock as well as the published surficial geology map

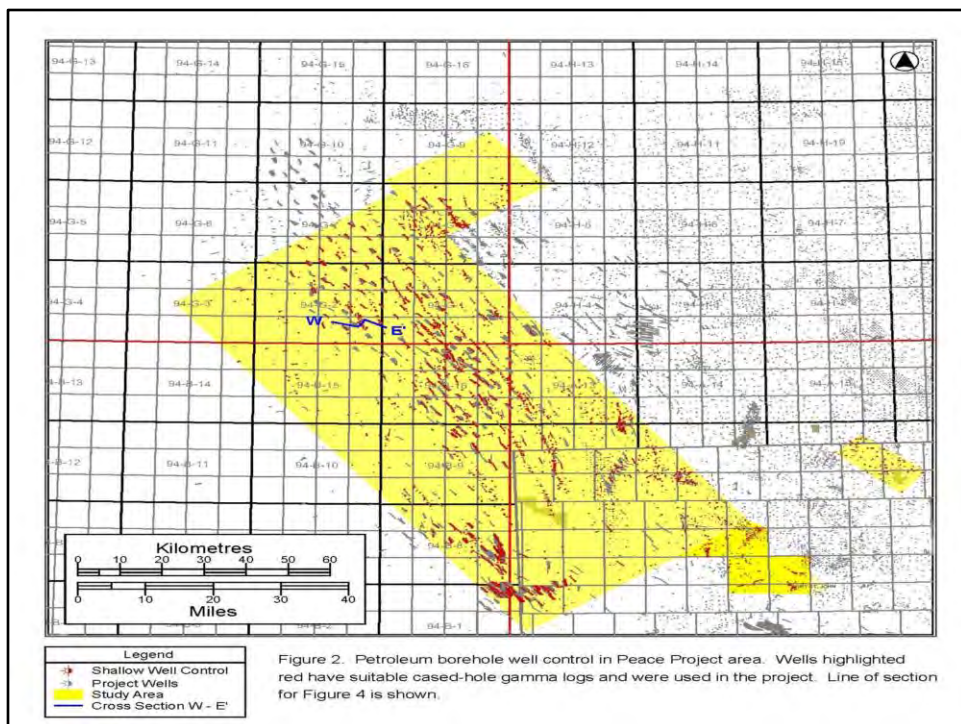


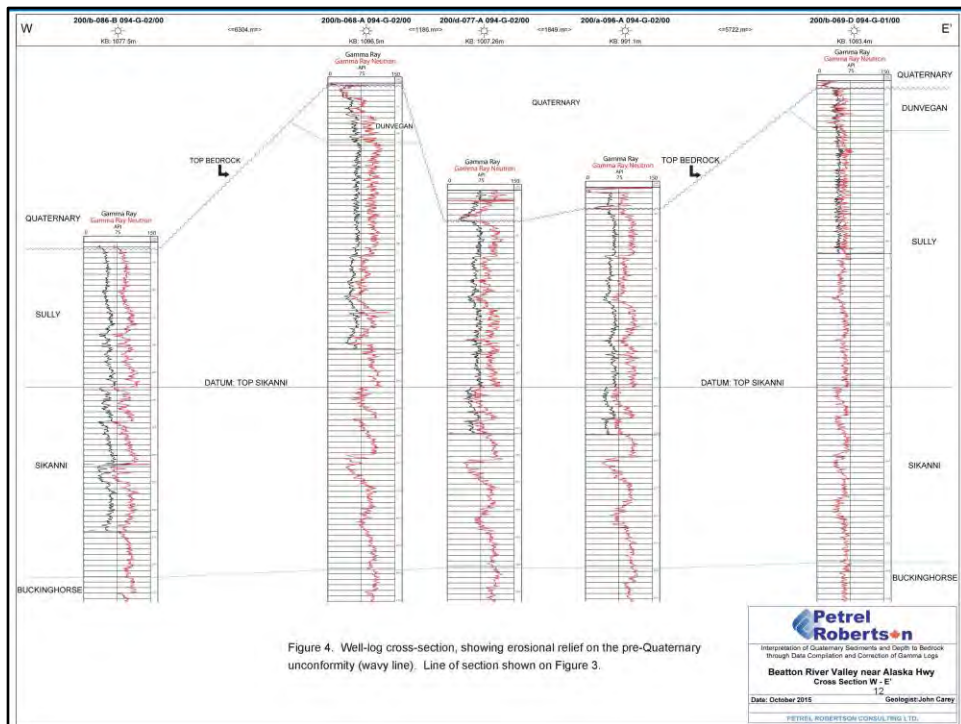
Figure 2. Petroleum borehole well control in Peace Project area. Wells highlighted red have suitable cased-hole gamma logs and were used in the project. Line of section for Figure 4 is shown.

