GRC 2020 VIRTUAL ANNUAL MEETING & EXPO

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Using Oil and Gas Data to Assess Geothermal Resources Within the Western Canadian Sedimentary Basin in Alberta

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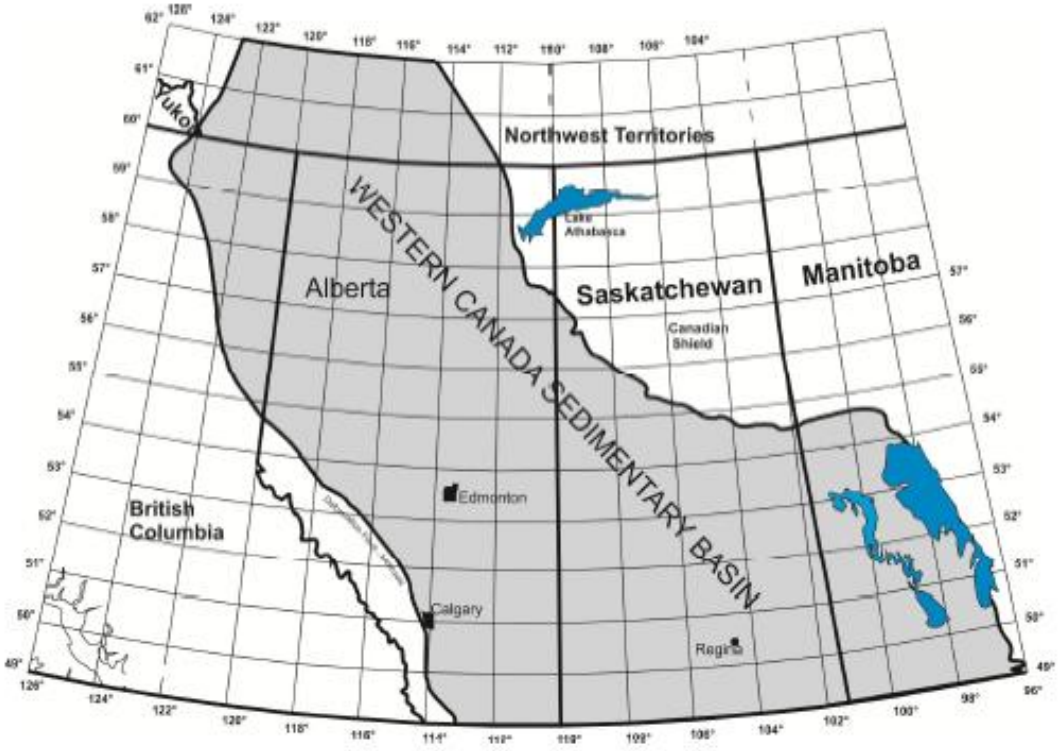
Regional Study

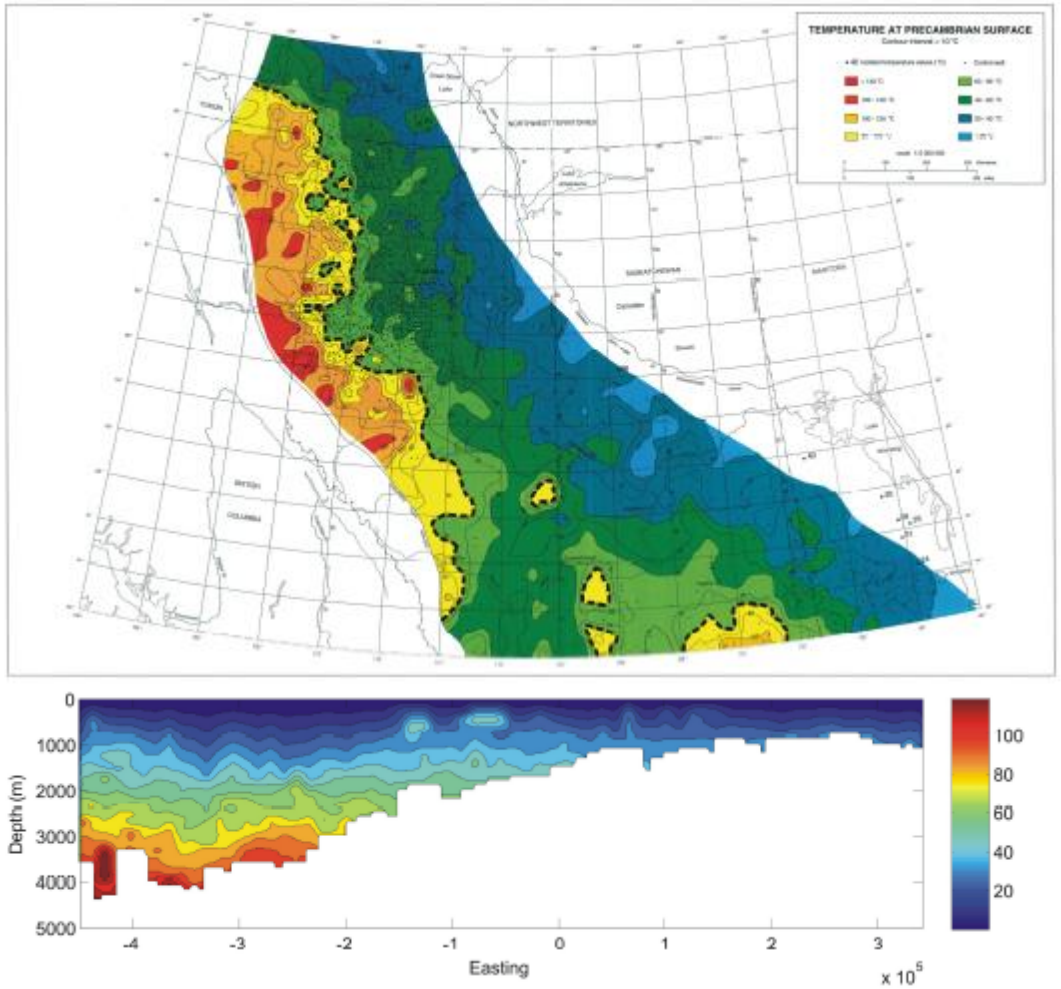
Identify areas within WCSB that meet 3 criteria:

1. Temperature gradient high enough for ≥120°C at depths ≤4500m
2. Formations at target depths with high fluid flow
3. Adequate existing infrastructure to for power and direct heat use



