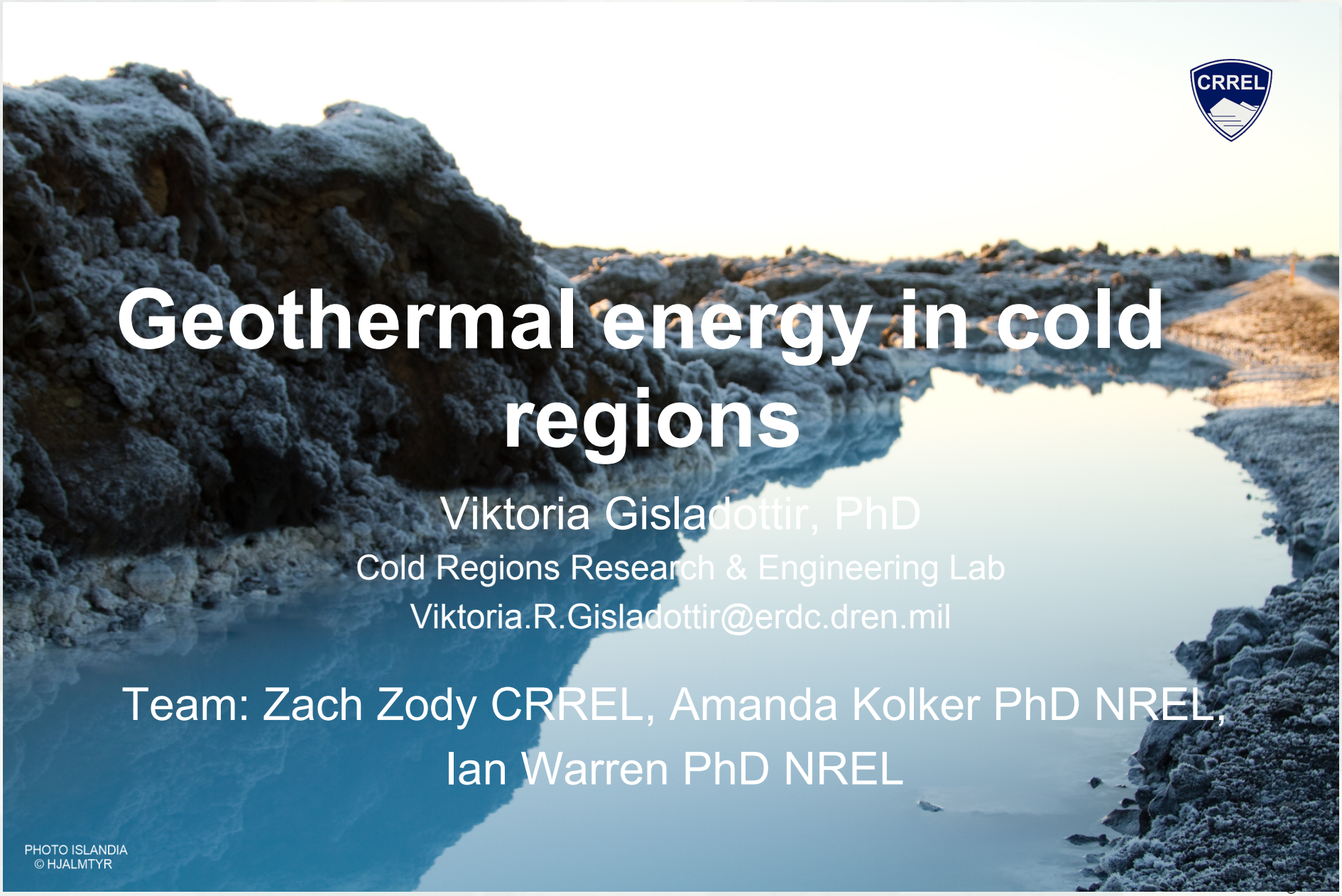

Geothermal energy in cold regions

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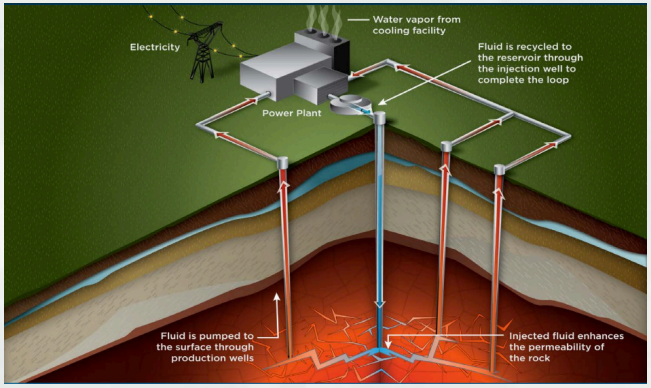
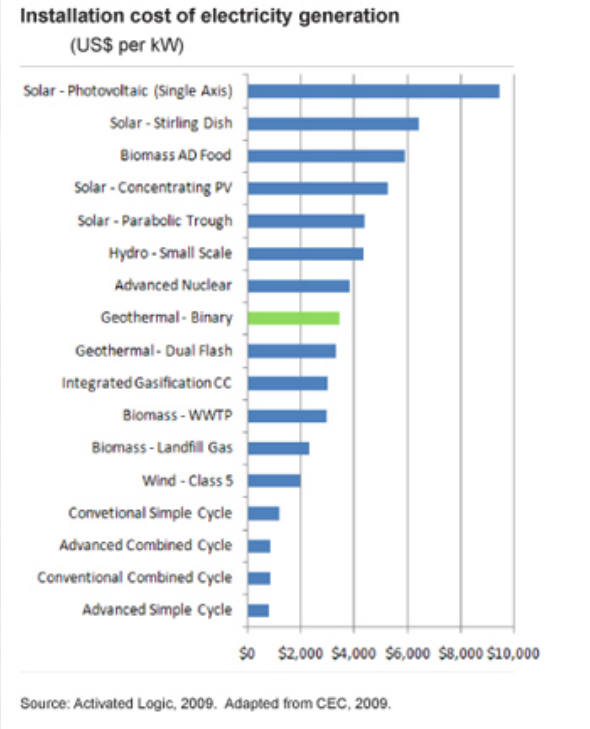
