Alaska's Geothermal Resources

Bernie Karl

Alaska Senate Resources Committee

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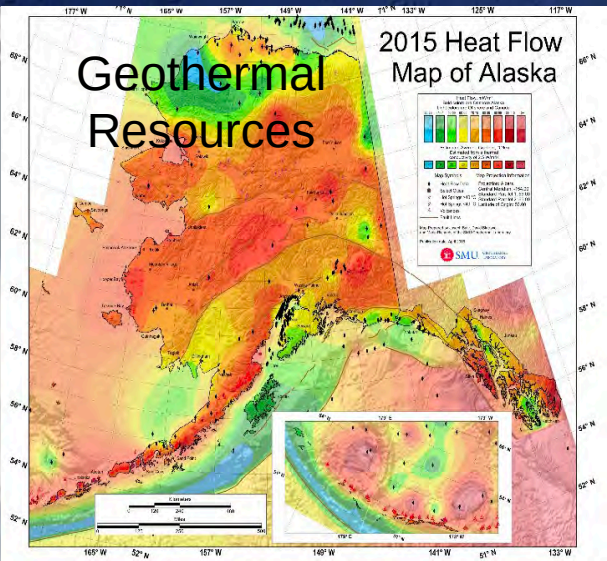
Juneau, Alaska

Alaska's Aleutian Arc – World's Largest Number of Geothermal Volcano Centers*

Geothermal Power Plant



* Shevenell et al., 2015, DOE EERE GTO, DE-EE0006725 Final Report.

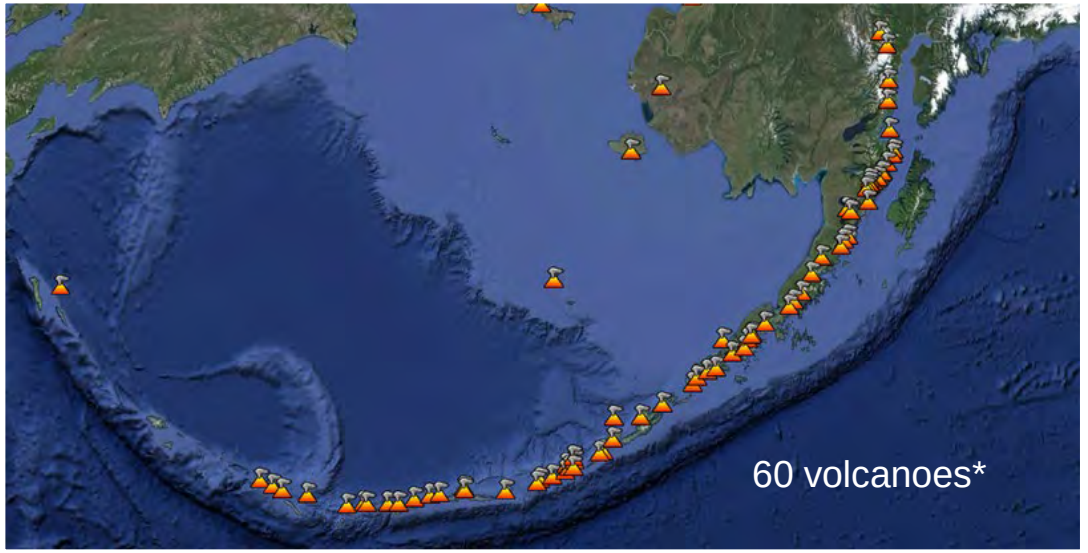
Video link:
https://www.alaskageothermal.info/video