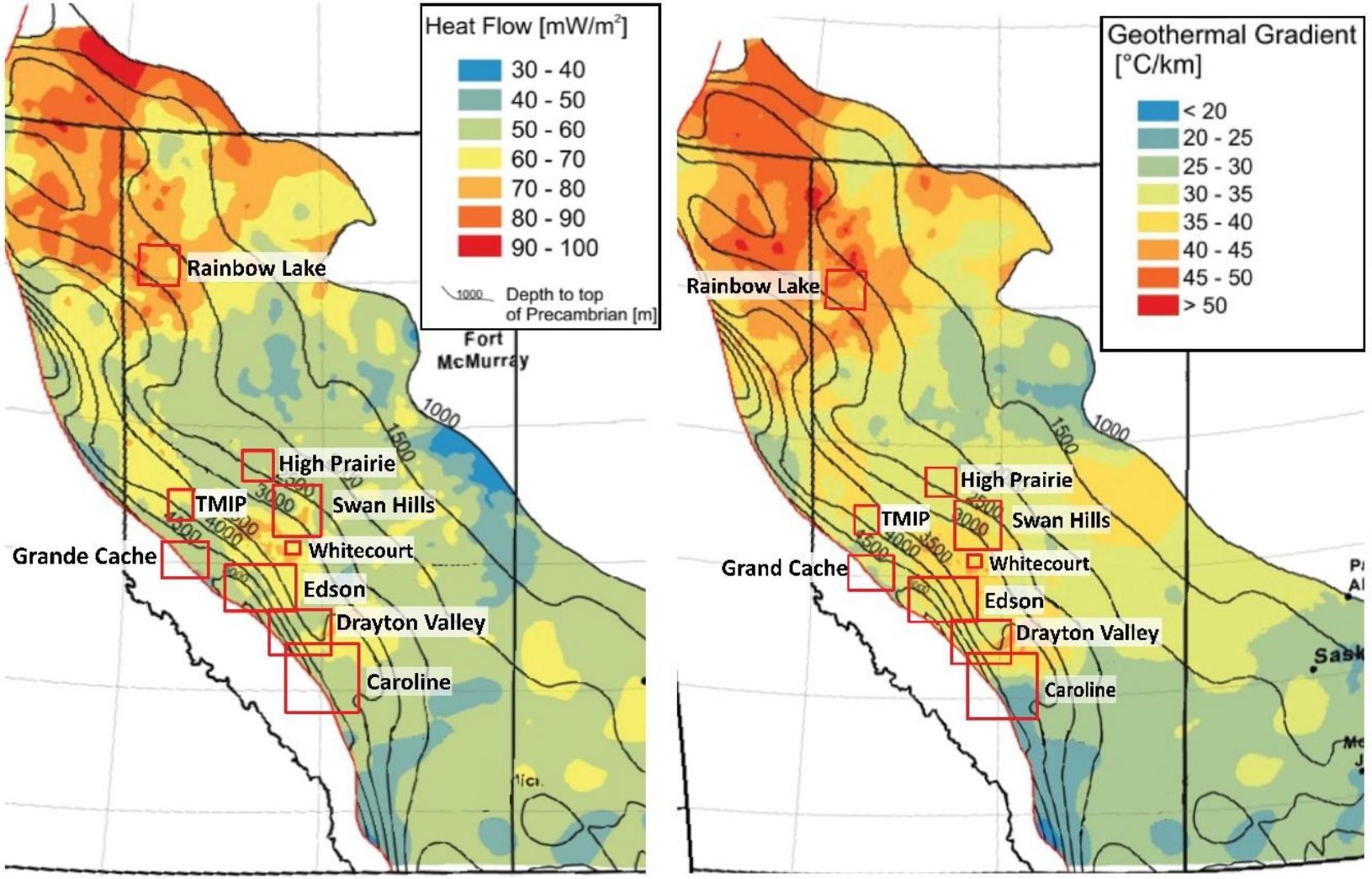
Based on Mossop and Shetsen, 1994

Literature Review: Temperature/ Heat Flow



Grasby et al., 2012

Literature Review: Temperature/ Heat Flow



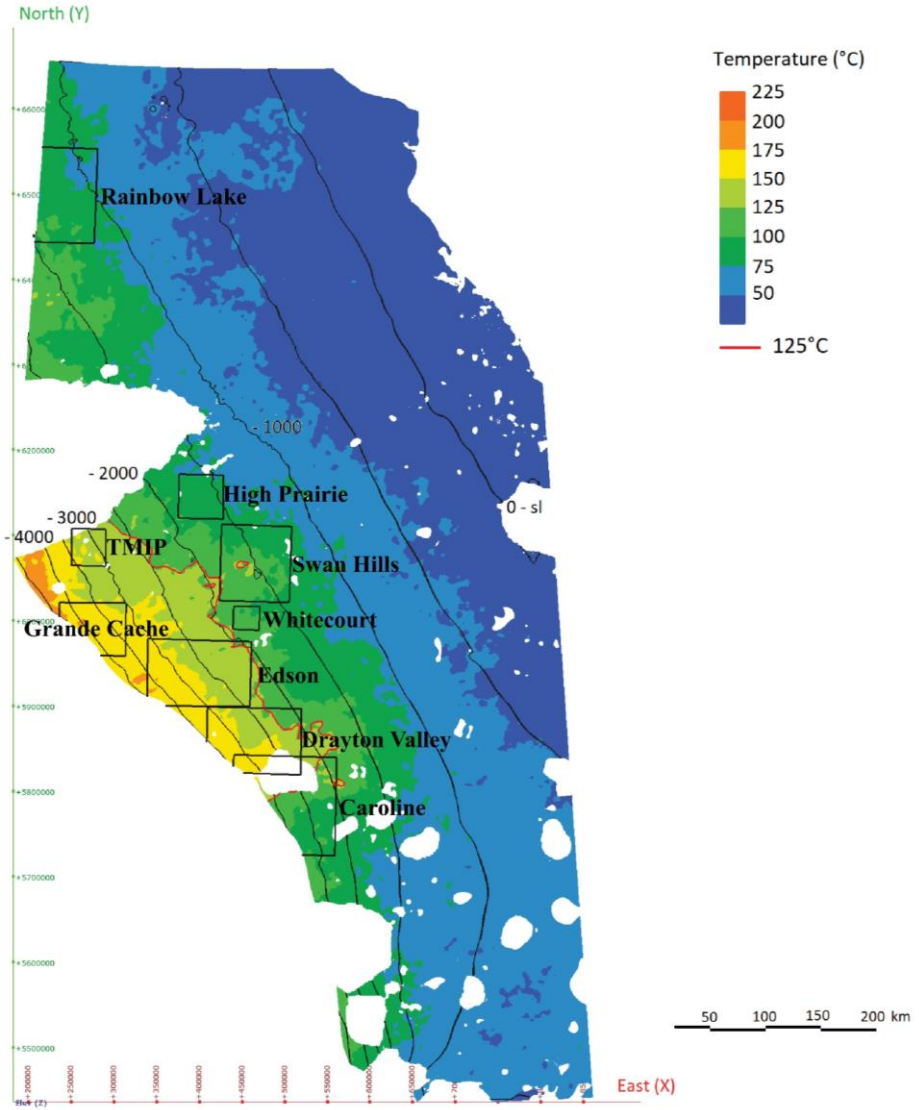
Adapted from Weides & Majorowicz, 2014

Study Locations

Selected Based On:

1. Communities with interest in pursuing geothermal projects
2. Areas with oil & gas wells known to produce hot water
3. Identified high heat flow and thermal gradients (Weides & Majorowicz, 2014)

Study locations on Swan Hills Formation elevation, courtesy B. Poux



Issues with Oil and Gas Temperature Data

ALBERTA NO.1 GEOTHERMAL ENERGY PROJECT.

