GTX Geothermal Datathon 2021

Team Name: GeoStars

Team Members:

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Project Overview

Quantitative

Problems

Underestimation

Limited True temperature measurements

Approaches

ML model for True Temperature Predictions

DST data and well log information

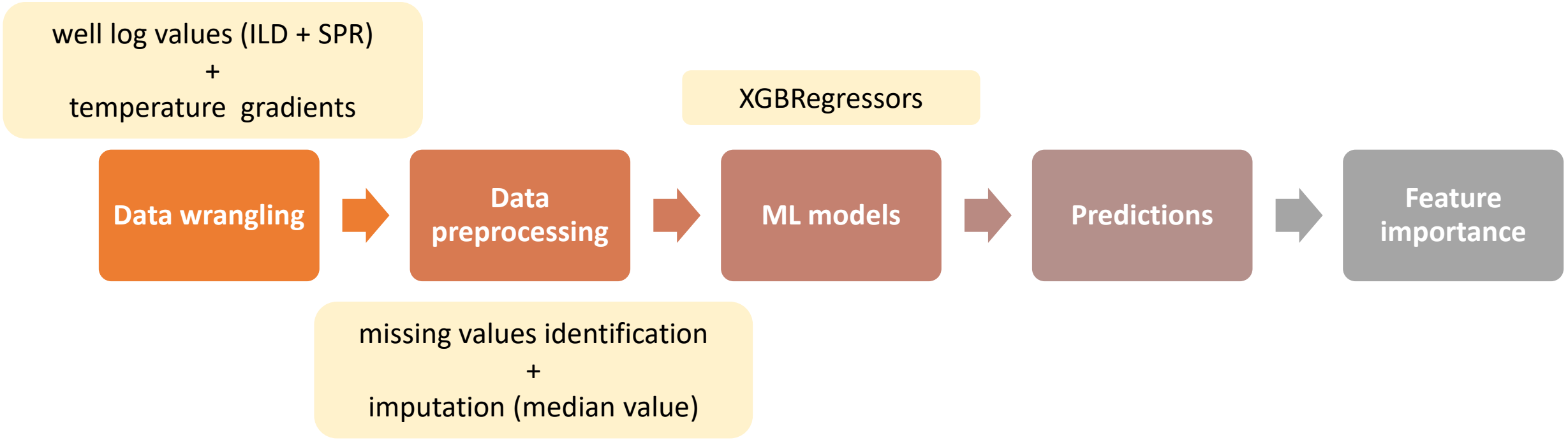
Qualitative

Estimate geothermal potential

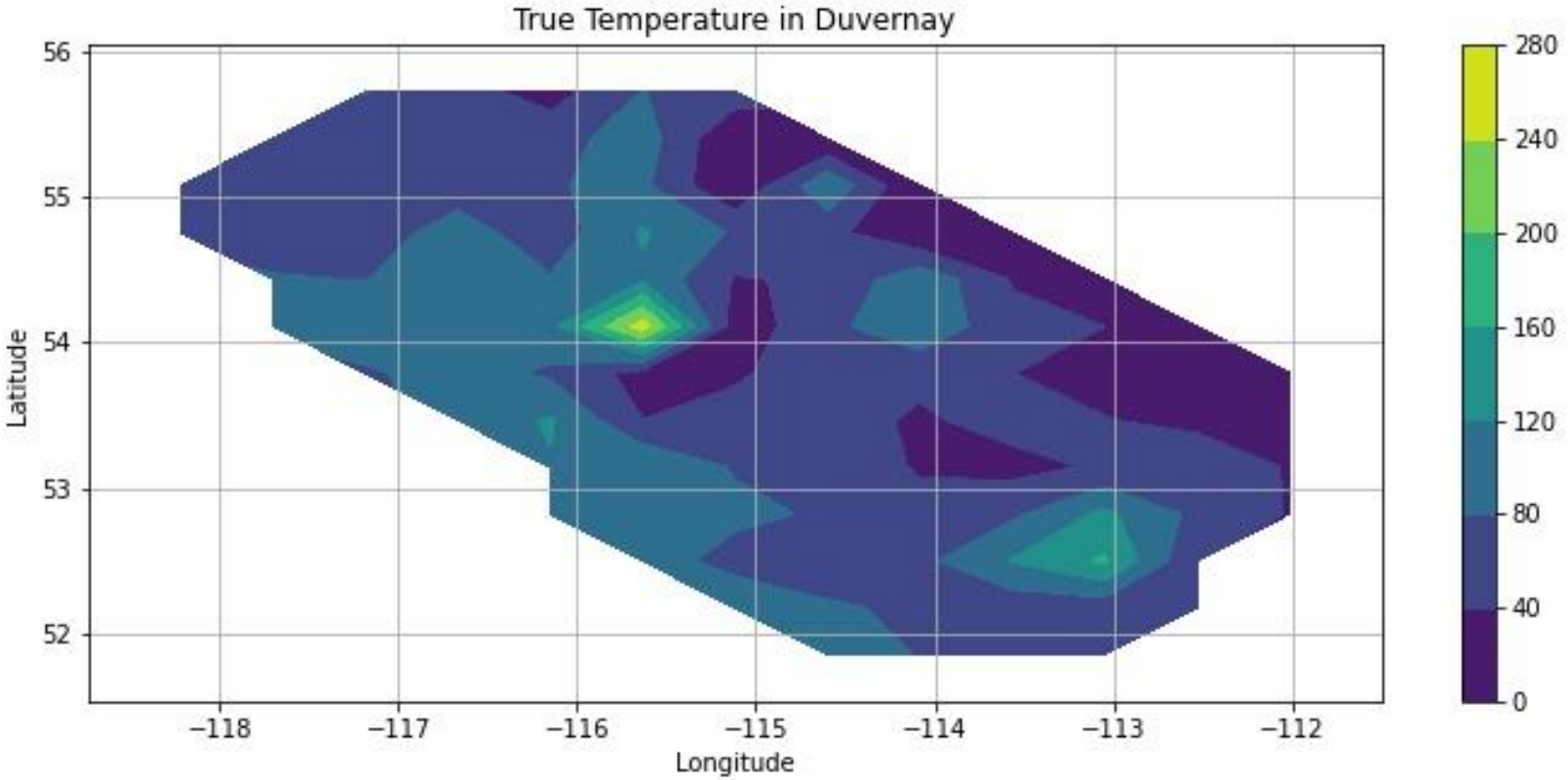
Identify high permeability/productive areas