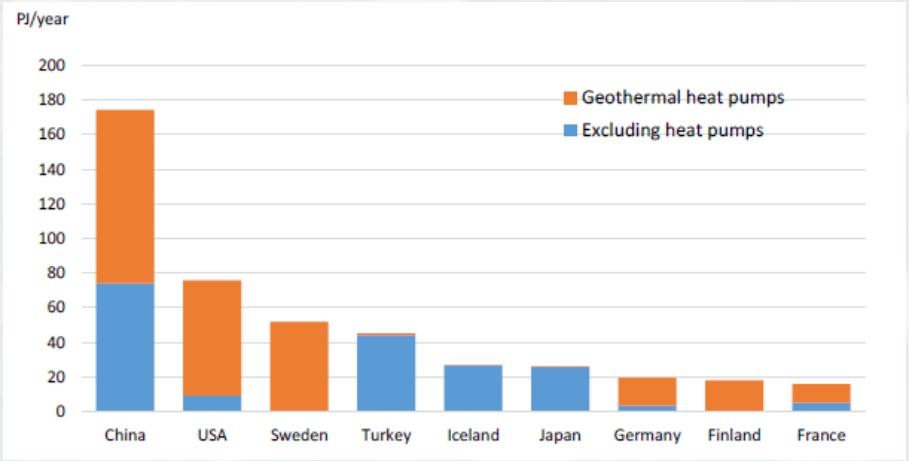
Geothermal energy in Cold Regions



- Baseline energy source
- Increased resilience – supply chain
- Economic benefit increases in cold climates where there is higher demand for heating.