- Drilling activities
- Measurement errors
- Single temperature point at one depth
- Limited temperature logs
- Unknown depth of BHT recording
- Not know how long after drilling BHTs were recorded
- BHT not important parameter for O&G exploration

Methodology

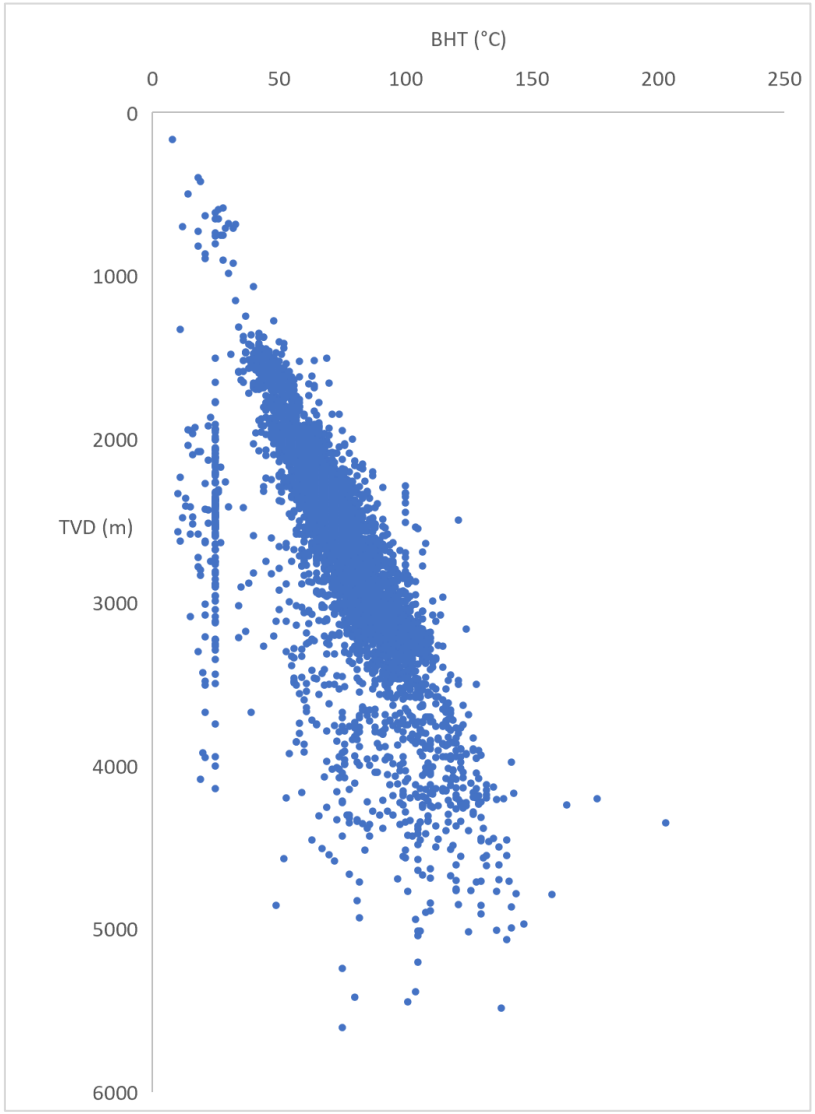
$$Gradient = 1000 * \frac{(BHT - ST)}{TVD}$$

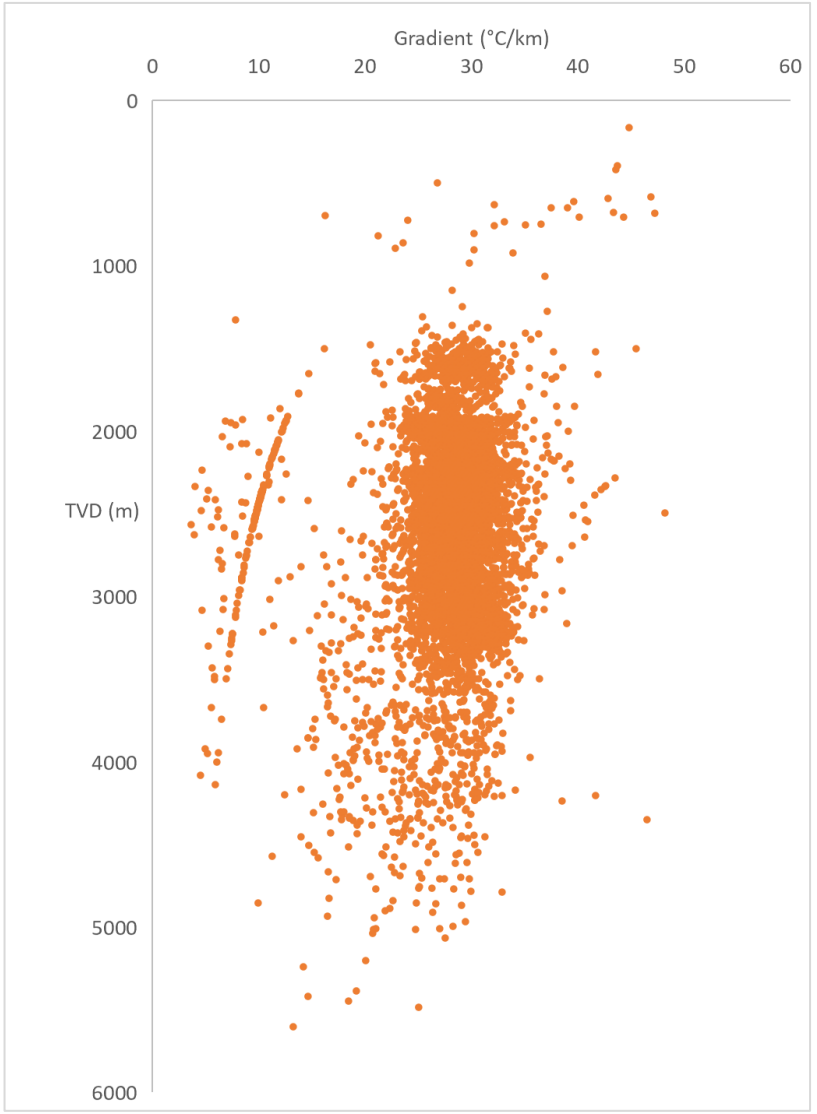
BHT: Bottom Hole Temperature (°C)

ST: Mean Annual Surface Temperature (°C)

TVD: True Vertical Depth (m)

Methodology: Filtering





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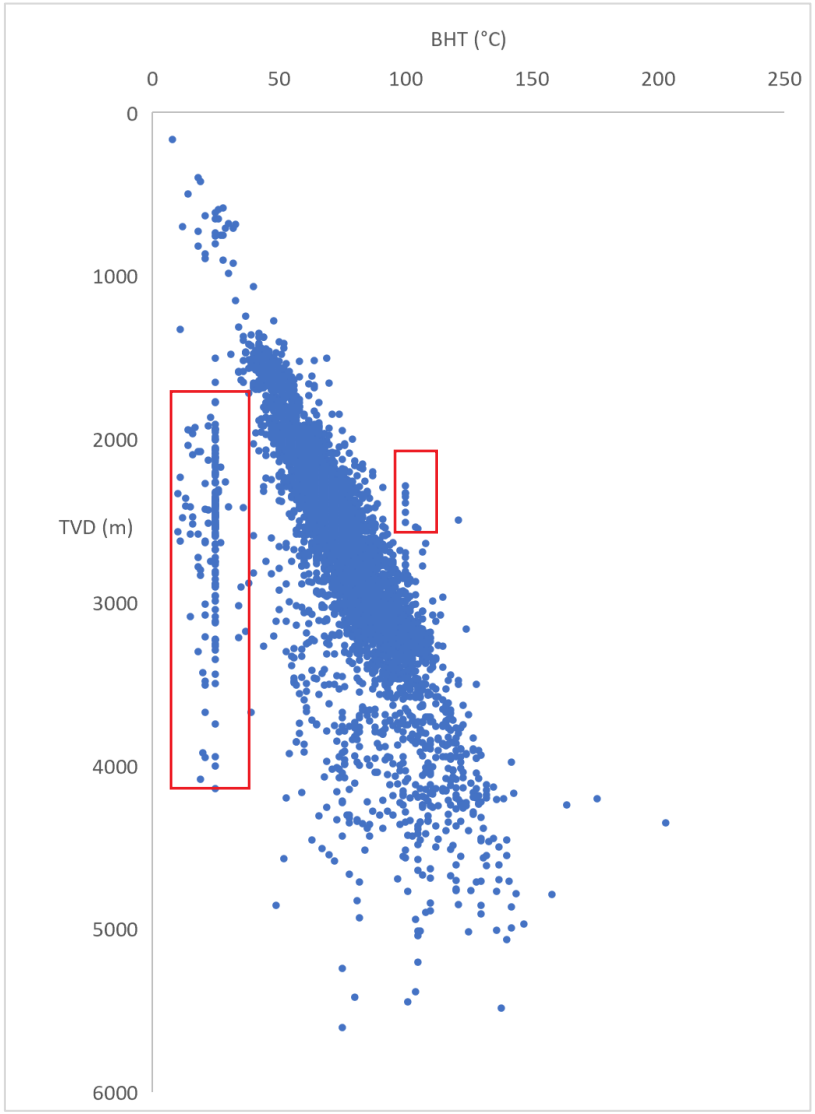

