Geothermal Energy in Alberta – Finding and Unlocking a Resource

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Summary

This presentation is focused on articulating the most scientficially viable geothermal resources in Alberta in addition to the economic and regulatory pathway required to unlock this resource.

The geothermal industry in Alberta is in it's formative stages with both signficant challenges and sizeable opportunities for development. A major challenge preventing the large scale development of this industry to date had been poor dentification of the optimal geothermal resources for exploitation. Unlike other forms of renewable energy such as wind or solar power, goethermal energy exploration and development has significant challenges simply in finding and validating a quality geothermal resource. Previous efforts to estimate geothermal potential in Alberta focused on estimated geothermal gradients and lacked the technical specificity that a commercially viable project could be initiated from.

The recent "Deep Dive Analysis of the Best Geothermal Reservoirs for Commercial Development in Alberta" project was completed by Dr. Jonathan Banks. This project focused on identifying the highest potential aquifers across four counties in west and northwest Alberta. Specific modelling was conducted to identify the depth to formation top, formation top topography, calculation of the predicted reservoir volumes & resevoir power production potential as well as 3-D fence stratigraphy modelling.

This preliminary scientific analysis was furthered by Terrapin Geothermics, an early stage project developer and technology firm. The focus of Terrapin's work was to create a sensitivity analysis that showcases project viability across a range of input costs, policy incentives and pricing scenarios.

Method

With existing geothermal gradient information indicating that the west and northwest sections of Alberta presented the most viable geothermal resources, this project started with these regions for further analysis. The deep dive analysis focused on the counties of Yellowhead, Greenview, Grand Prairie and Clearwater. Existing well information from GeoScout provided primary data on general temperatures at various depths in these counties. This well information was used to identify hot spots of potential geothermal resources at which point 3-D fence stratigraphy was done to identify specific formation types and depths in 20-75 km radius circles around the estimated hot spots. This provided an understanding of the various formations within the mapped area with this information being used to create isopach maps focused on calculating the estimated depths to the top of the ideal geothermal reservoirs in the mapped region.

With the ideal reservoir depths and volumes in these four counties being understood, power potential models we're calculated to estimate the total recoverable power from each of the ideal reservoirs identified. This analysis was done by calculating:

- Total thermal content of the reservoir
- Recovery factor (0.1)
- Entropy losses
- Total usable thermal energy (Exergy; W_a)
- Thermal power potential over 30 - years
- Electrical utilization factor (0.08)
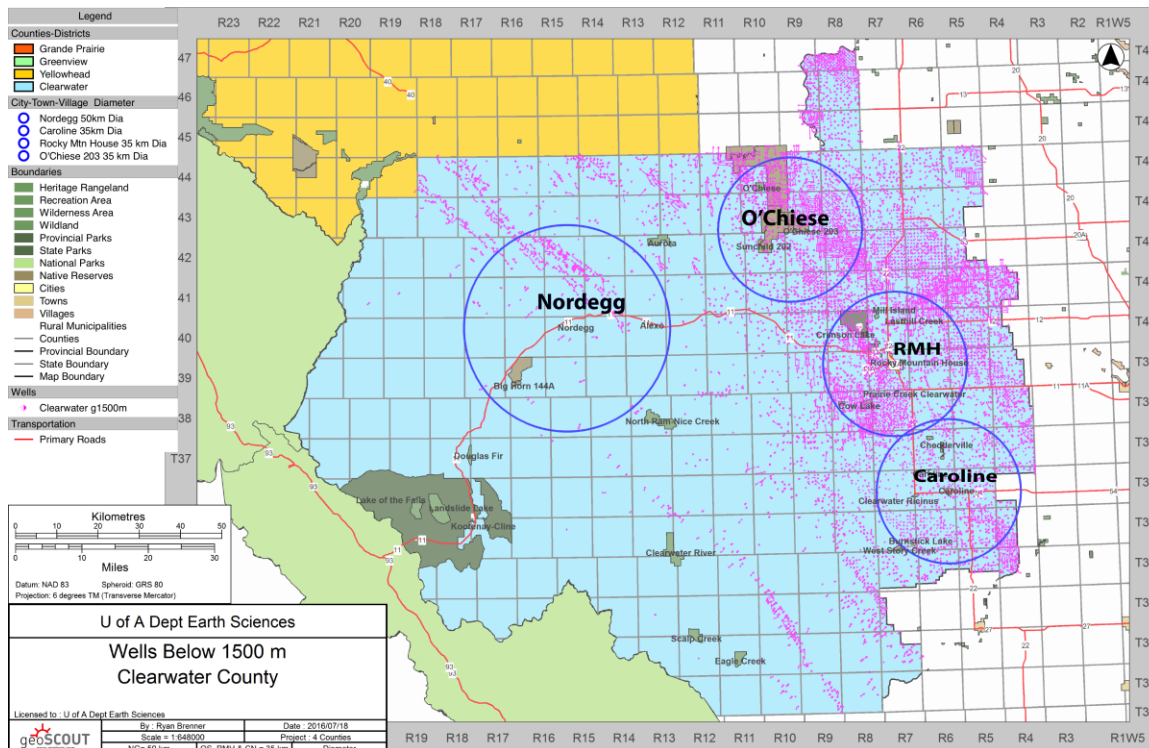- Electrical power potential over 30 – years