Gamma log study

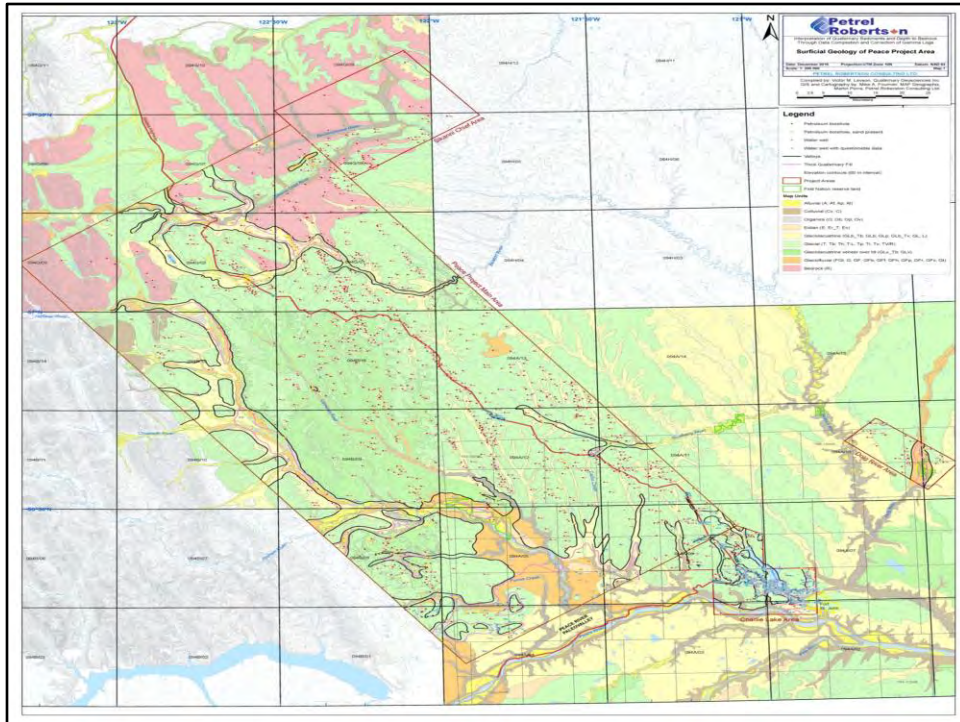
- Method developed by Quatero et al from U of Calgary. Used to correct for gamma absorption within the casing and cement.
- Compared wells that had gamma measurements within a given formation (bedrock) that was cased and within the same formation that was not cased. This provided a statistical method of obtaining a correction factor for the casing and cement effects.
- This factor was applied to all cased portions of all wells.