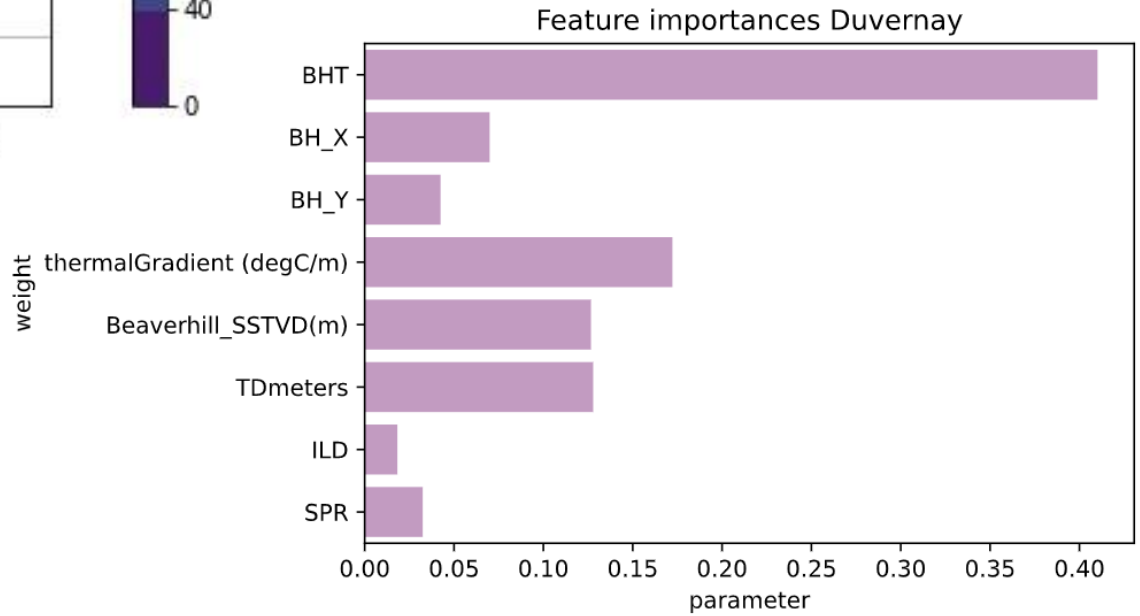
Simplified economic evaluation

Machine Learning Model

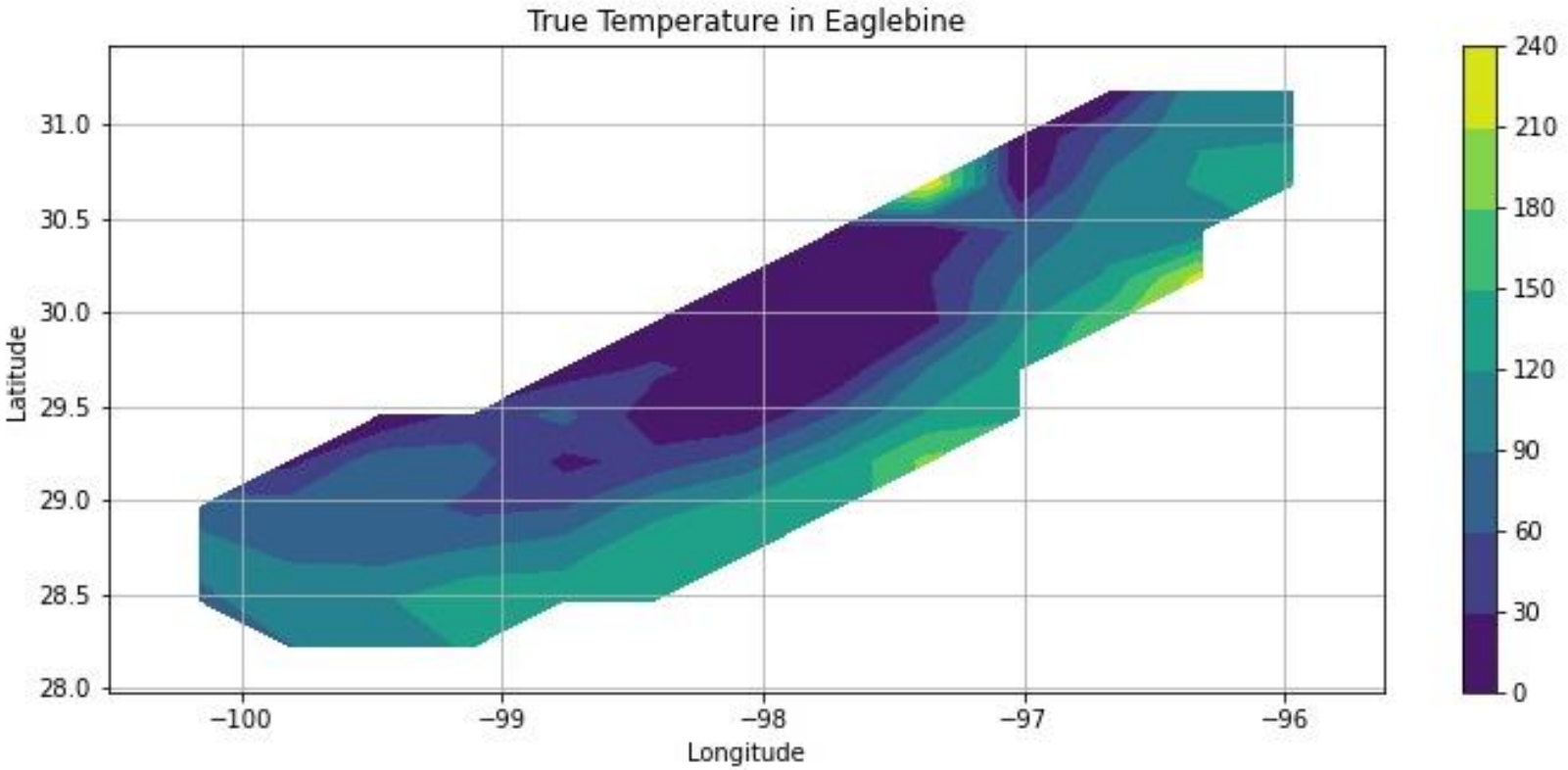


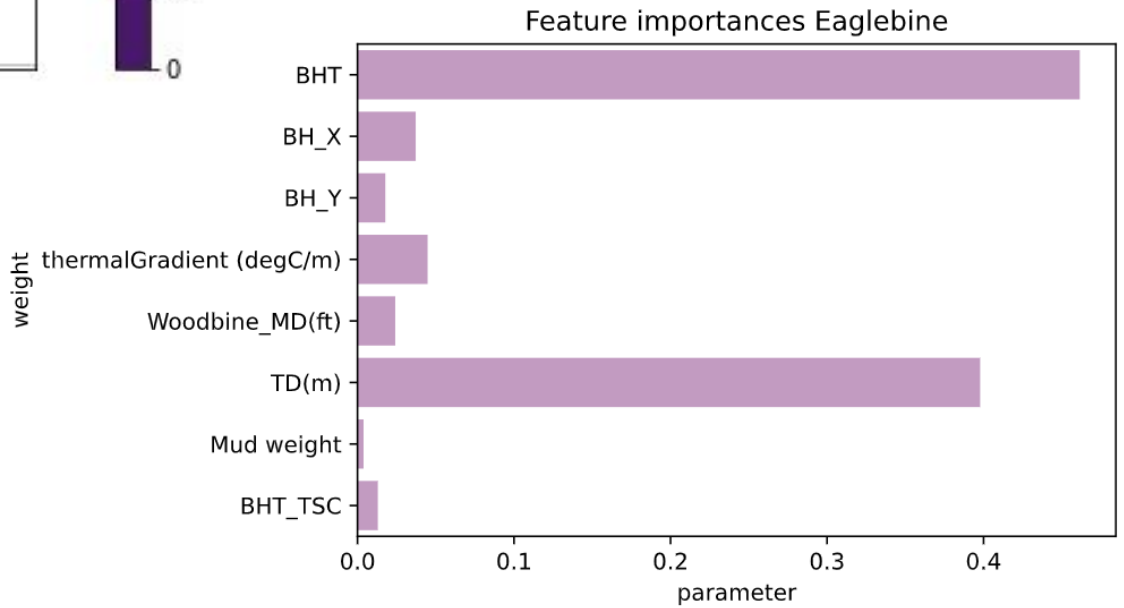
Predictions & Feature Importance – Duvernay