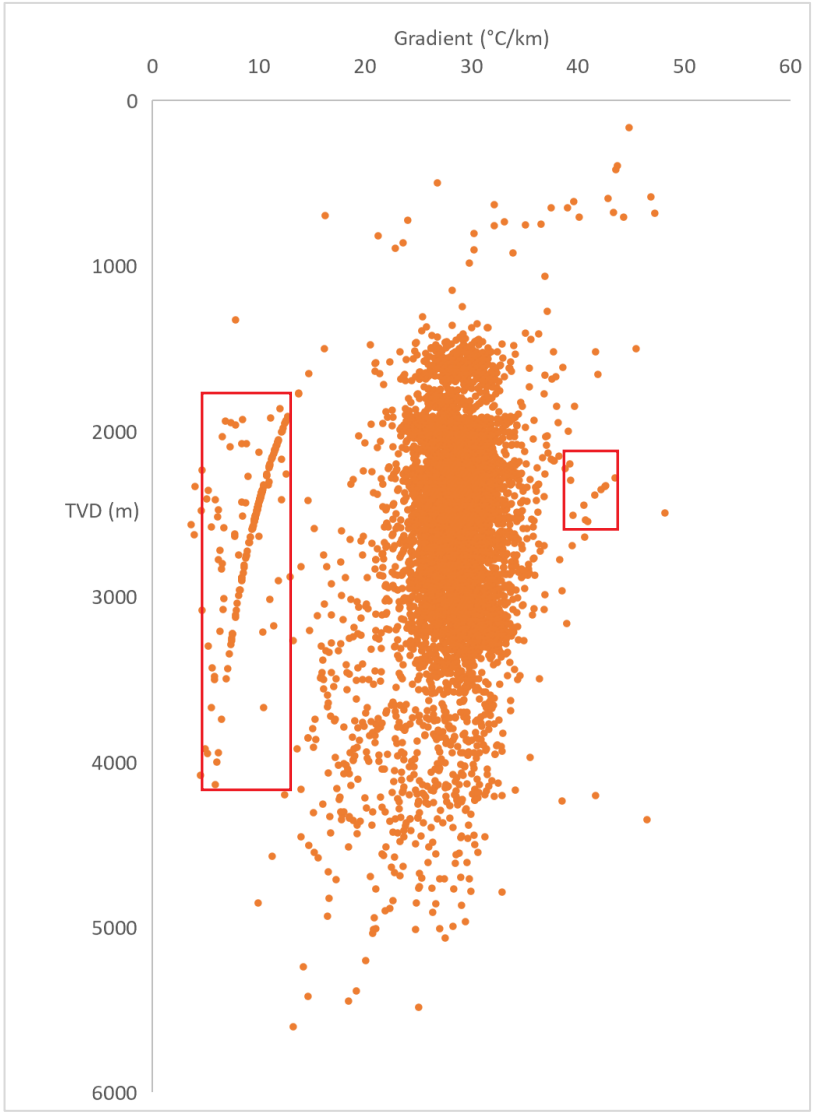

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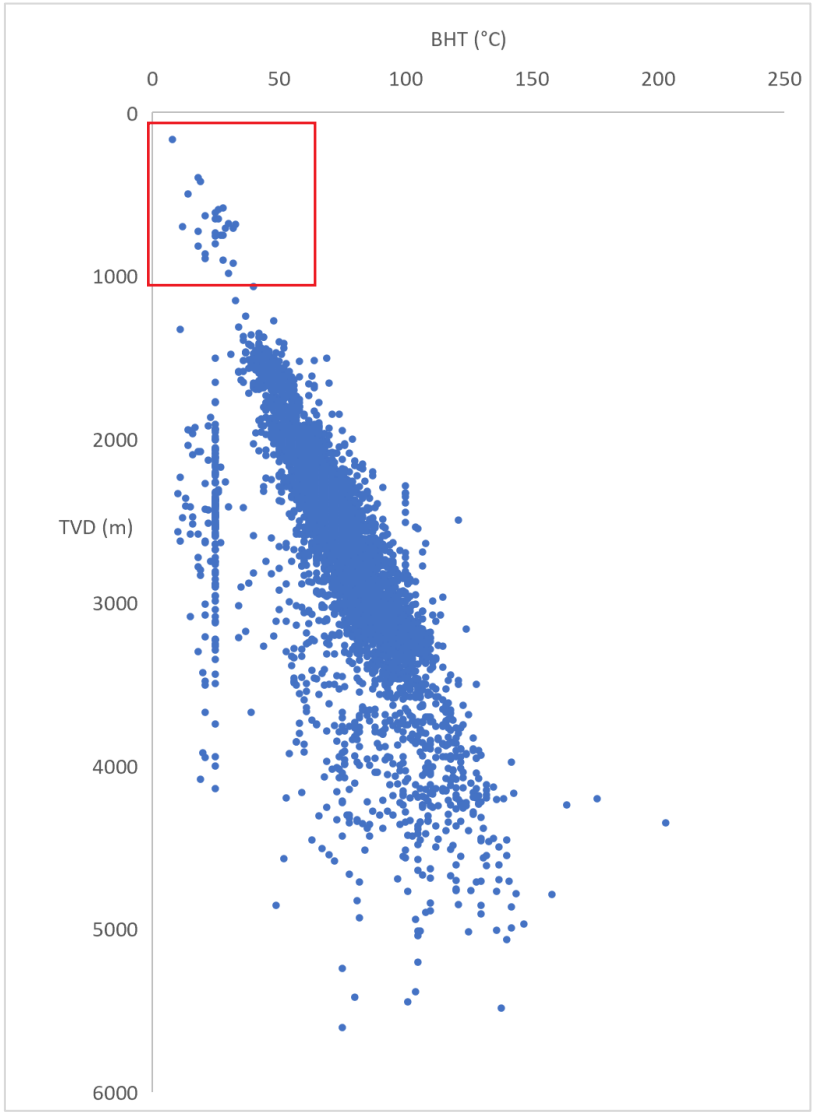