Gamma log products

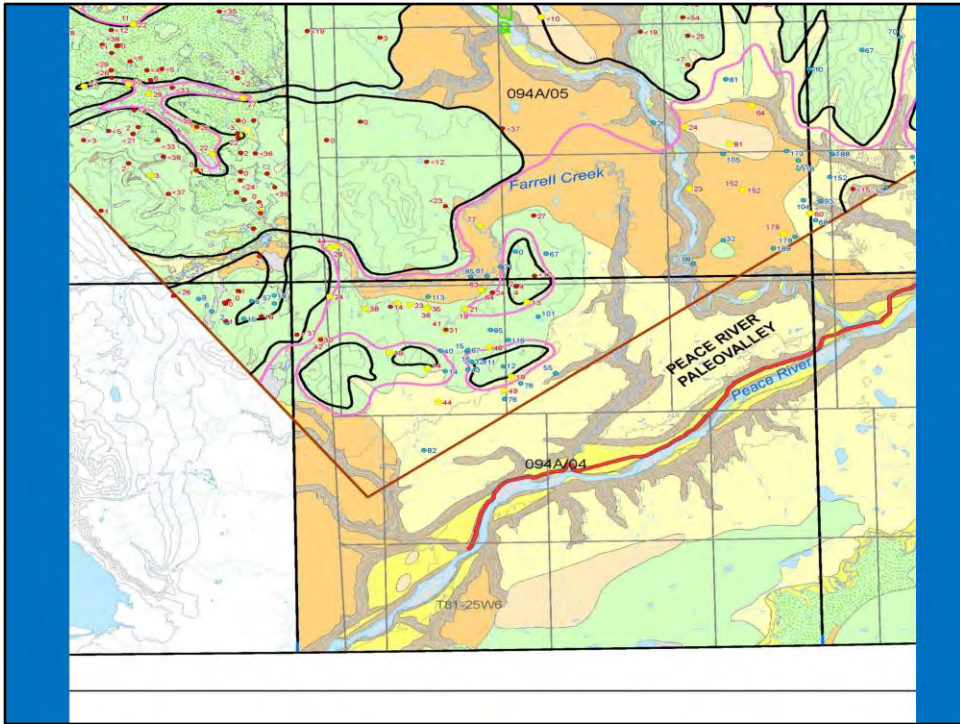
- Corrected gamma logs
- Cross sections
- Quaternary (surficial) geology map
- Depth to bedrock map(s)
- Shallow bedrock formation



Dunvegan (Cetaceous sand and silt with shale lenses) tends to be limited to higher elevations. Quaternary is thicker in low elevations. Sully is a Cretaceous shale unit (expect it to have high gamma and be conductive)



Light yellow –glacio lacustrine, green - glacial (mostly tills), orange - glacial fluvial, brown - colluvial



AEM system

- Skytem312^{fast} used to collect airborne EM data
- 600 m traverse line spacing (approx NE-SW)
- 2400 m NW-SE tie line spacing (approx NW-SE)
- Average terrain clearance of EM system is
- approximately 58 m
- Uses low and high transmitter moments
- Approximately 21,000 line km collected

Laterally constrained inversion

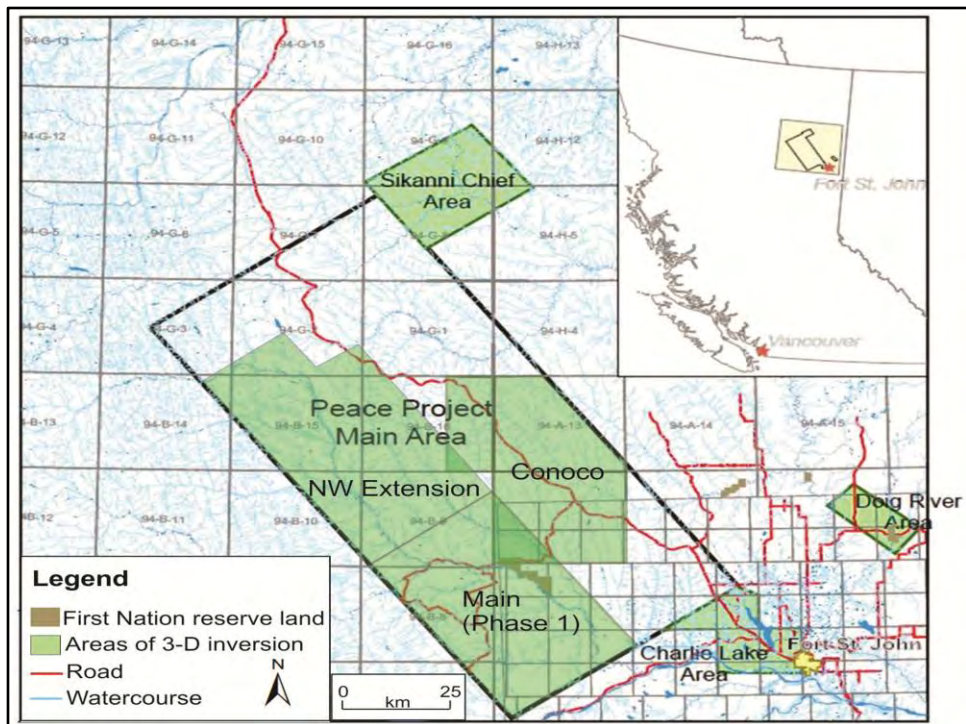
- Aarhus workbench
- Multiple 1D inversions but constrained laterally
- Used 30 fixed layers for 1D inversions with layer thickness increasing with depth