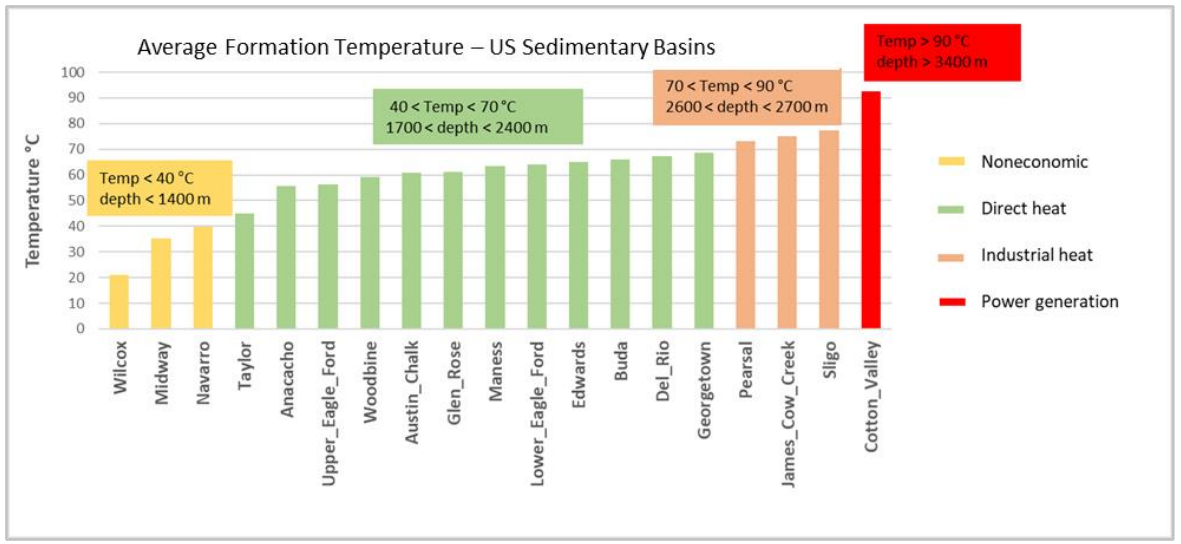


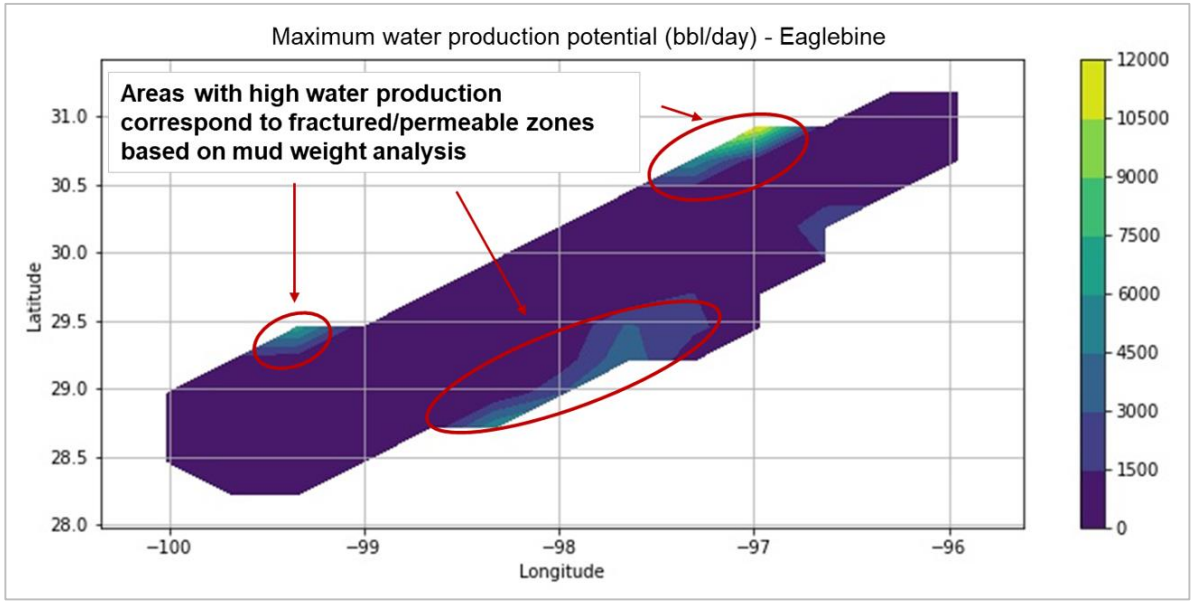
Predictions & Feature Importance – Eaglebine