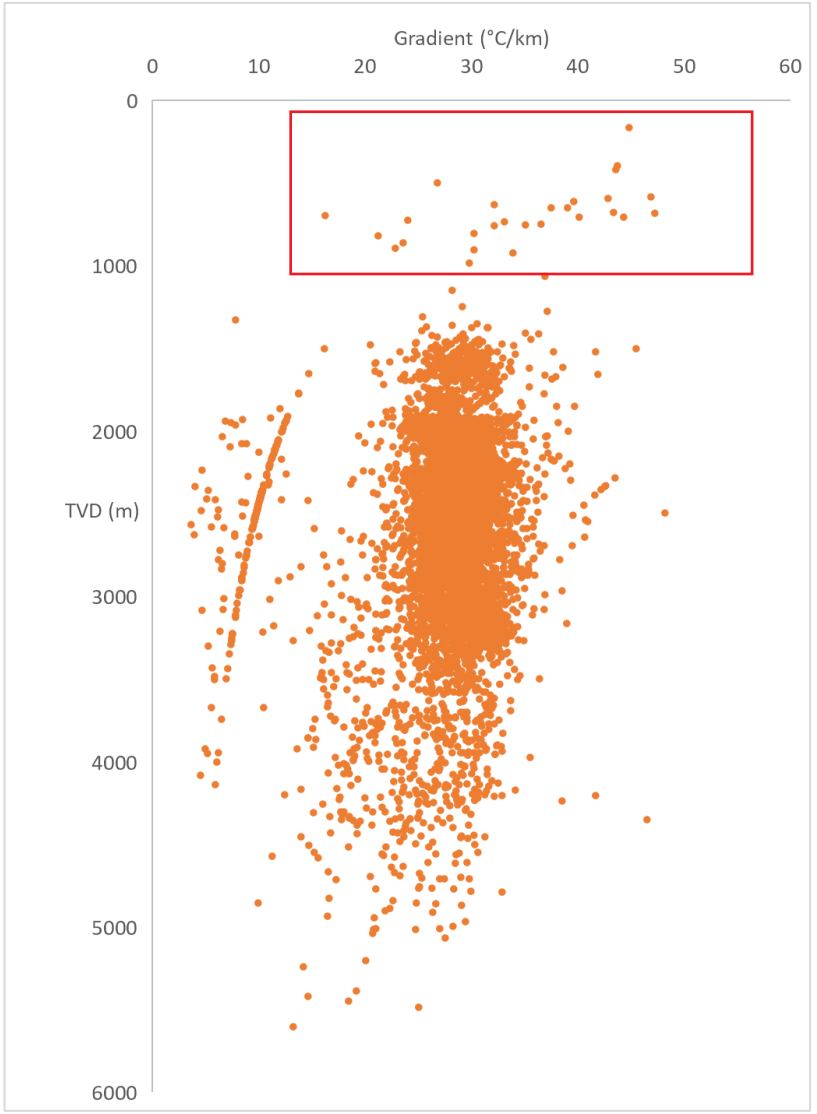

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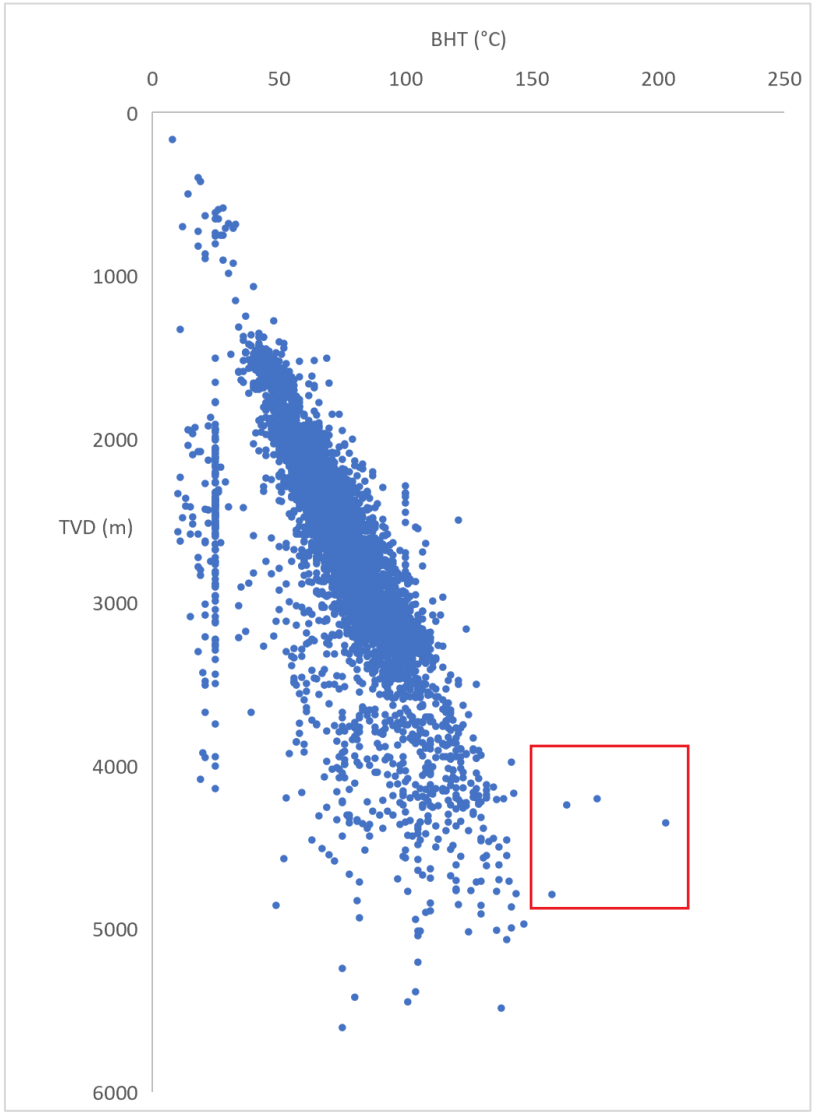