AEM products

- Flight lines
- DEM
- 1D inversions
 - - Cross sections
 - - Depth slices

Priority areas

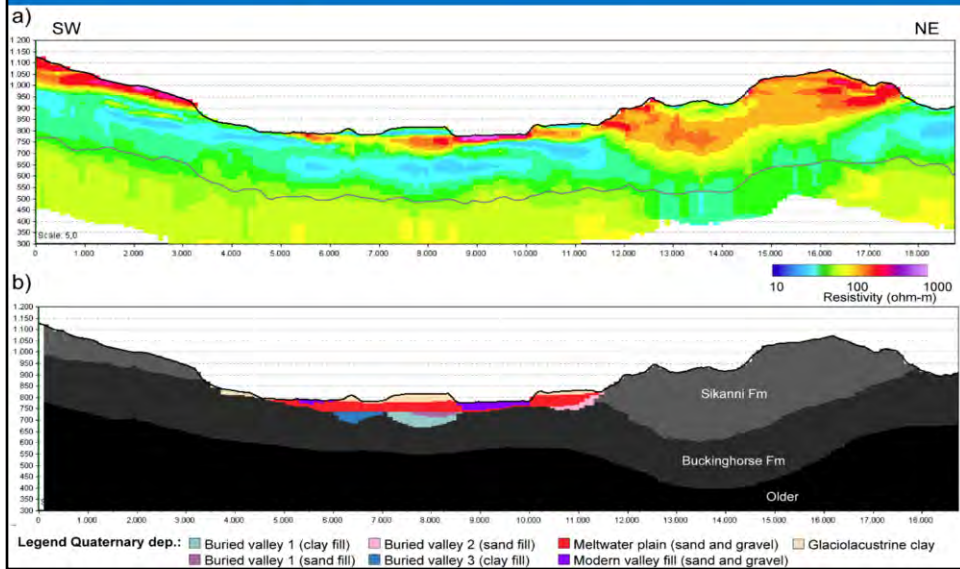
- Areas selected for re-processing and preliminary interpretation based on:
 - - Gamma study
 - - First Nations input
 - - Municipality of Fort Saint John
 - - Petroleum companies



Aarhus Geophysics reprocessing

- Reprocessing consisted of:
- Careful editing of noisy data
- Corrections for tree height using GPS data
- Laterally constrained combined with spatially constrained inversions

Example from the NW extension



Well selection and logging program

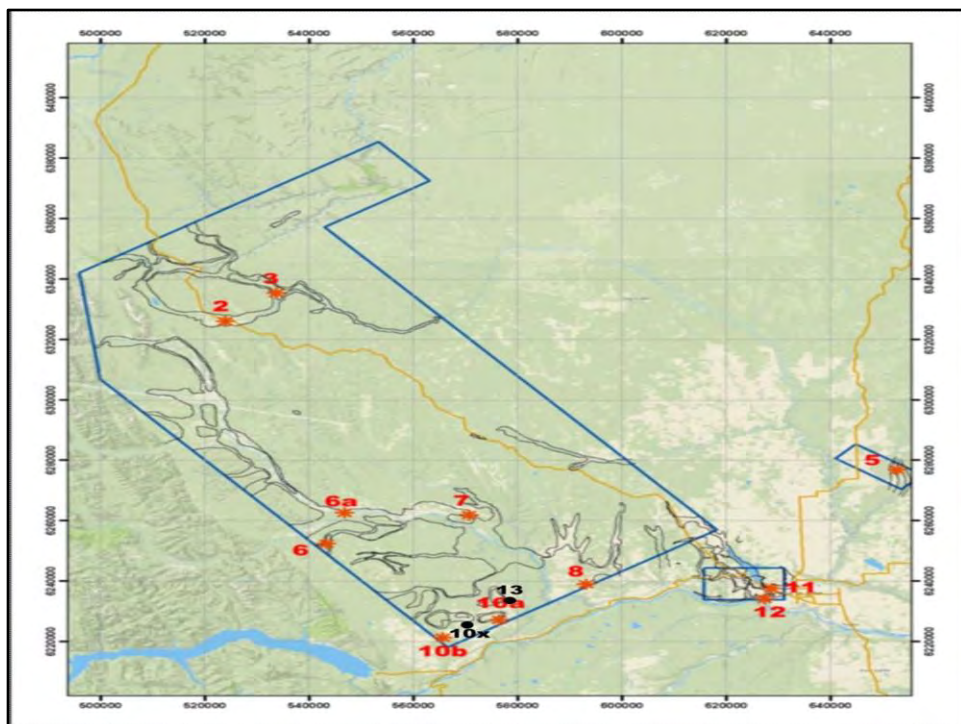
- Used the following information to select wells
 - - Aarhus Geophysics resistivity sections
 - - Gamma log study
 - - Stake holder's input
 - Location of roads and other forms of access
 - (for example seismic lines)