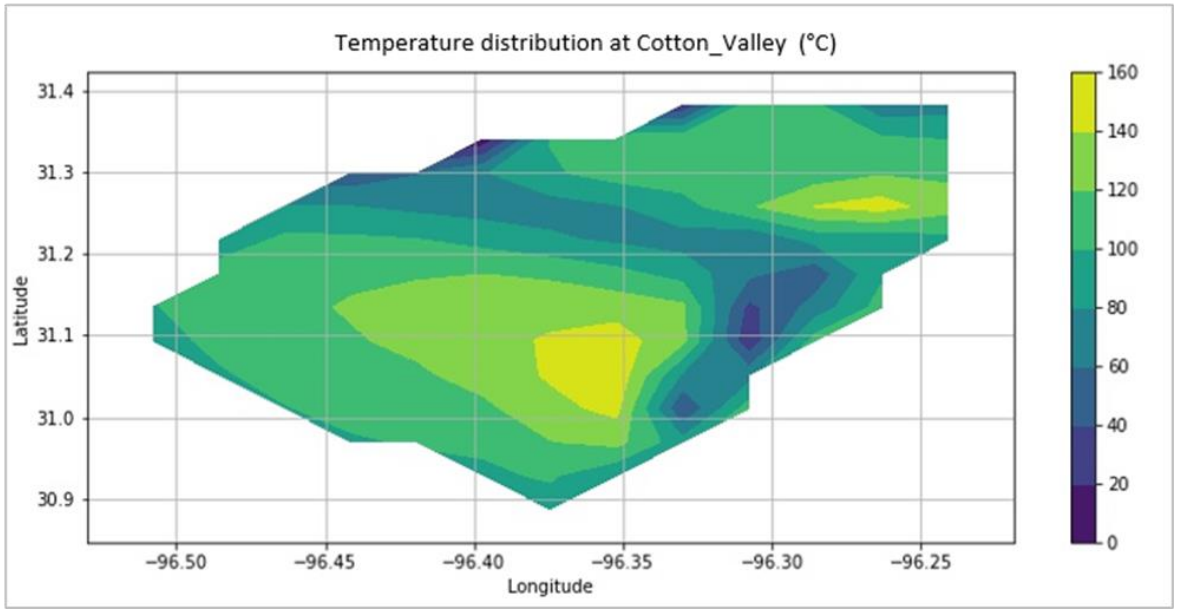


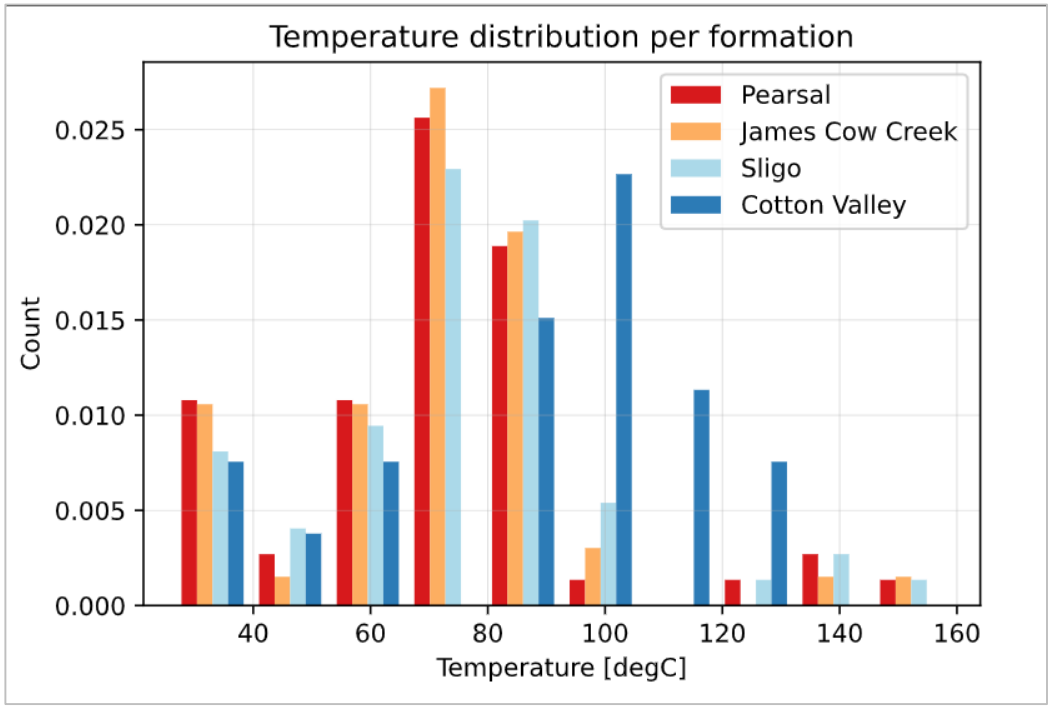


Eaglebine

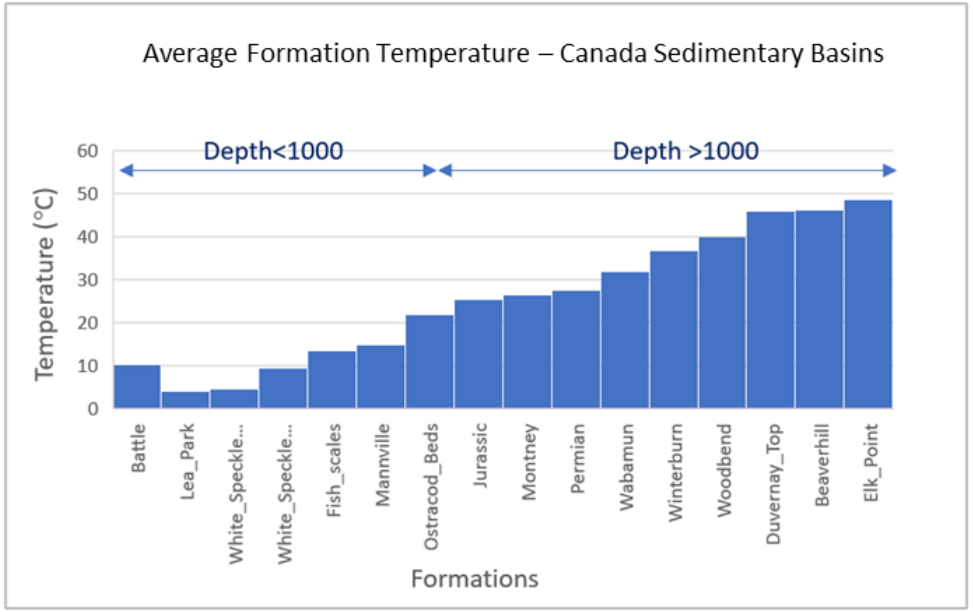

Average Formation Temperature – US Sedimentary Basins
Temperature °C
Temp < 40 °C
depth < 1400 m
40 < Temp < 70 °C
1700 < depth < 2400 m
70 < Temp < 90 °C
2600 < depth < 2700 m
Temp > 90 °C
depth > 3400 m
Noneconomic
Direct heat
Industrial heat
Power generation
Wilcox
Midway
Navarro
Taylor
Anacacho
Upper_Eagle_Ford
Woodbine
Austin_Chalk
Glen_Rose
Maness
Lower_Eagle_Ford
Edwards
Buda
Del_Rio
Georgetown
Pearsal
James_Cow_Creek
Sligo
Cotton_Valley

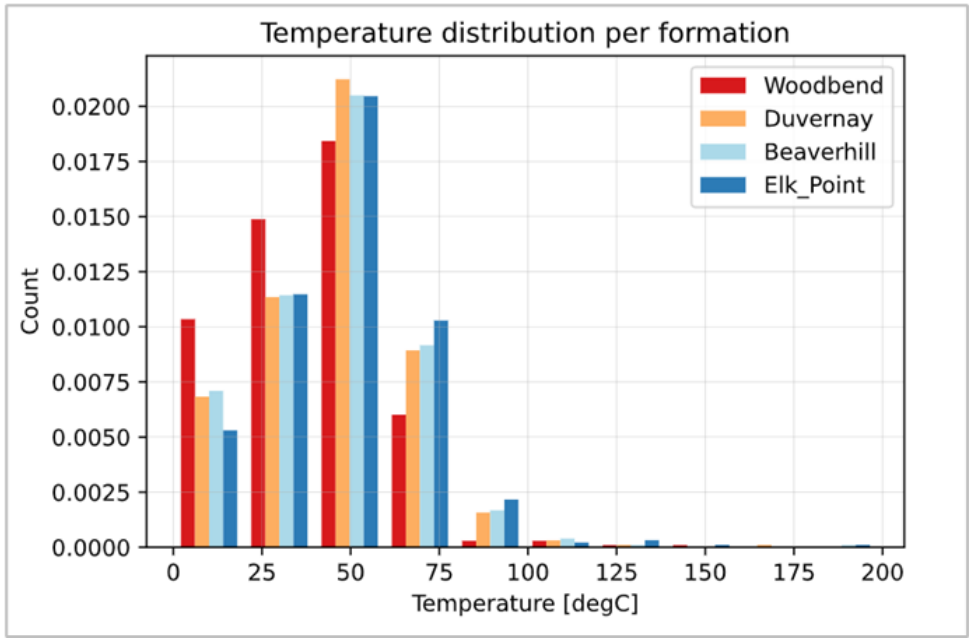

Maximum water production potential (bbl/day) - Eaglebine
Areas with high water production correspond to fractured/permeable zones based on mud weight analysis
Latitude
Longitude