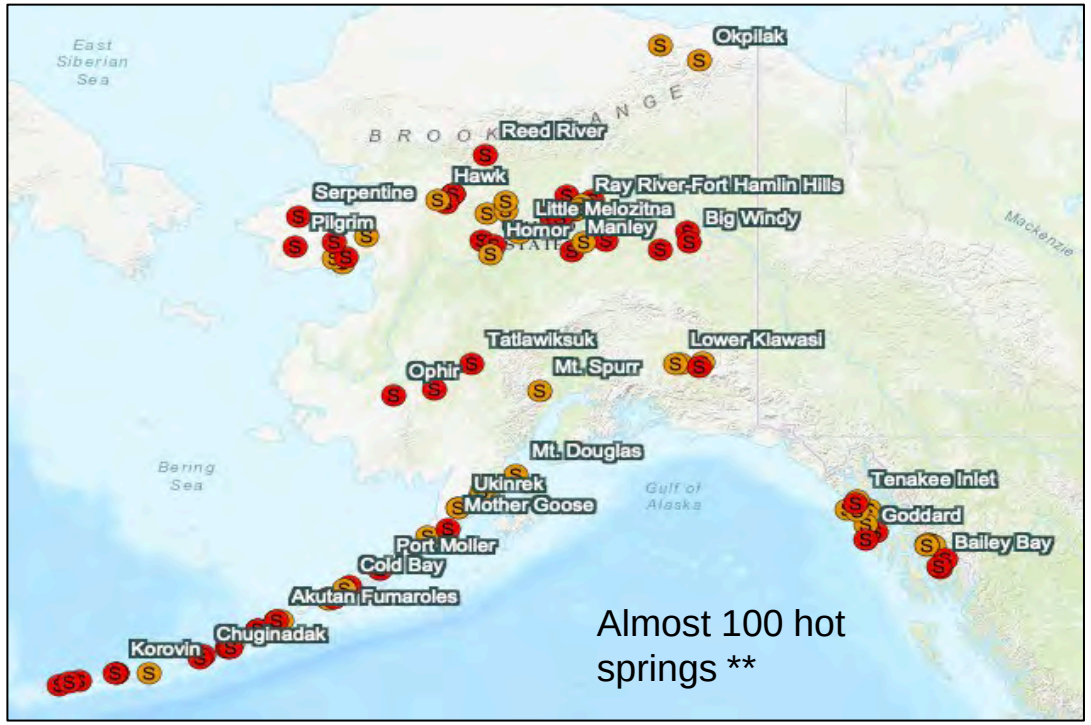
Alaska Has Significant Geothermal Phenomena

Alaska has abundant geothermal phenomena including hot springs and active volcanos. Economic resources are commonly, but not necessarily, associated with these phenomena. This is an area of ongoing discovery.

In general, economic hydrothermal systems in Alaska are related to geologically young volcanoes, fractured granitic bodies, and large sedimentary basins.

DGGS and USGS have conducted exploration efforts to uncover Alaska's promising geothermal potential.**