Geothermal cost and use

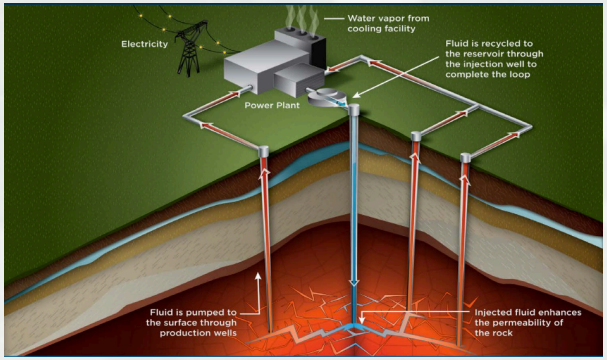


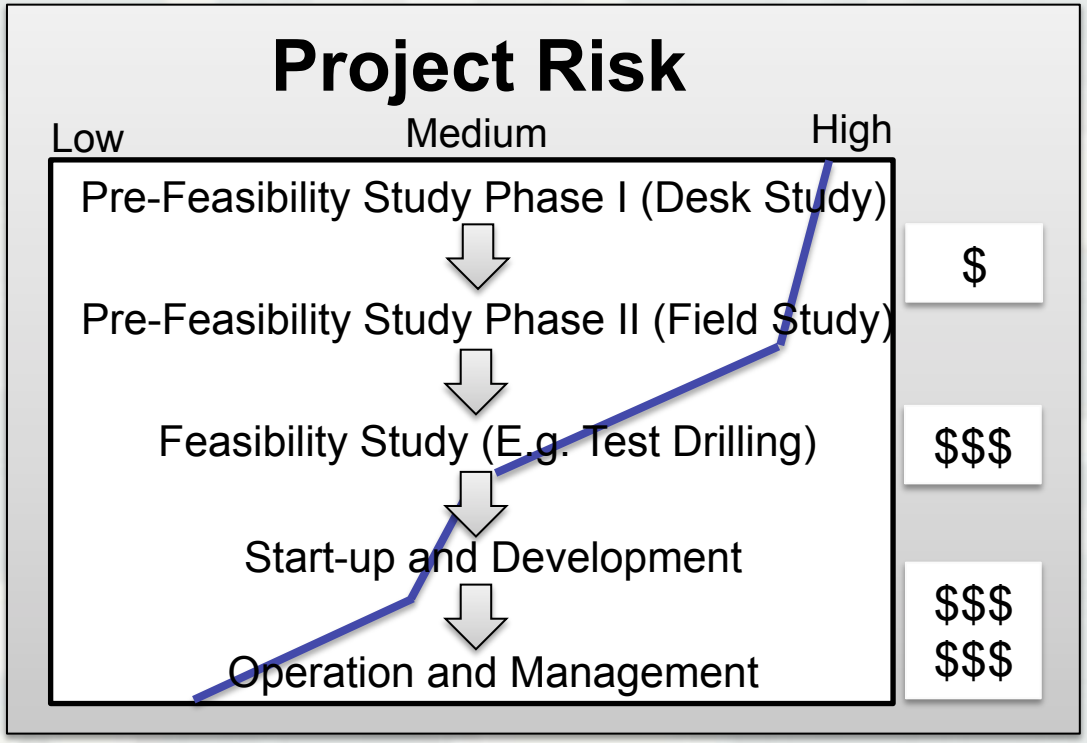


Traditional geothermal exploration

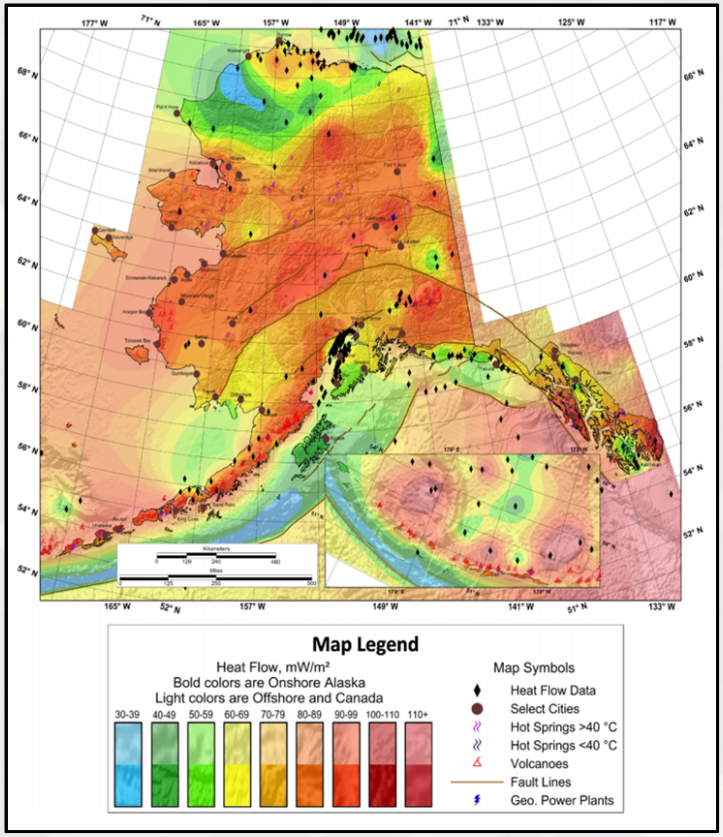
Critical components:

- Heat
- Accessible fluids
- Permeability
- Caprock or seal





Geothermal potential in Alaska



- Regional untapped potential
- Proven resource with small scale production Chena Hot springs

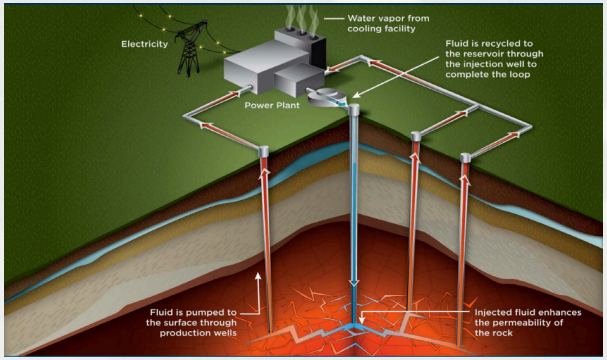
Updated heat flow map of Alaska (Batir et al 2016), showing higher than average heat flow (65 mW/m^2 for continental crust) for most of Interior Alaska

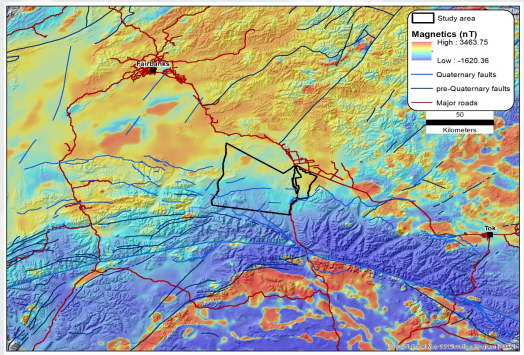
Play Fair Analysis (PFA) for geothermal exploration

Critical components:

- Heat
- Accessible fluids
- Permeability
- Caprock or seal

- From the petroleum industry
- DOE is investing in it
- Incorporates regional or basin-wide distribution of known geologic factors besides heat flow