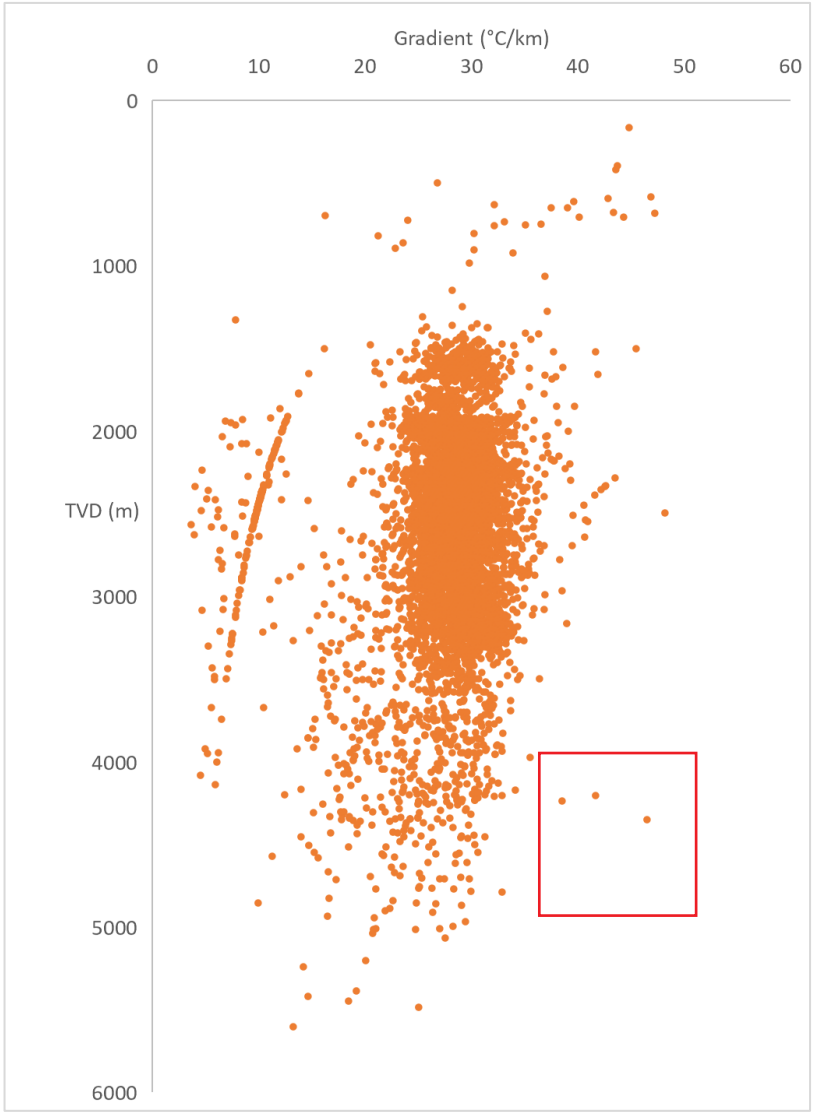

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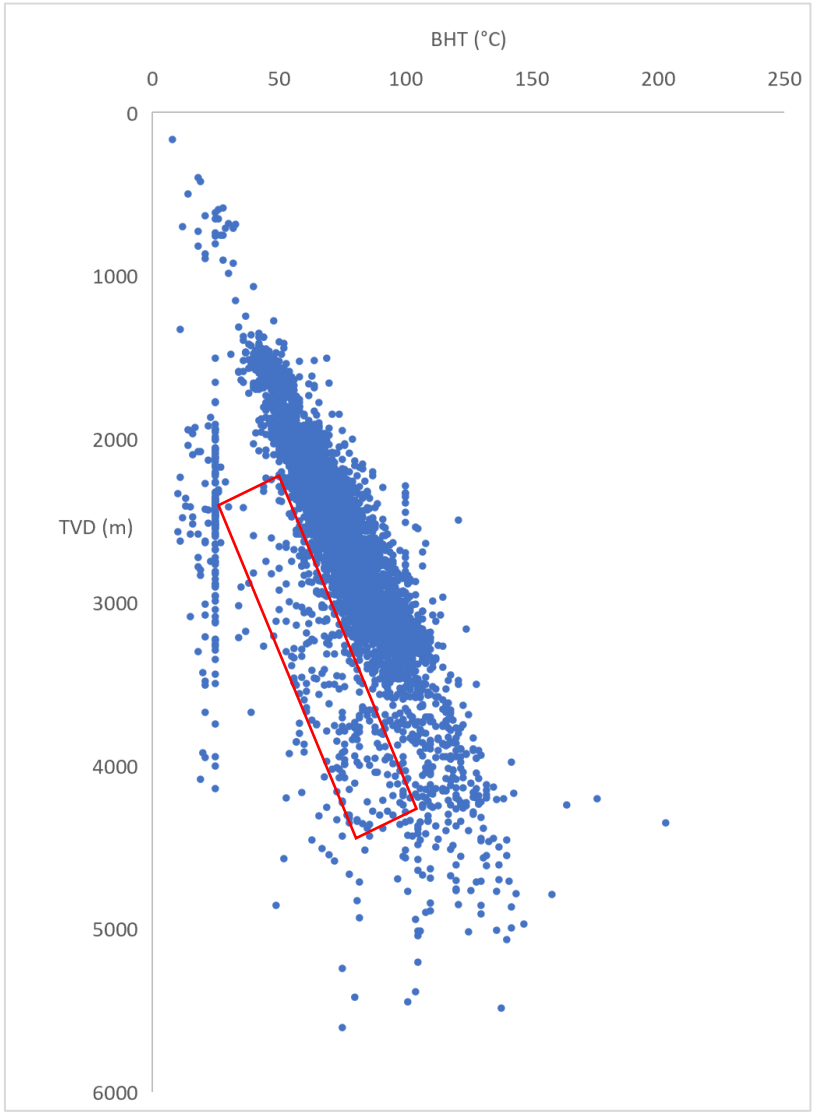