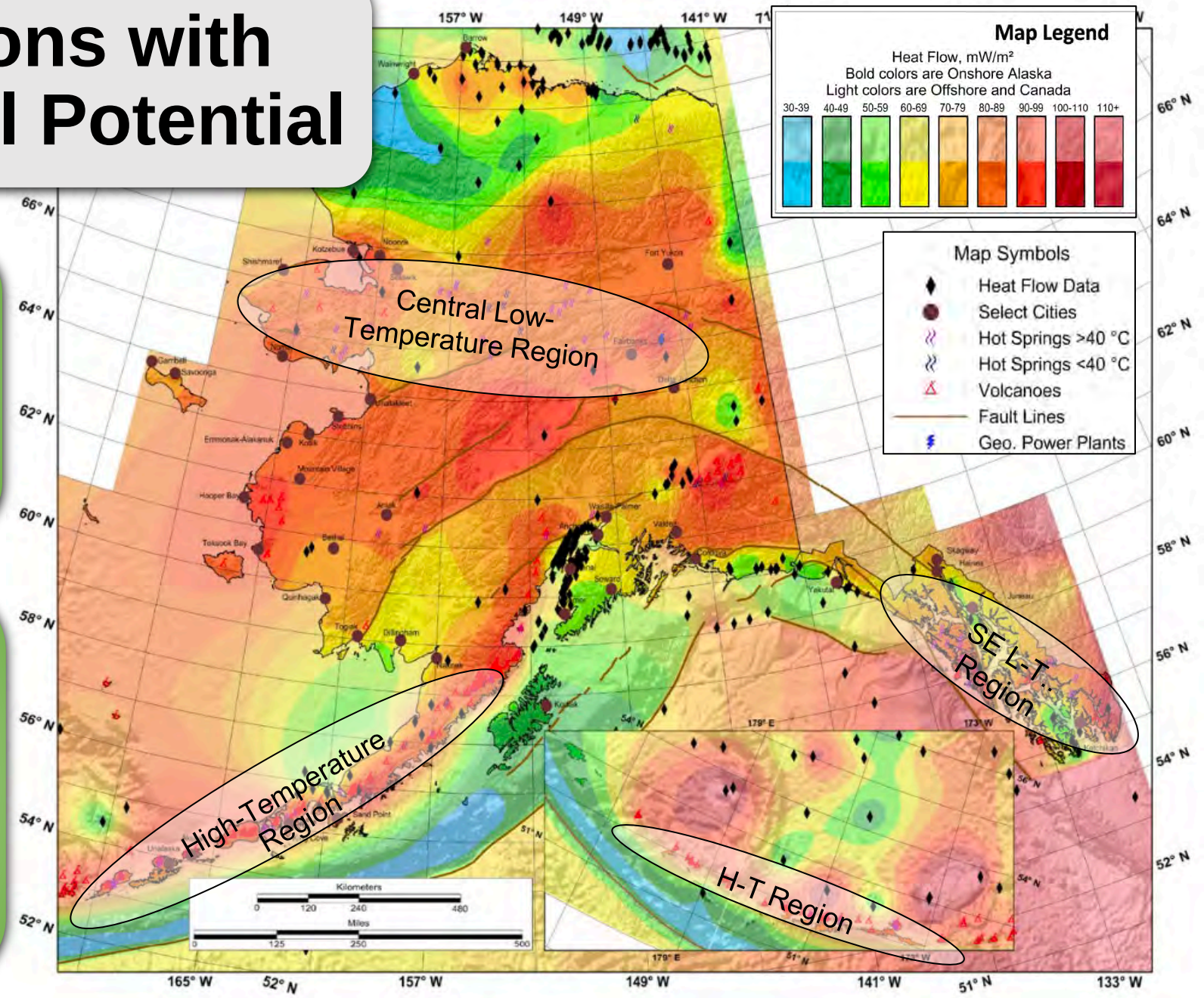
* 59 volcanos with an estimated 250,000 MW thermal, Smith and Shaw, *USGS Circular 790, 1978.*

*** From: https://geoportal.dggs.dnr.alaska.gov/portal/apps/webappviewer/index.html?id=28ed3938684448bb8d8fabad2c505e4d*

Three Major Regions with Alaskan Geothermal Potential

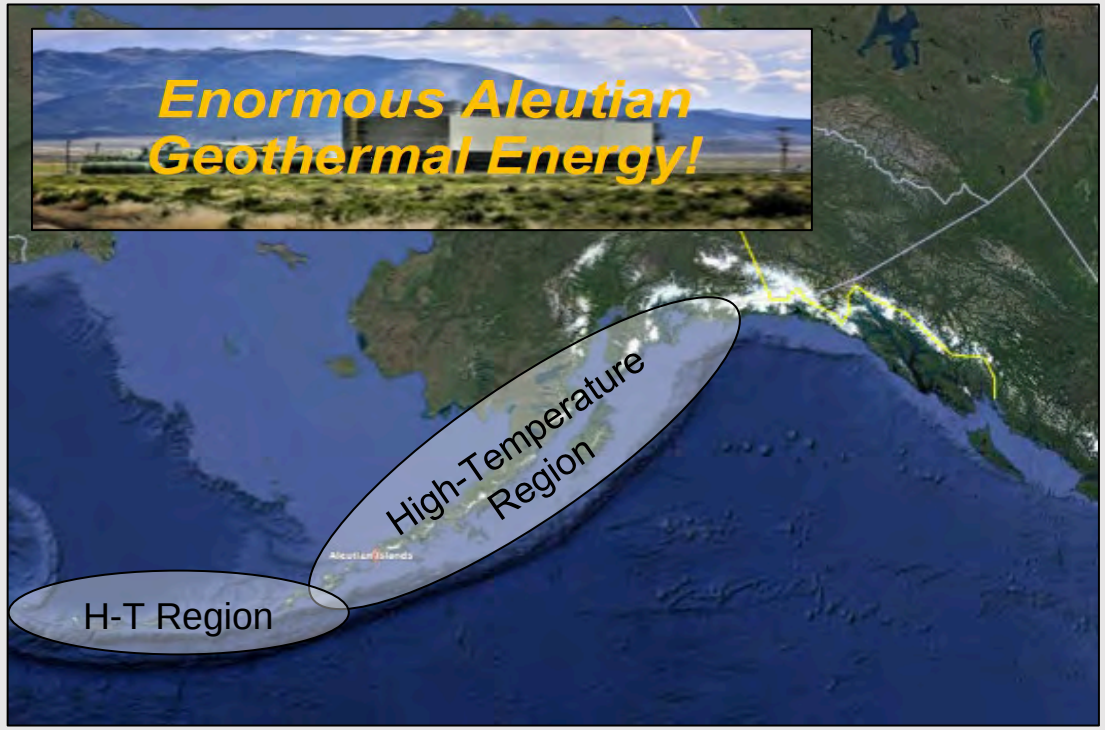
In a 2015 report, Batri et al.*, presented an updated heat flow map of Alaska identifying potential regions for geothermal energy.