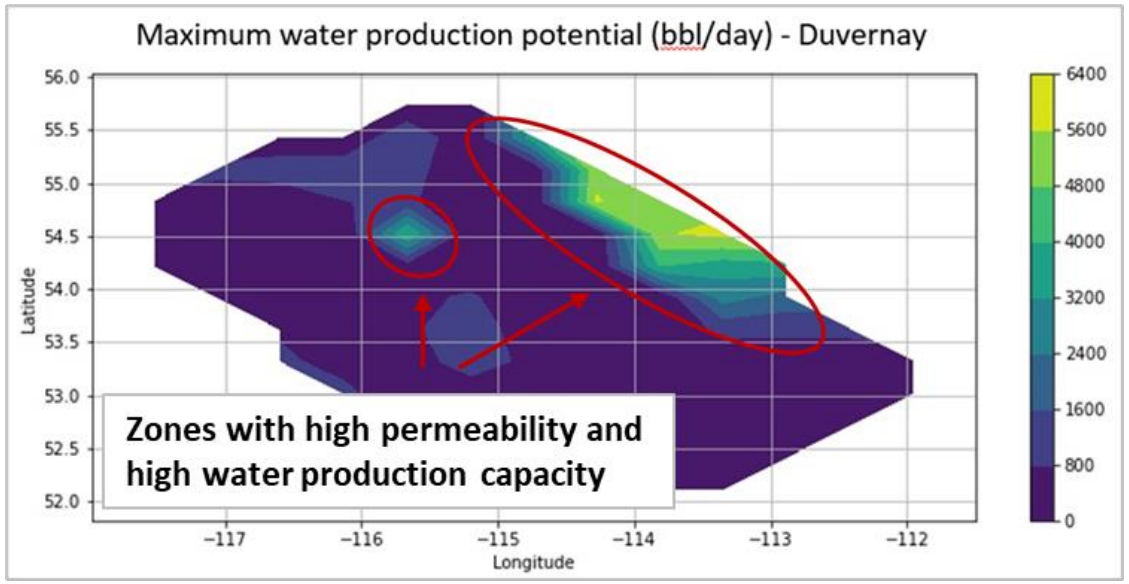

Temperature distribution at Cotton_Valley (°C)
Latitude
Longitude


Temperature distribution per formation
Pearsal
James Cow Creek
Sligo
Cotton Valley
Count
Temperature [degC]

Duvernay


Average Formation Temperature – Canada Sedimentary Basins
Depth<1000
Depth >1000
Temperature (°C)
60
50
40
30
20
10
0
Battle
Lea_Park
White_Speckle...
White_Speckle...
Fish_scales
Mannville
Ostracod_Beds
Jurassic
Montney
Permian
Wabamun
Winterburn
Woodbend
Duvernay_Top
Beaverhill
Elk_Point
Formations


Temperature distribution per formation
Woodbend
Duvernay
Beaverhill
Elk_Point
Count
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0
25
50
75
100
125
150
175
200
Temperature [degC]


Maximum water production potential (bbl/day) - Duvernay
Zones with high permeability and high water production capacity
Latitude
56.0
55.5
55.0
54.5
54.0
53.5
53.0
52.5
52.0
−117
−116
−115
−114
−113
−112
Longitude
6400
5600
4800
4000
3200
2400
1600
800
0

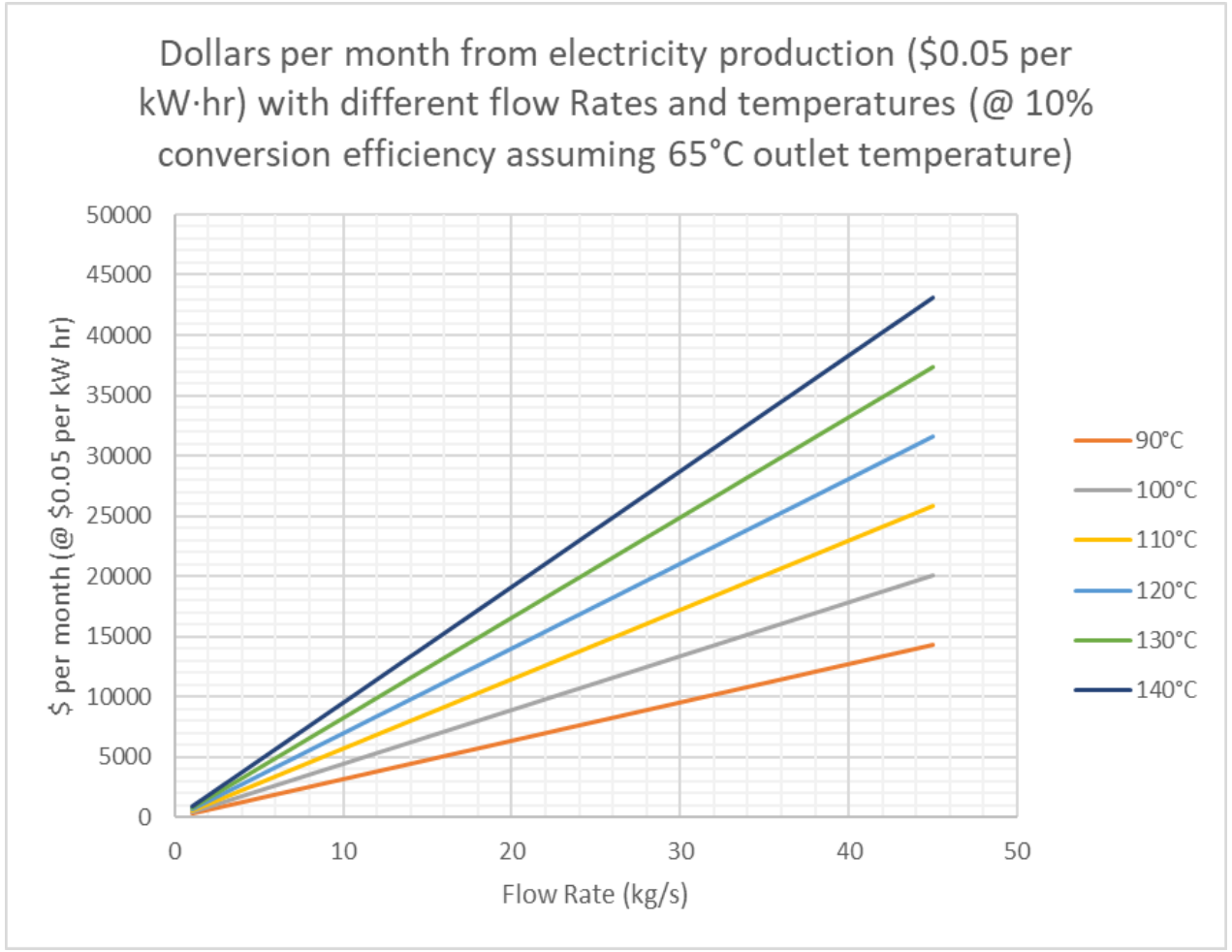
Geothermal Economics

Energetic productivity

Energy produced = Heat Capacity x Flow Rate x Temperature Change x Conversion Efficiency

Economic Factors

- **Flow rate**
- **Temperature**
- Surface infrastructure
- Pump and heat exchanger maintenance
- Well integrity (age)
- Purpose