With high level power potential models complete, Terrapin was then able to input this information into a sensitiviy analysis that focused on the ranges of economic profitability based on variable inputs including:

- Drilling cost estimates
- Power plant construction and operation
- Land, grid connection and regulatory approval costs
- Minimum viable power offtake pricing for economic viability at various input costs
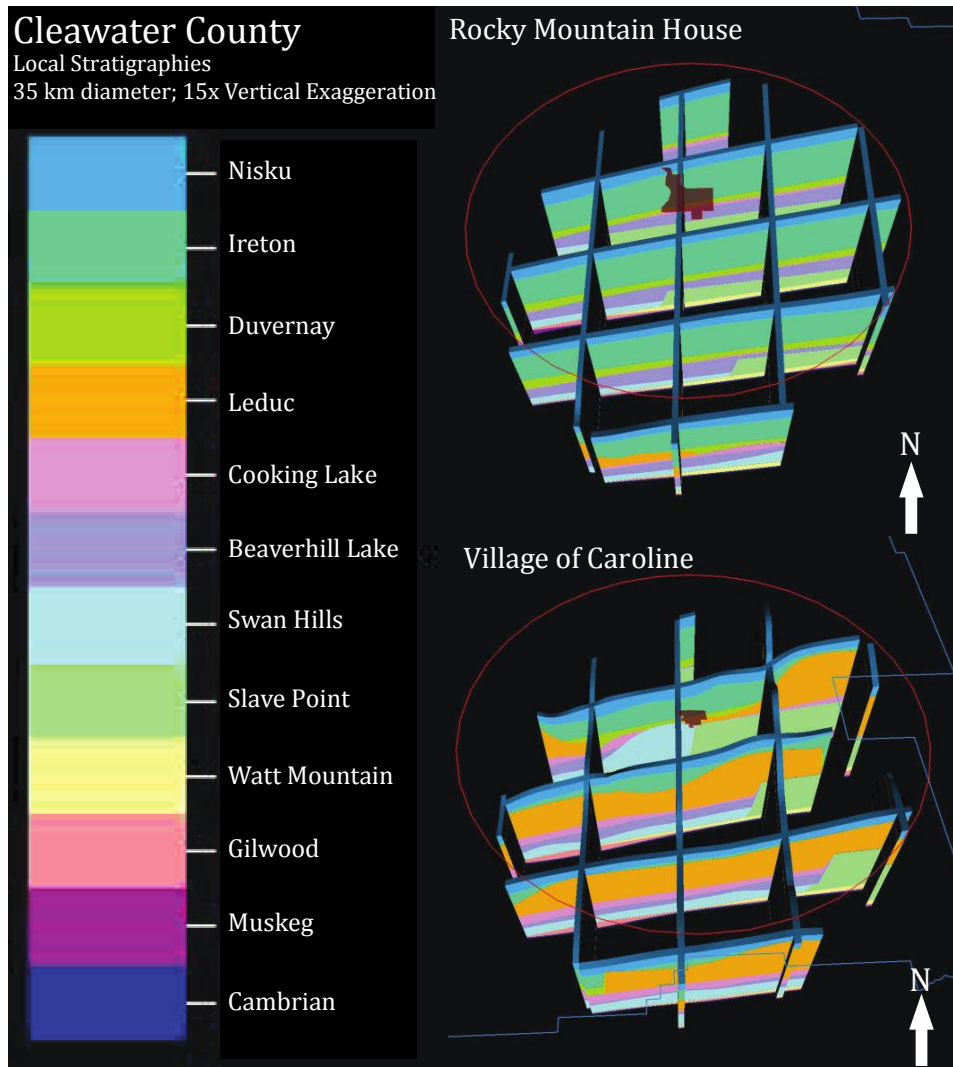
Examples