A low-temperature (L-T), fractured granitic belt (Chena Hot Springs to Pilgrim) in central Alaska, a L-T SE Alaska region and, of course, the Aleutian Islands with high temperatures.



** Heat flow and temperature-depth curves throughout Alaska: Finding regions for future geothermal exploration,* Batir et al., Journal of Geophysics and Engineering, June 2016.

Alaskan Geothermal Resources, How Much?



In 1978, as part of the newly formed USGS Geothermal Program, R.L. Smith and H.R. Shaw, estimated the total energy of volcanoes in Alaska's Aleutian region in a report titled, *Igneous-Related Geothermal Systems.**

26 Aleutian volcanoes assessed, and total volcanic energy was estimated as 10^{22} joules with Makushin volcano's at $3x10^{19}$ joules.

Later in 2016, a DOE-funded report** evaluated 59 Aleutian volcanos and six were identified with favorable♀ conditions with Makushin and Akutan at the top of the list.

* A report in the USGS Circular 790, *Assessment of Geothermal Resources of the United States*, L. J. P. Muffler, Editor.

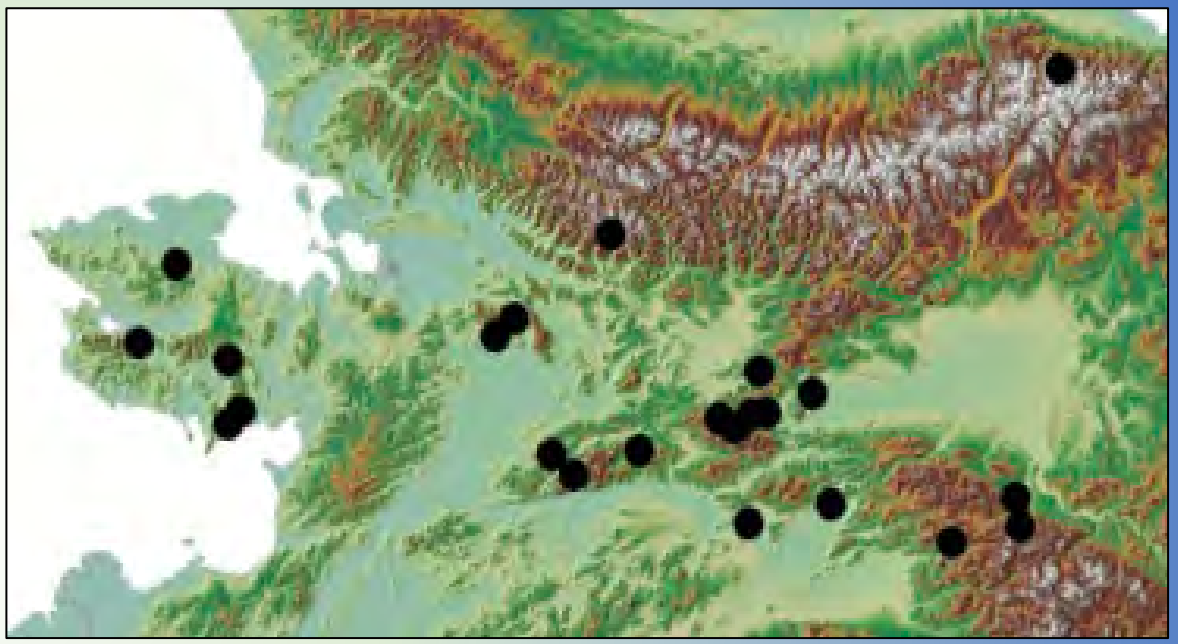
** *Geothermal Potential of the Cascade and Aleutian Arcs, with Ranking of Individual Volcanic Centers for their Potential to Host Electricity-Grade Reservoirs*, Shevenell et al., DOE EERE – Geothermal Technologies Program, DE-EE0006725 Final Report, 2015.