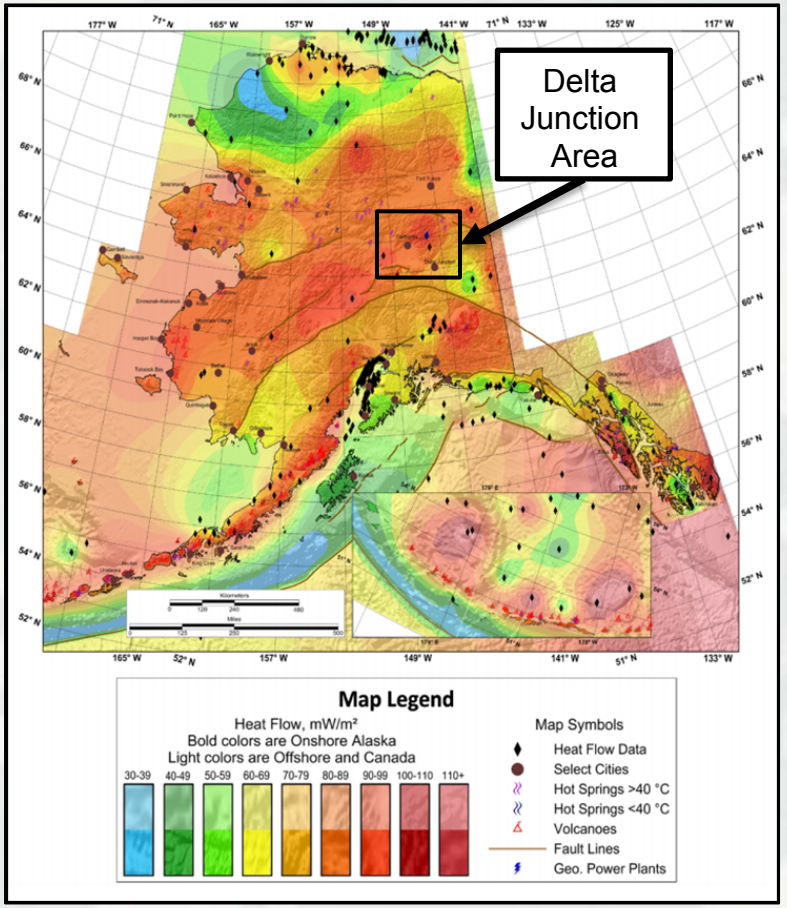




Play Fair Analysis (PFA) in AK e.g. Ft Greely

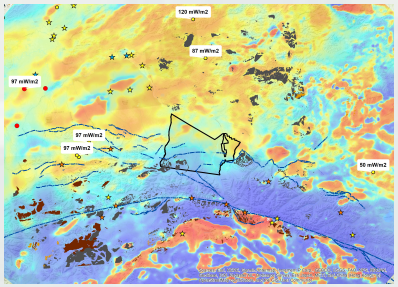
Exploring for blind geothermal resources is an emerging field and best practices are still under development.

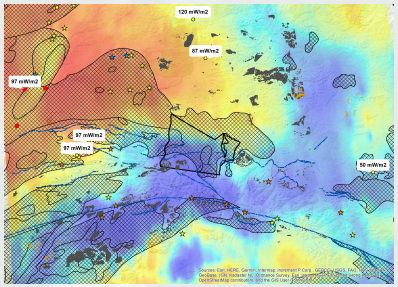
- Current PFA approach cannot be applied in full in many locations in Interior Alaska
  - Sparseness of most available datasets
  - Uncertainty inherent in extrapolation from the data
- The framework can be applied to better understand what is present at targeted sites (e.g., by defining the characteristics of Chena with multiple datasets and looking for that signature across the region).

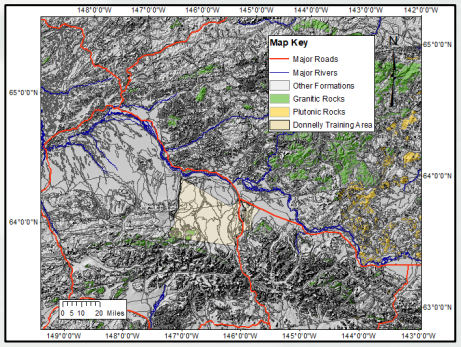


Geothermal Opportunities Assessment at Ft Greely

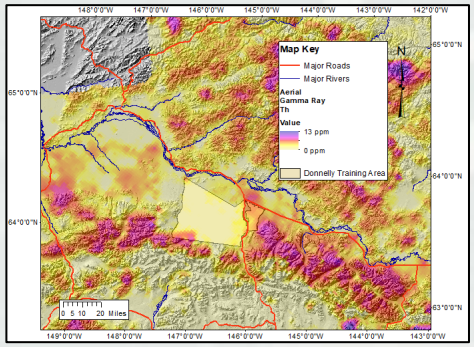
- Data gathering and analysis
- Pre-fieldwork analysis
  - Recommendations to guide more focused exploration
  - Constrain the local geothermal resource potential
  - Reduce development risk