Well selection and logging program continued

- Initially selected 10 wells to test the geological model
- Several additional wells were added later on by SFU and UBC
- After checking detailed access dropped several of the locations
- drilling contractor had limitations so several more were dropped as well
- Mobilization was an issue since the distances between some of the wells was more than 80 km, i.e. Ran out of funds to drill all the planned wells

Table of wells drilled

Well #	Original UTM easting	Original UTM northing	Original EM line number	Final UTM easting	Final UTM northing	Final EM line number	Approx. distance between original & final locations
3	533632	6335392	L 104802	532800	6337068	L 104503	1870 m
6a	546718	6262698	L 115801	546650	6262600	L 115801	120 m
7	570600	6261960	L 118302	570761	6262059	L 118302	190 m
10b	565670	6221360	L 123 202	564653	6220724	L 123202	1170 m
10 x	-	-	-	570720	6225047	L 123202	-
12	627284	6234107	L 301701	627050	6234063	L 301701	240 m
13	-	-	-	579293	6234812	L 122801	-



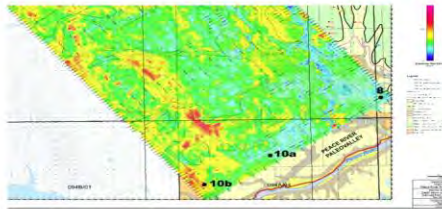


Example from well 10b

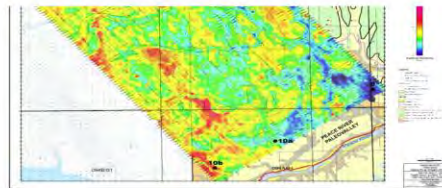
- This well was selected for the following reasons:
- - resistive values near surface to a depth of approx 30 m
- - in an area of known landslide hazards
- - road access reasonable
- - close to civilization

Example of prognosis versus logging well 10b

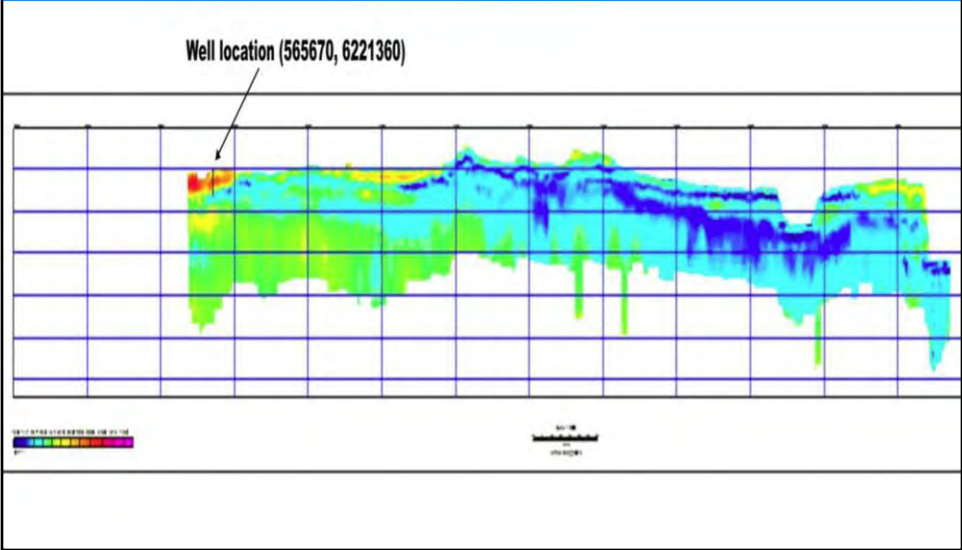
a) SW PEACE BLOCK
Resistivity depth slice (5 – 10) south