♀ *Favorable* means strong potential to produce electricity.

Chena Hot Spring's Low-Temperature, Electricity Generation Is the Perfect Solution for the Central Alaska Region

Many low-temperature, but high flow rate hot springs, like CHS are spread out across central Alaska.*

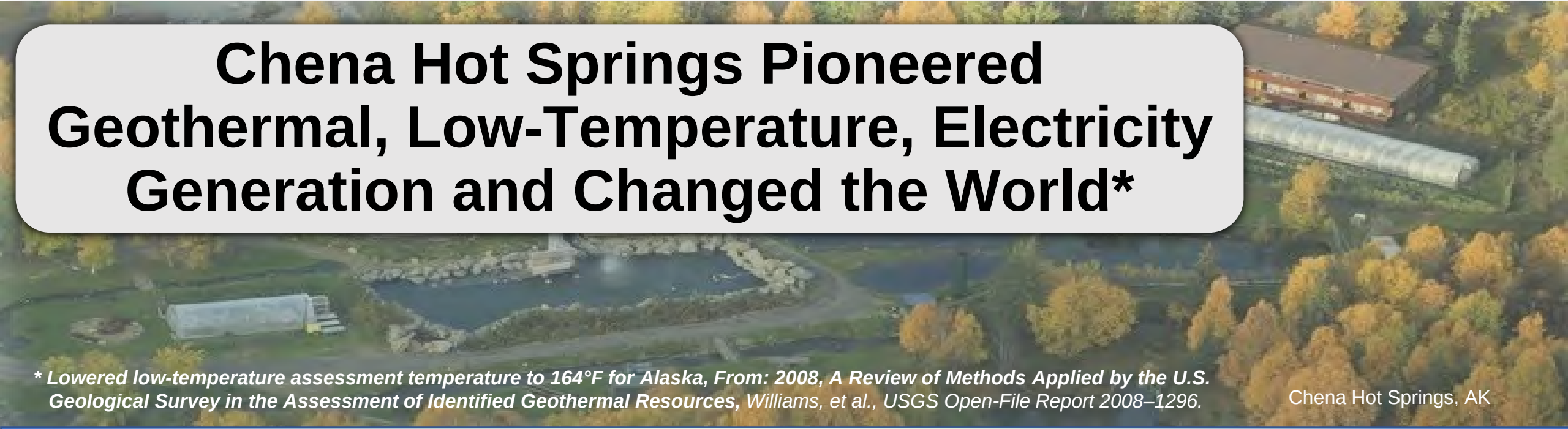
Low-temperature geothermal electricity generation was not thought possible at less than 194°F, CHS moved the temperature to less than 167°C. and 'opened the door' for Central Alaska geothermal development.



Chena Hot Spring's binary, geothermal power plant, operating since 2006, at a nominal 350 MWe, has generated clean, carbon-free renewable energy for sustainable operations.

* 2008, *Assessment of Moderate- and High-Temperature Geothermal Resources of the United States*, Williams et al., USGS, Fact Sheet 2008–3082.

Chena Hot Springs Pioneered Geothermal, Low-Temperature, Electricity Generation and Changed the World*



** Lowered low-temperature assessment temperature to 164°F for Alaska, From: 2008, A Review of Methods Applied by the U.S. Geological Survey in the Assessment of Identified Geothermal Resources,* Williams, et al., USGS Open-File Report 2008–1296.