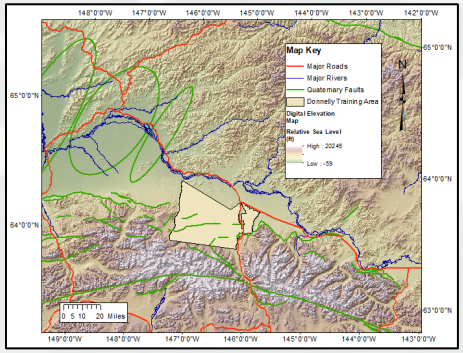




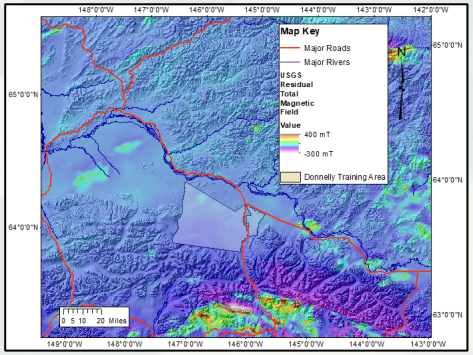
(USGS 2019)



(USGS 1974-77)



(ADNR DGGS 2012)



(USGS 1974-77)

Ft. Greely – expanding on PFA

Geothermal resource type	Uses	Likelihood of existing at Ft. Greely	Risk
Aquifer or ground source in permafrost-free zone	GHP	High	Low
Conduction-dominated intracratonic basin (sedimentary)	Direct use	Medium	Medium
Concealed convection-dominated radiogenic hydrothermal	Direct use Electricity gen. <1 MW	Low to medium	High
Concealed convection-dominated deep circulation or magmatic hydrothermal	Direct use Electricity gen. >1 MW	Low	High

- **Likely hood of existing at Ft Greely and risk associated**

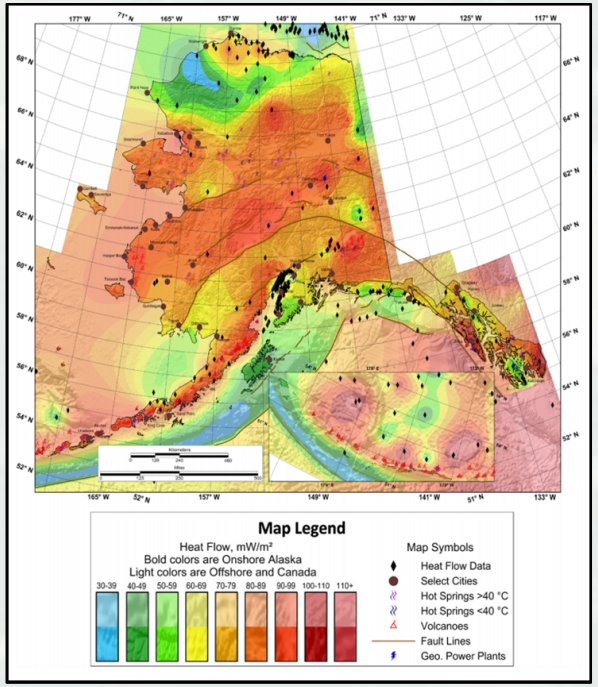
Ft. Greely – expanding on PFA

Geothermal resource type	Play of the type described b
Conduction-dominated intracratonic basin (sedimentary)	Allis, 2015
Concealed convection-dominated radiogenic play	Kolker, 2008 and Witter, 2018
Concealed convection-dominated magma-hydrothermal plays	Lautze, 2017 and Shevenell, 2015
Petrothermal (EGS or AGS)	

- Identified and developed exploration methods
  - Typical exploration methods (e.g. Moeck, 2014)
  - **Custom exploration methods for the interior to evaluate the different geothermal resource type**

Geothermal energy in Alaska

- A highly resilient thermal and in some cases electric energy source
- Biggest opportunities for advancement
  - ▶ Further development of PFA/ framework specifically targeting geothermal prospecting in Alaska.
  - ▶ Data gathering =>> drilling (TG wells)
  - ▶ Improved decision models/framework for each step of feasibility studies