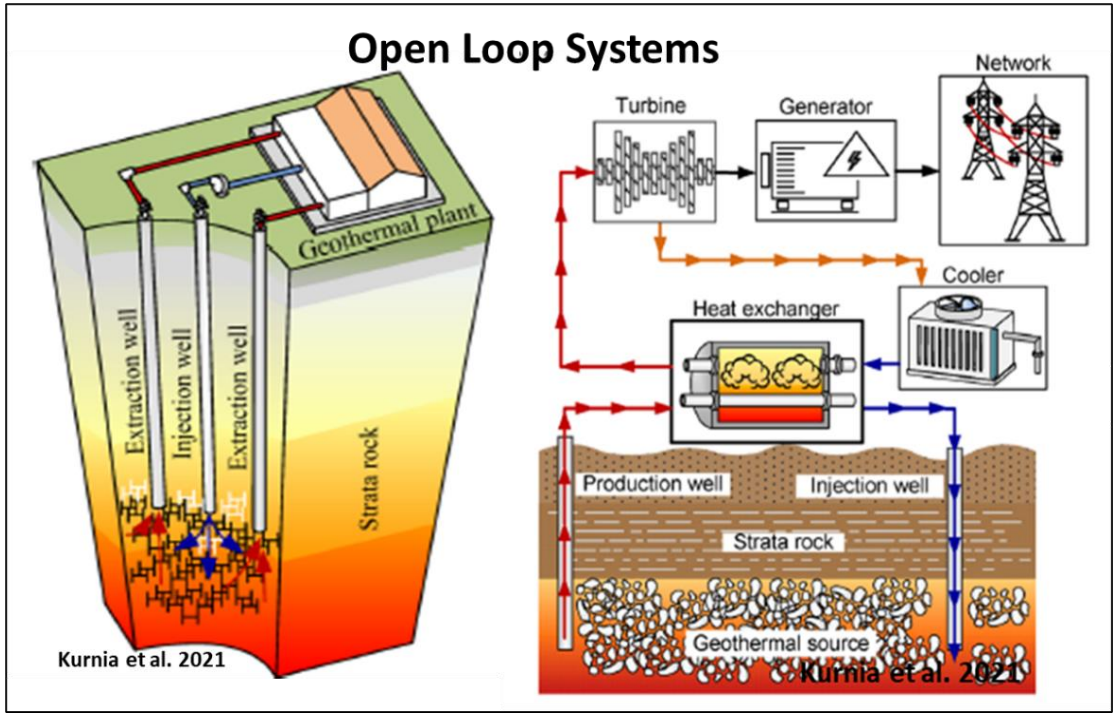


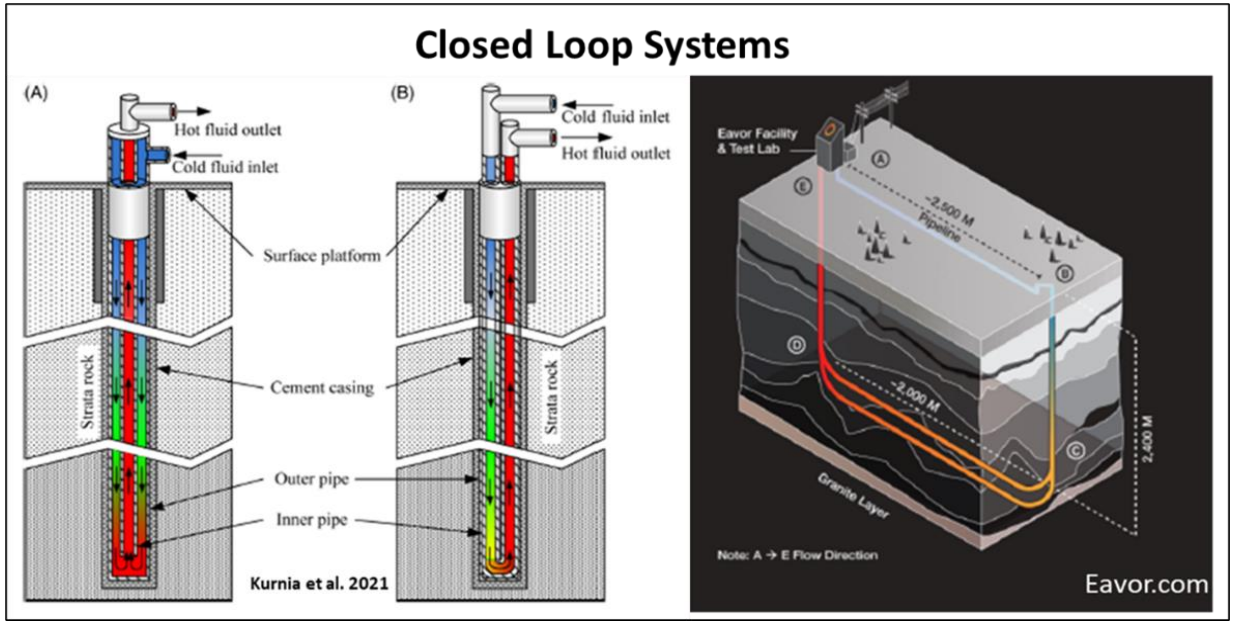
Technology

Perceived Value

utilization of hot, currently producing wells with high water cuts for combined heat, power, and oil production

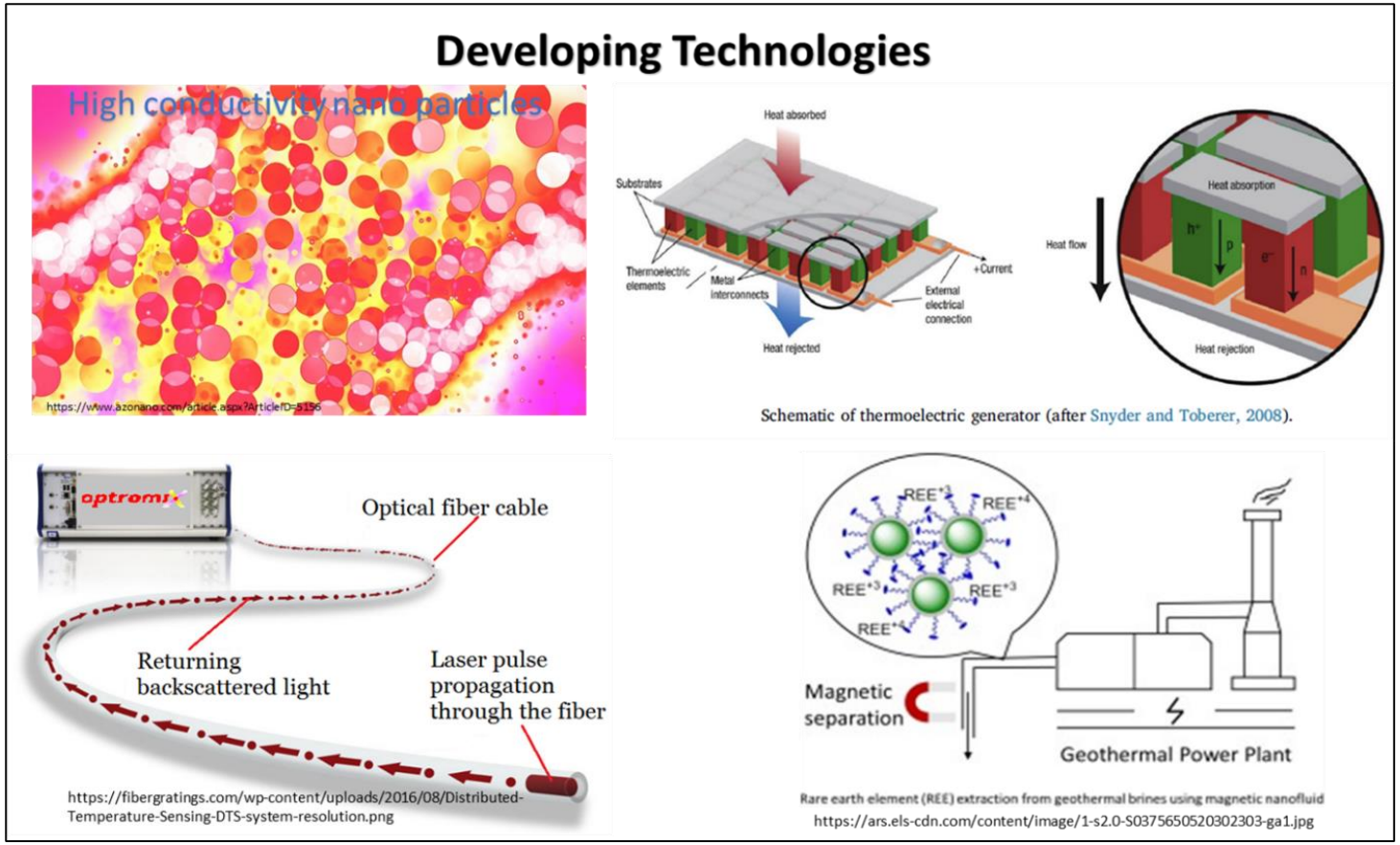
- Longer lifespan of producing wells
- Low carbon energy
- Future operations can consider two resources
- Heat and power can be used locally to reduce carbon intensity of oil and gas operations
- Initiates geothermal operations in prospective area
- Abundant wells for reinjection or monitoring