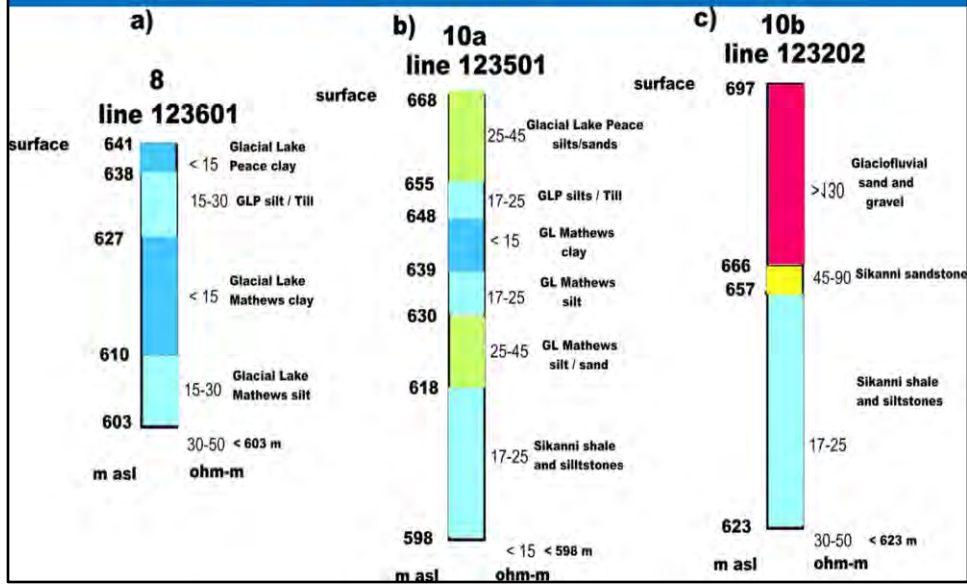
b) SW PEACE BLOCK
Resistivity depth slice (15 – 20) south



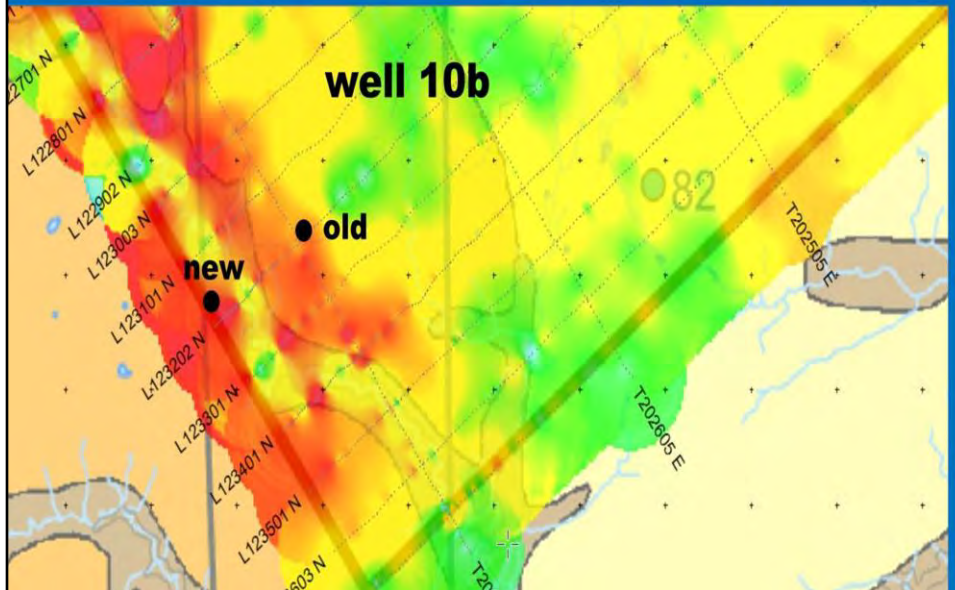
Resistivity cross section from flight line
123202