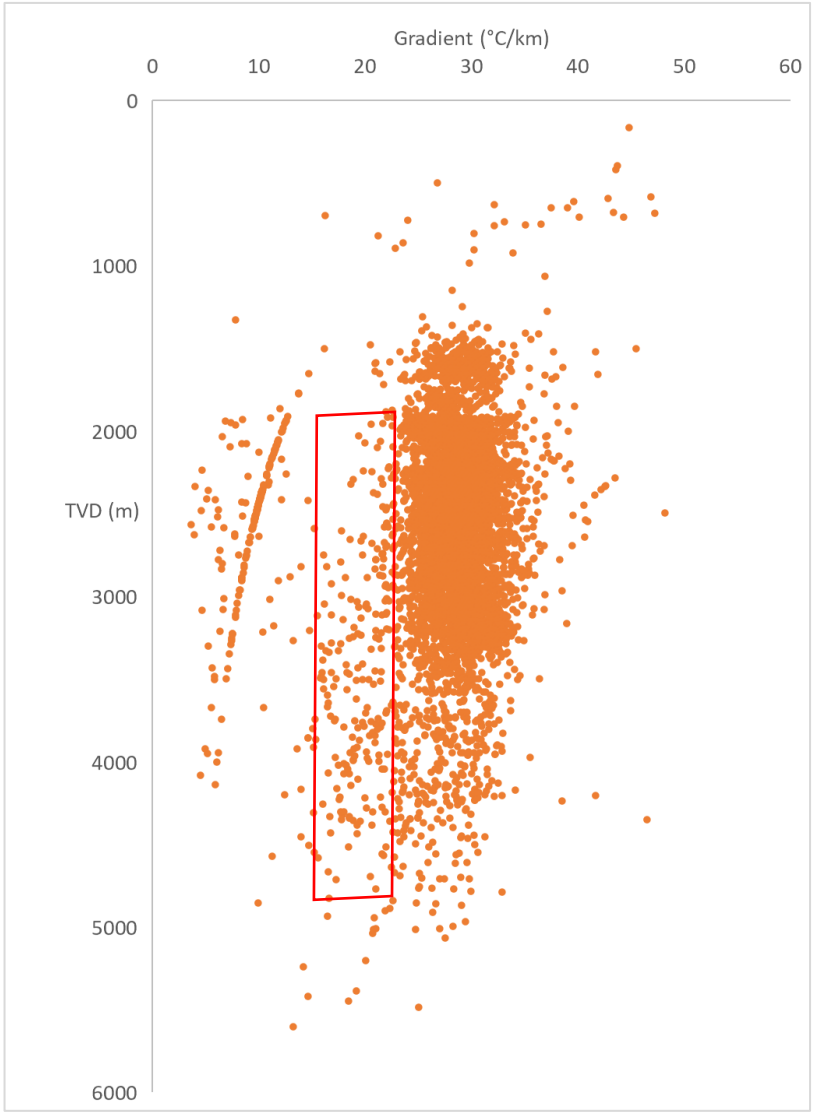

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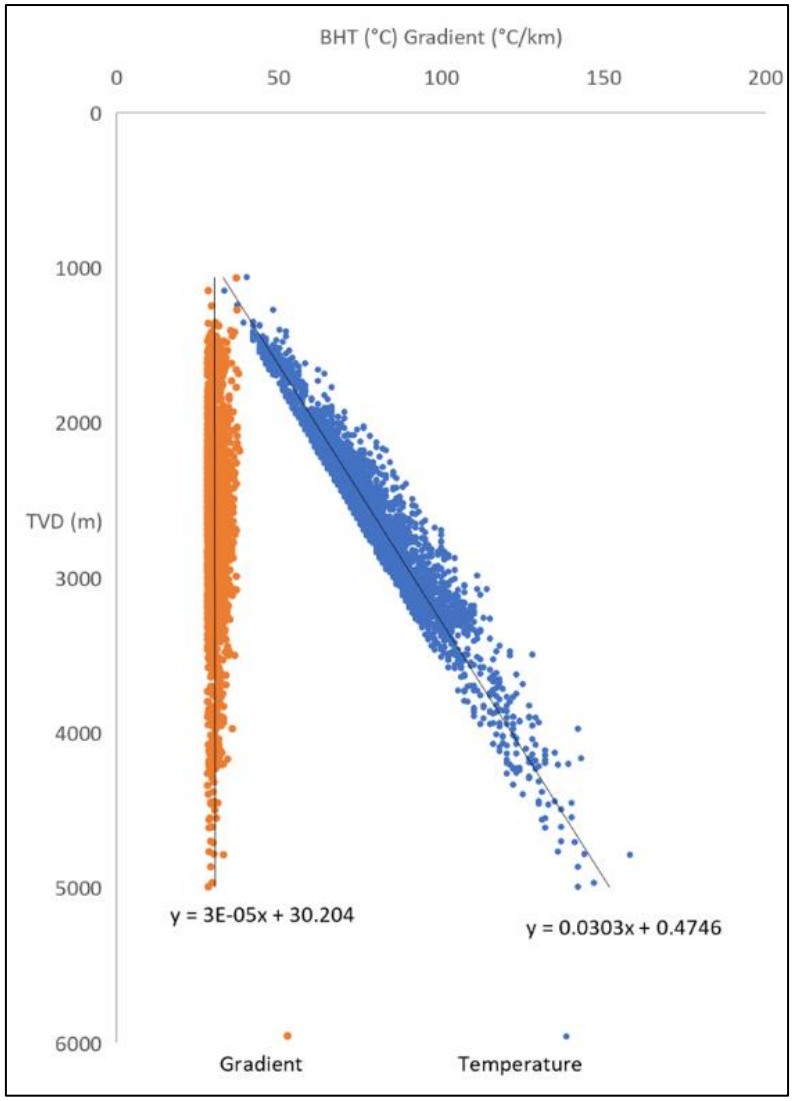
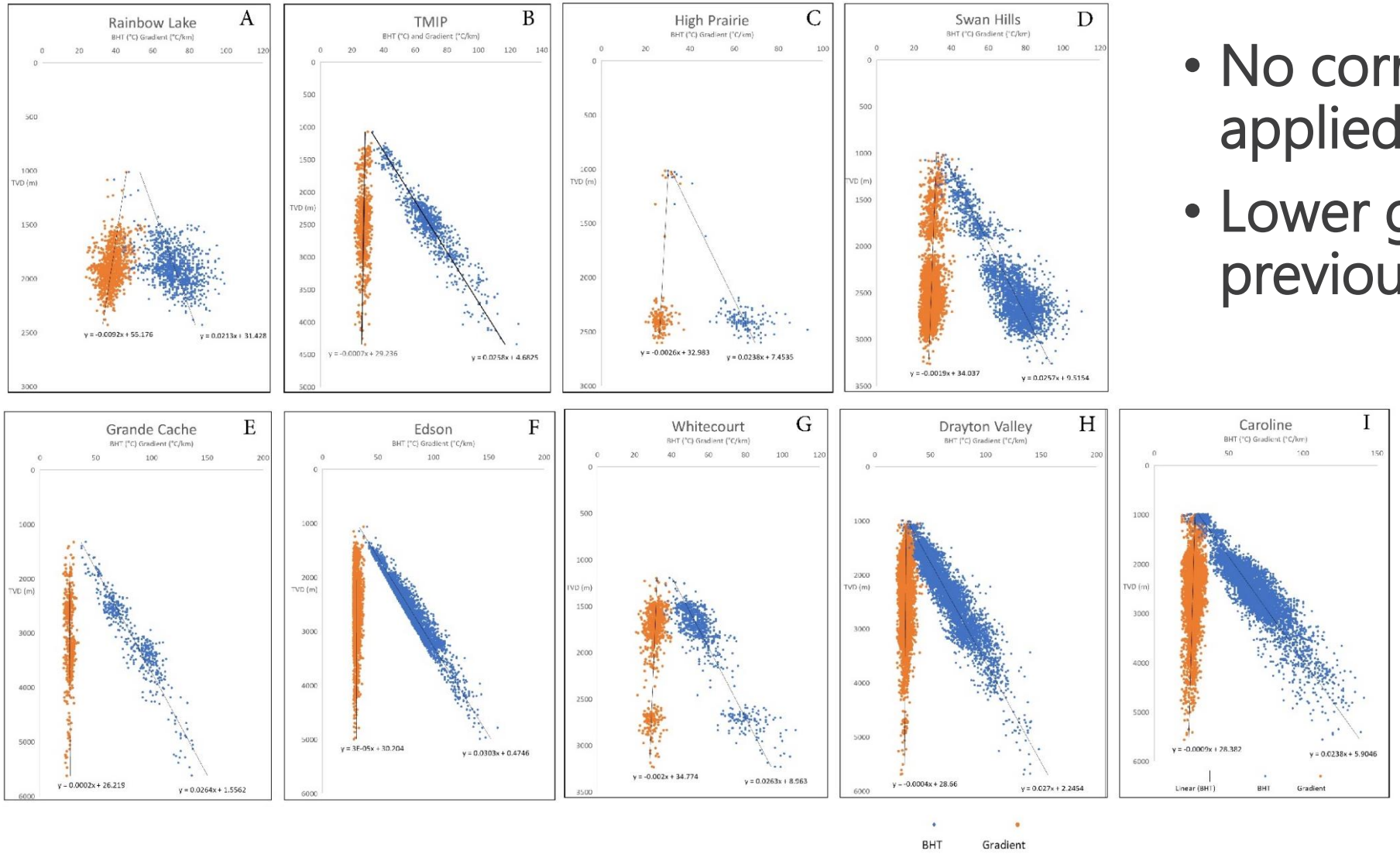


Temperature Gradients from BHT



- No correction method applied
- Lower gradients than previous research

Temperature Gradients from BHT

Study Area	Average Thermal Gradient	Average Gradient Change with Depth
Rainbow Lake	21.3°C/km	-9.2°C/km
Grande Prairie	25.8°C/km	-0.7°C/km
High Prairie	22.5°C/km	-4.6°C/km
Swan Hills	25.7°C/km	-1.9°C/km
Grande Cache	26.4°C/km	0.2°C/km
Edson	30.3°C/km	-0.0006°C/km
Whitecourt	26.3°C/km	-2.1°C/km
Drayton Valley	27.0°C/km	-0.4°C/km
Caroline	23.9°C/km	-1.2°C/km

Purpose for Assessing Corrections

- Corrections generally increase estimated formation temperature
- Estimated formation temperature has implications for required flow rate to produce electricity