Future Development

- Fluid engineering for binary systems
- Nano particles in closed loop fluids
- Thermoelectric generators (near 100% efficiency)
- Element extraction from brine (not just lithium)
- Real time monitoring using DAS fiber optics
- Accurate BHT temperature method



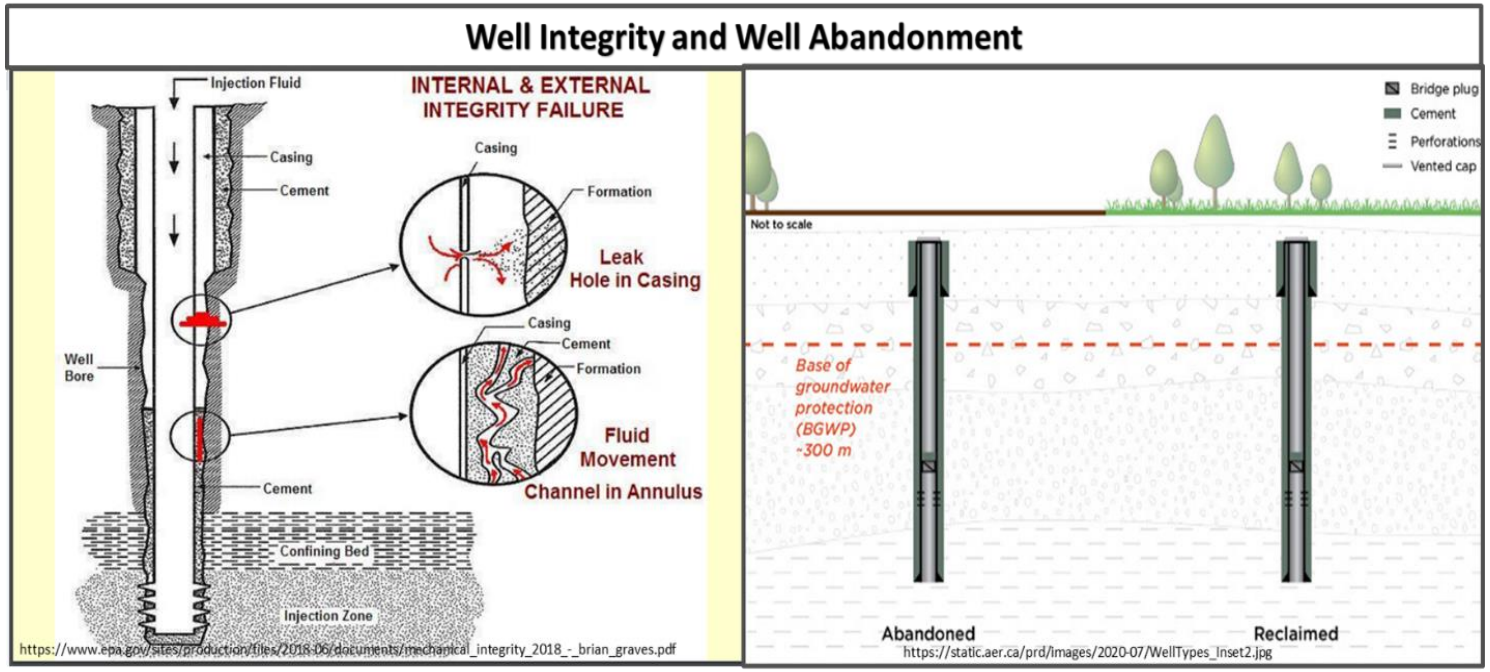
Using existing/developed wells and basins

Advantages

- Subsurface disturbance already exists
- Data is abundant
- Infrastructure of some sort already exists
- Opportunity to reassess safety of suspended and abandoned wells
- Abundant wells for various purposes