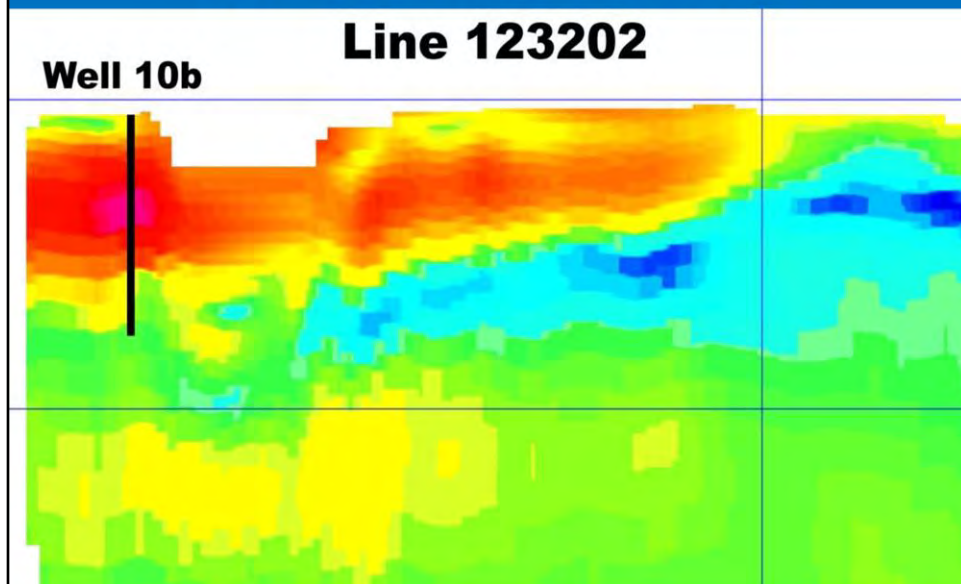
Prognosis for well 10b



Final location of well 10b



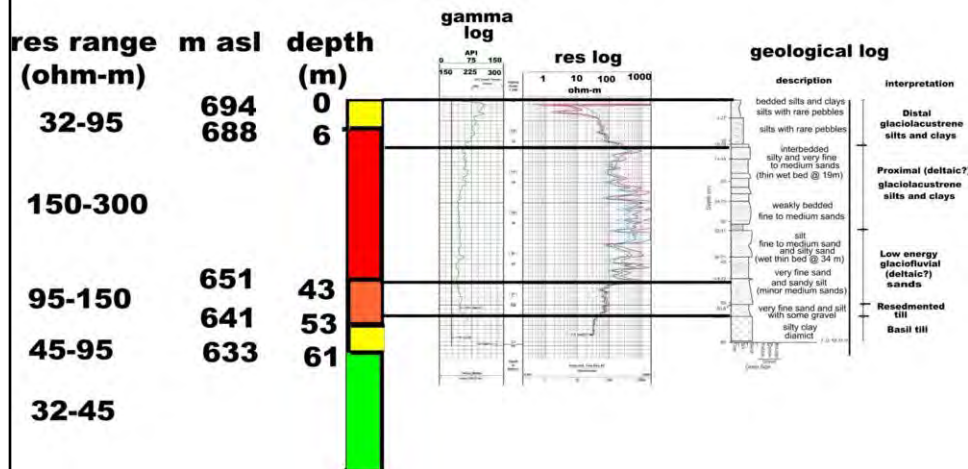
New location of well 10b



Actual results from logging well 10b

well 10b

AEM inversion



SFU main summary points

- Thickness of Quaternary sediments varied considerably over the entire area
- Quaternary section contains multiple successions of advance and retreat phases
- Generally the Quaternary section is heterogeneous
- Resistivity values of different units can overlap making geological interpretation difficult

SFU main summary points continued

- Permeable Quaternary deposits exists within the peace region
- Obtaining reliable depth to bedrock is challenging due to spacing of petroleum wells and existence of overlapping resistivity and gamma values of Quaternary and bedrock formations (shale and clay for example)

Bedrock is deeper than predicted - implies basal resistivity units may be sand /gravel aquifers

SFU main summary points continued

- The paleovalley network in the Peace region is complex and could contain several stacked valleys of different ages
- Connections between groundwater aquifers and surface water is an important aspect which requires further investigation
- Recharge of paleovalleys and its impact on stream flow is difficult to assess

Suggested future studies

- Ground geophysical follow-up in some areas
- Drilling and logging at specific well locations
- Skytem survey in south portion of Montney play, i.e. south of Fort Saint John