Updated heat flow map of Alaska (Batir et al 2016

References

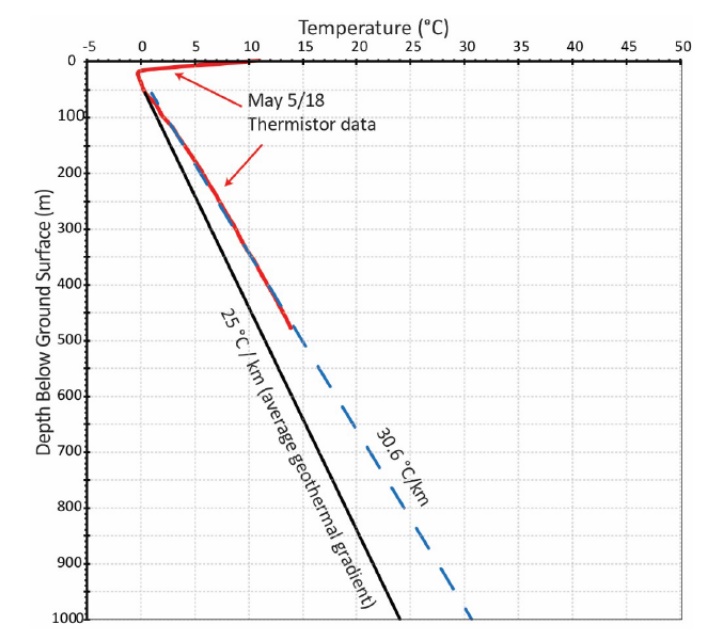
J. F. Batir, D. D. Blackwell and M. C. Richards, "Updated Heat Flow Map of Alaska: Developing a Regional Scale Map for Exploration from Limited Data," in *World Geothermal Congress*, 2015.

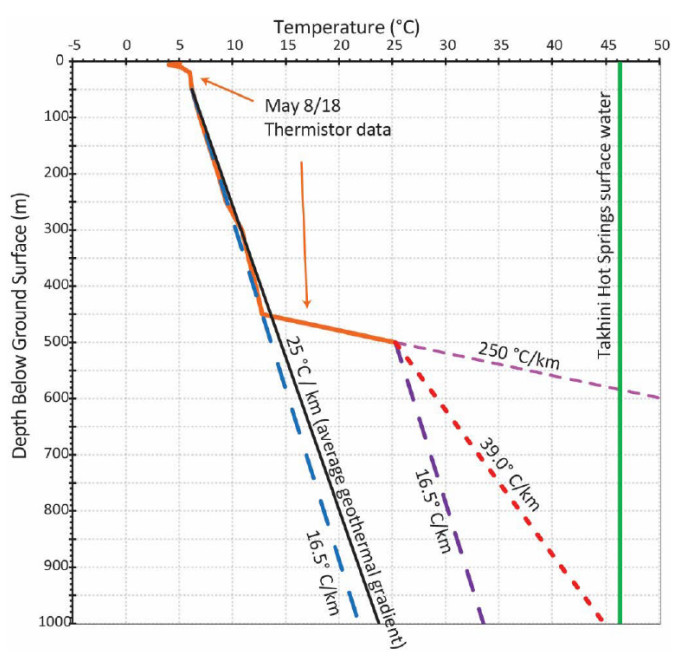
Kolker, B. Kennedy and R. Newberry, "Evidence for a Crustal Heat Source for Low-Temperature Geothermal Systems in the Central Alaskan Hot Springs Belt," *GRC Transactions,* vol. 32, pp. 225-230, 2008.

Moeck, I.S., 2014, Catalog of geothermal play types based on geologic controls: Renewable and Sustainable Energy Reviews 37, p. 867–882.

L. Rybach, "Radioactive Heat Production in Rocks and its Relation to other Petrophysical Parameters," *Pure and Applied Geophysics,* vol. 114, pp. 309-317, 1975.

Thermal gradient drilling in Yukon, Canada





Temperature profiles from thermal gradient wells from Yukon, Canada (Fraser et al 2018). Left: Tintina well; Right: Takhini Hot Springs well. Both wells were drilled to 500m.