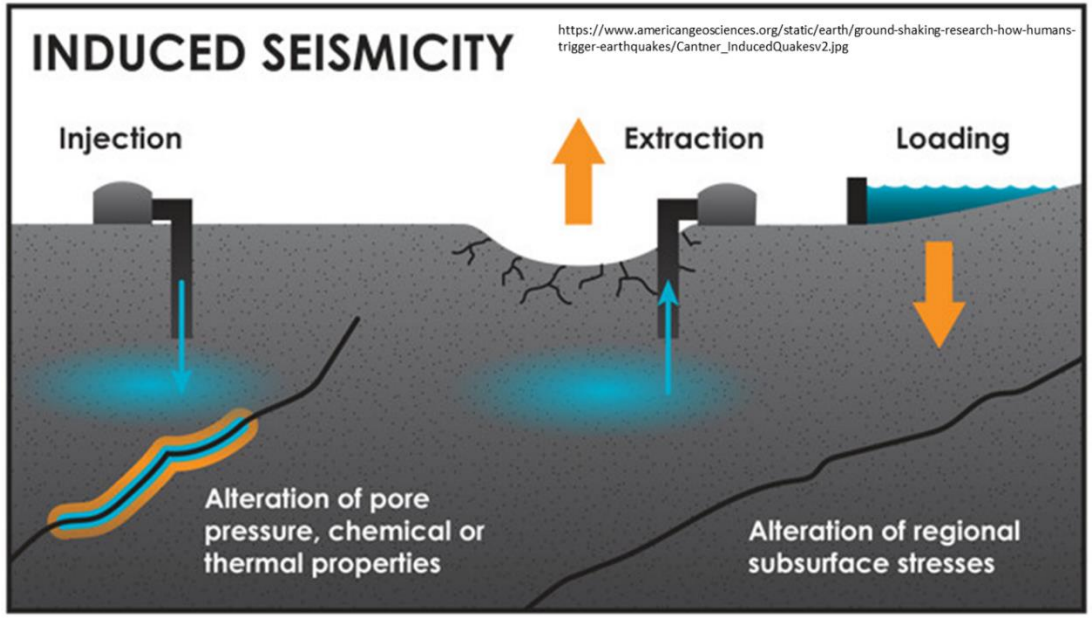
Problems

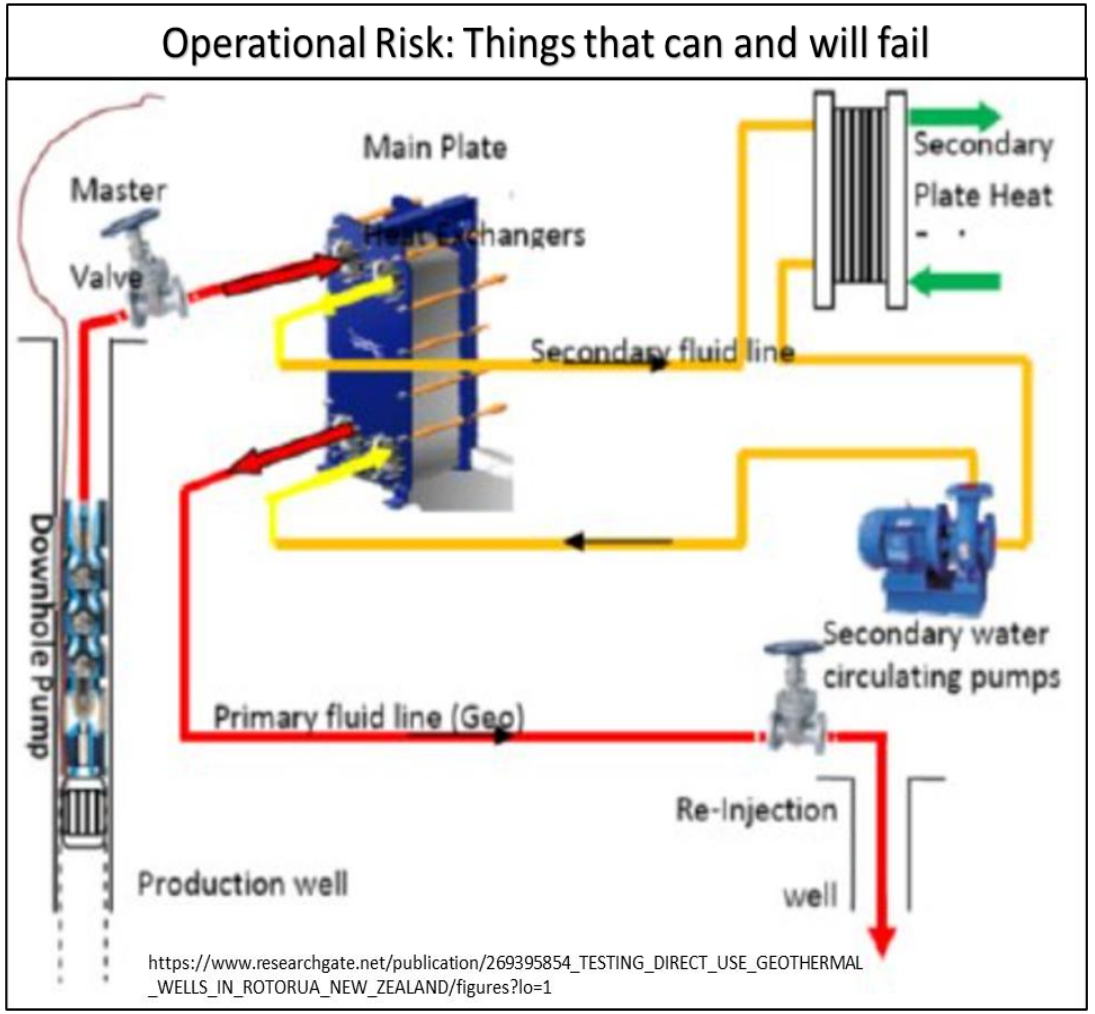
- Well integrity
- Abandonment costs
- Pressure issues
- Environmental responsibility
- Long payback times
- Casing size and flow rates



Operational Risks

- Pump failure
- Formation damage
- Heat exchanger scaling
- Well integrity
- Induced seismicity





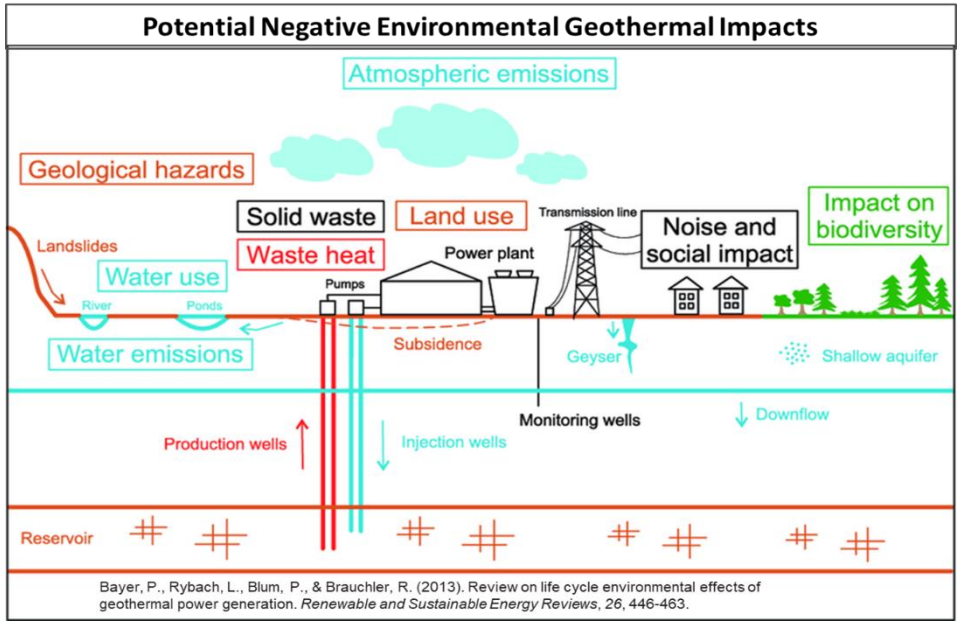
Environmental Impacts

Negative

- Well casing failure/well integrity (older is typically worse)
- Induced seismicity and formation fracturing
- Re-disturbing surface
- Brine spills
- Large withdrawal of geothermal fluids
- Waste production and disposal
- Noise
- Impact on sensitive living organisms
- Released gases

Positive

- Non carbon intensive electrical energy
- Low emission base load power
- Low impact and low cost thermal energy
- Re assessment of old wells in previously developed basins
- Drive for reworking poorly abandoned wells
- Monitoring of heavily drilled “mature” oil and gas basins



Barriers And Opportunities

- Oil and gas companies see a challenging regulatory, operational and financial situation in geothermal
  - Needs to be changed with regulations and incentives
- Commercial viability
  - Needs to be demonstrated and incentivized
- Societal and financial recognition of baseload power
  - Needs societal baseload power understanding
  - Needs appropriate baseload power regulation and valuation
- Recognition of emissions from current baseload power production
  - Geothermal impact on emissions needs to be quantified and shared

- Consistent long term plan for carbon tax, carbon credits, or carbon trading
  - Increase value and create a potential carbon economy
- Long term energy policy with substantial incentives
  - Derisk and provide value
- Effectively regulate and recognize heat as a resource
- Exploration/Research & development government tax breaks
- Faster and more consistent geothermal permits and exploration licenses
- Drilling insurance for failed wells

Thank you!