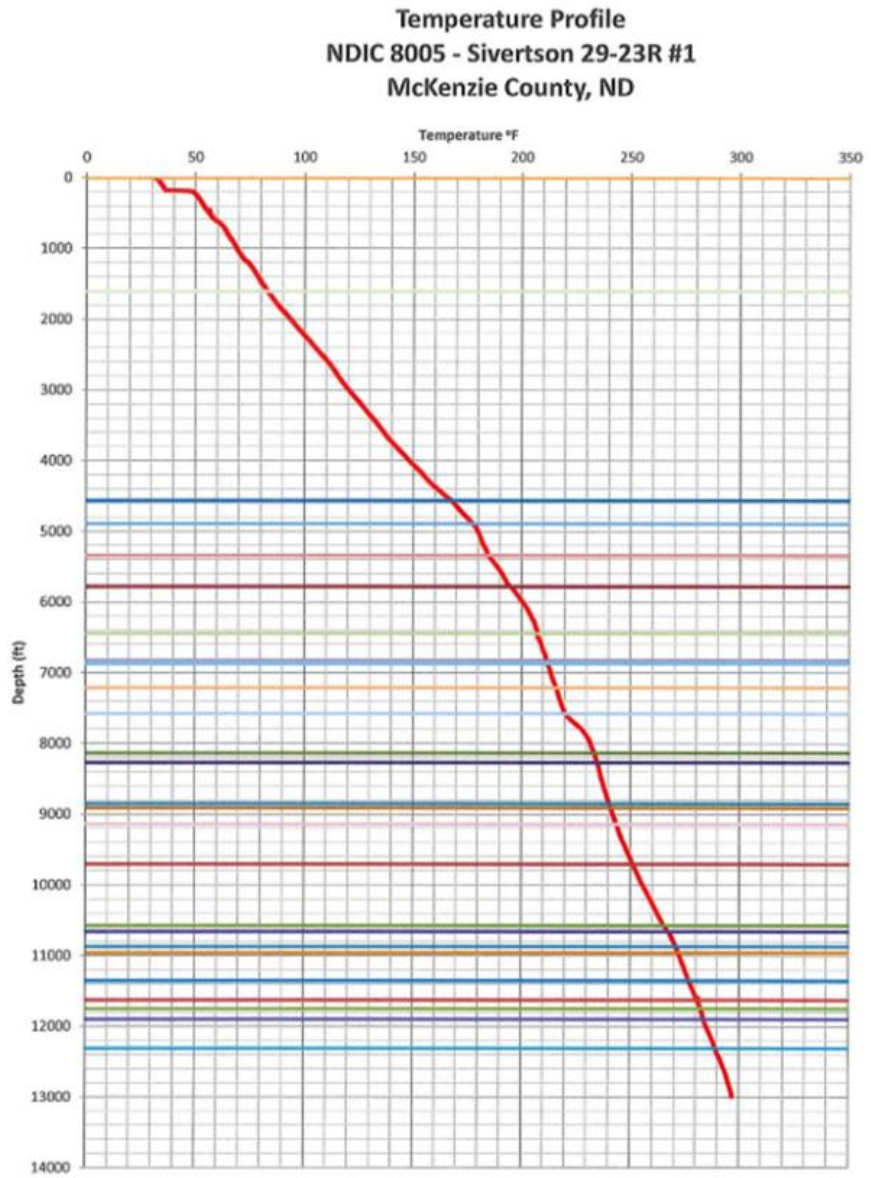
Temperature Corrections

Corrections:

- Horner, 1951
- Harrison et al., 1983
- Kehle et al., 1970
- Förster et al., 1996

Interpretations

- Stutz et al., 2012
- Weides et al., 2014a; 2014b
- Grasby et al., 2012



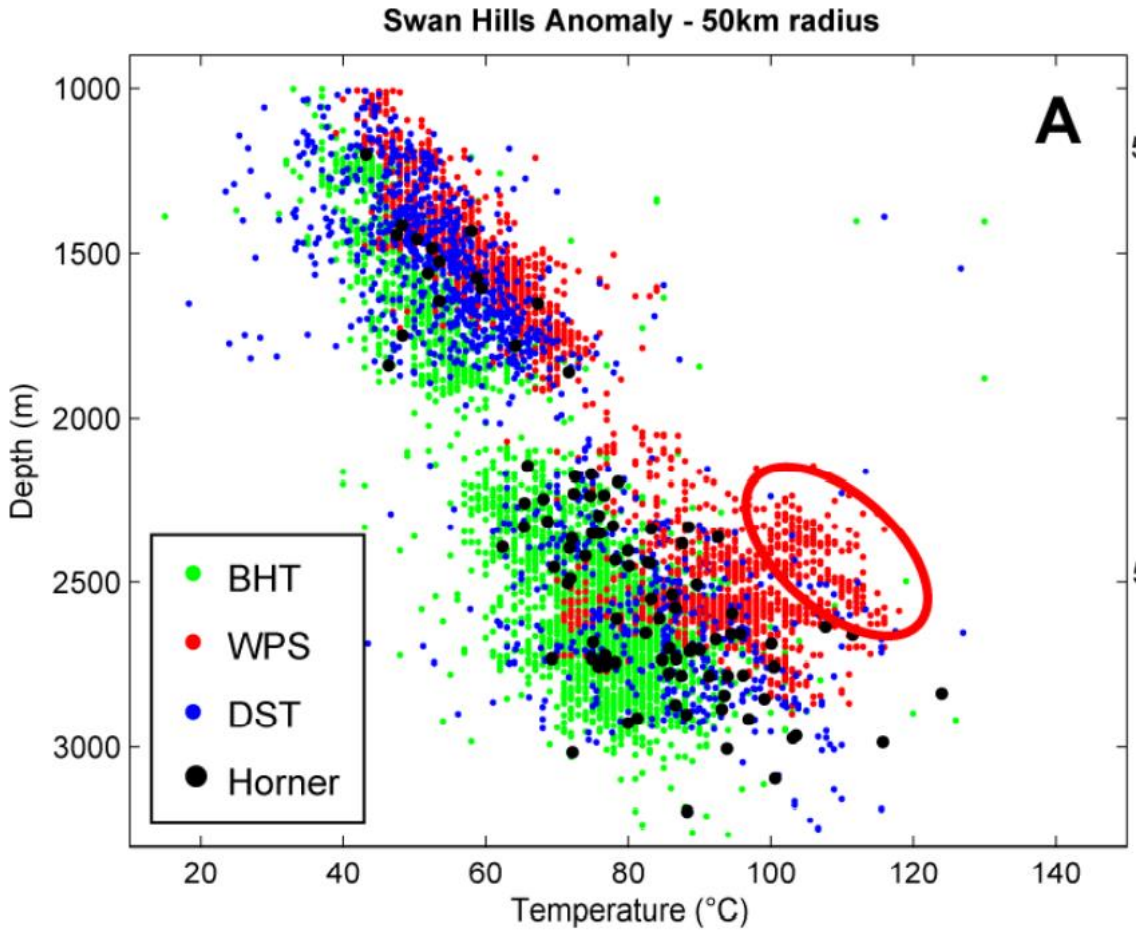
McDonald, 2015

Discussion

- Can BHT data be more reliable than previously thought?
- Circulation during drilling lasts for short period of time at bottom of well
- Circulation after TD is reached continues to retrieve cuttings
- Drilling fluid circulation time varies between well

Discussion

- Linear gradient fits most data well
- BHT data may provide lower temperature estimates
- Actual formation temperatures may be higher or lower
- Gradients are relative



Nieuwenhuis et al., 2015

Next Steps

- More detailed analysis within each area
  - Outliers
  - DSTs and AOPT
  - Structure
  - Gamma logs with temperature
- Wellhead temperature measurements

Conclusions

- Horner and Harrison corrections were not used for these data sets
- BHT data have inaccuracies but may be used to find relative gradient
- Gradients from this study are lower than previous heat flow/gradient studies which use corrections
- Formation temperatures not confirmed until geothermal well is drilled

Questions?

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