A walkthrough of the data from Clearwater County will be presented below:

Initial mapping of wells below 1500 metres from GeoScout:

3-D Fence Stratigraphy of 35km radius around Rocky Mountain House and Caroline

Cleawater County
Local Stratigraphies
35 km diameter; 15x Vertical Exaggeration

Rocky Mountain House

Village of Caroline

- Nisku
- Ireton
- Duvernay
- Leduc
- Cooking Lake
- Beaverhill Lake
- Swan Hills
- Slave Point
- Watt Mountain
- Gilwood
- Muskeg
- Cambrian

Depths to Top of various formations within Clearwater County:

Formation	Depth to Top	Temperature	Porosity
Leduc	~2500 – 3000 m	109.58 ± 18.16˚ C	5.7 ± 3.4%
Swan Hills	~3300 - 3200 m	125.53 ± 35.34˚ C	5.6 ± 4.4%

Isopach Models:

Clearwater County
Swan Hills Depth to Top (m)

Clearwater County
Swan Hills Isopach (m)
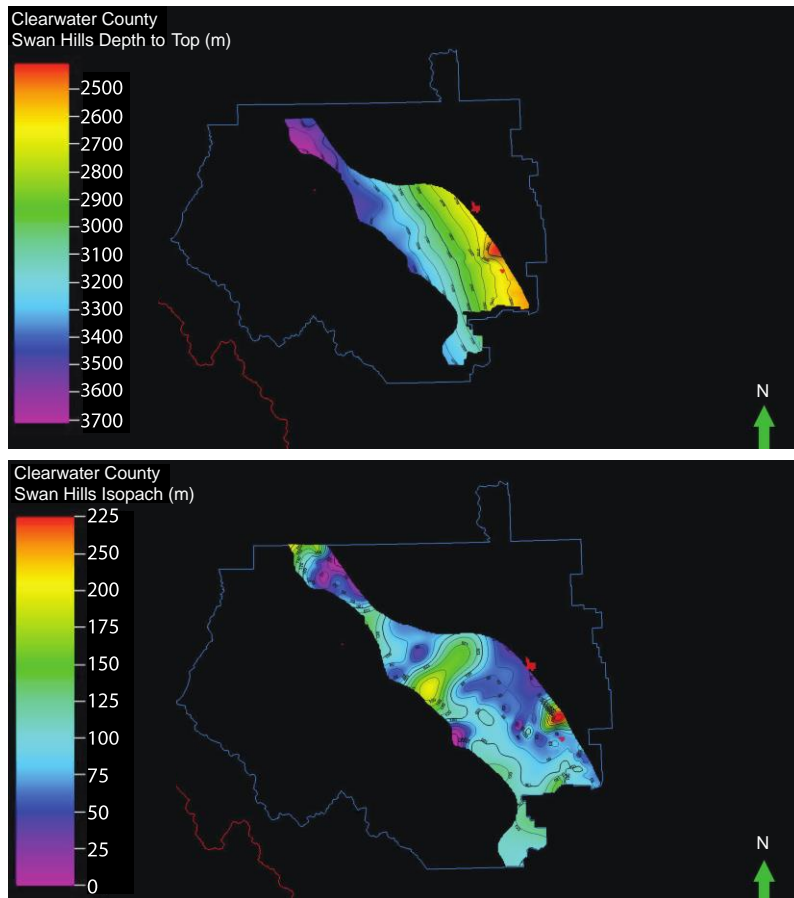
Conclusions

With a greater understanding of the technical location and availability of geothermal energy in these counties, a much clearer picture of the most viable geothermal development areas in Alberta is starting to emerge. With changes coming to the renewable energy auction program, the creation of a capacity market and increasing value of carbon offsets, we now understand the pricing inputs needed to create a market for long-term baseload geothermal power production in Alberta.

Acknowledgements