Chena Hot Springs, AK

Geothermal Enables

Fresh Food Greenhouses

Recycling

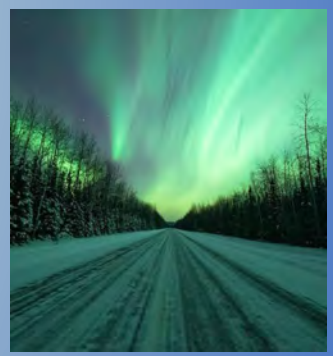
Clean H_2 Fuel

Balneology

South-Eastern Alaska Region Will Also Benefit from Chena Hot Springs Low-Temperature Geothermal System

In addition to Chena Hot Spring's binary, geothermal power plant for electricity, geothermal waters are further employed to heat buildings, outdoor walkways and grow food year-round and, cool the icehouse. This is called direct use of geothermal energy.

Heat flow estimates in the SE region of Alaska (except Juneau) might be able to generate electricity, but certainly SE cities would benefit from direct usage.*



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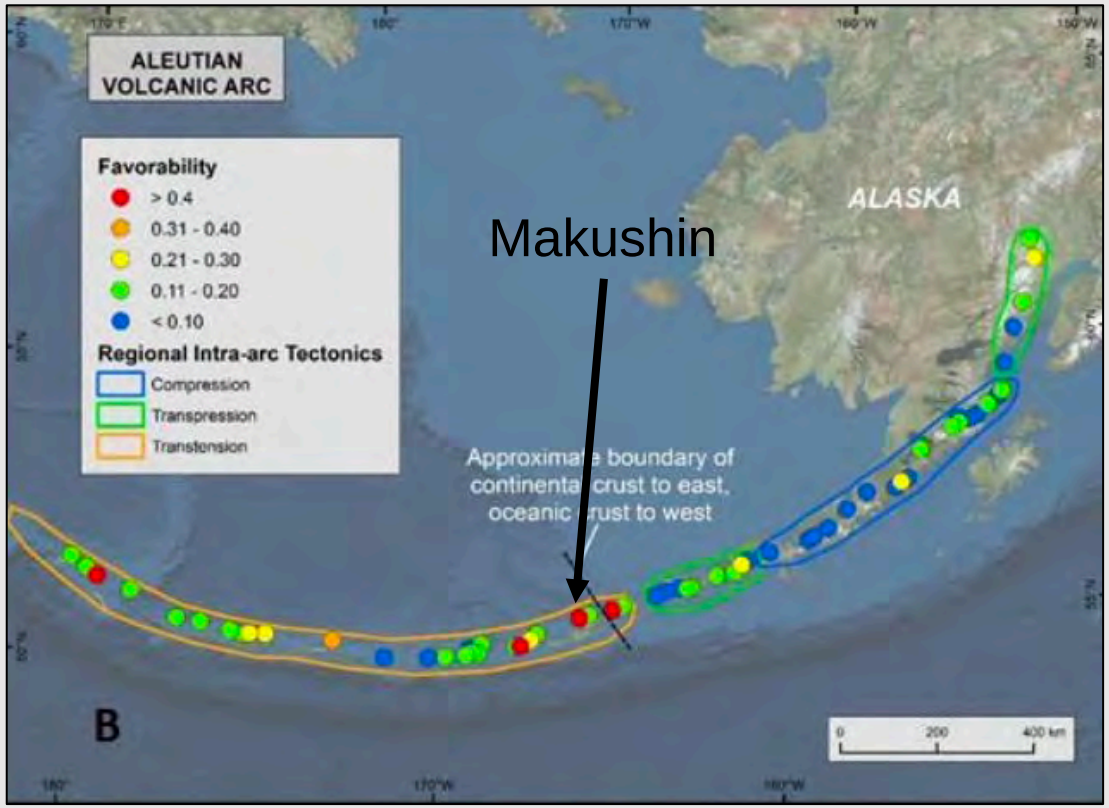
Aleutian Islands Have an Enormous Untapped Geothermal Potential

Alaska's Aleutian Islands are the largest island arc volcanic center in the World.** Total Aleutian volcanic energy was estimated as 10^{22} joules.* How to tap into this enormous source of energy for Alaska's benefit?

In 2016, Makushin scored first on a DOE-EERE-GTO funded report assessing island arc geothermal-potential, favorability♀ list of over 59 Aleutian volcanos near population centers.



Geothermal favorability♀ map of the Aleutian Islands** Red color is best.

Makushin volcano is estimated at $3x10^{19}$ joules is the key.*

* A report in the USGS Circular 790, *Assessment of Geothermal Resources of the United States*, L. J. P. Muffler, Editor.

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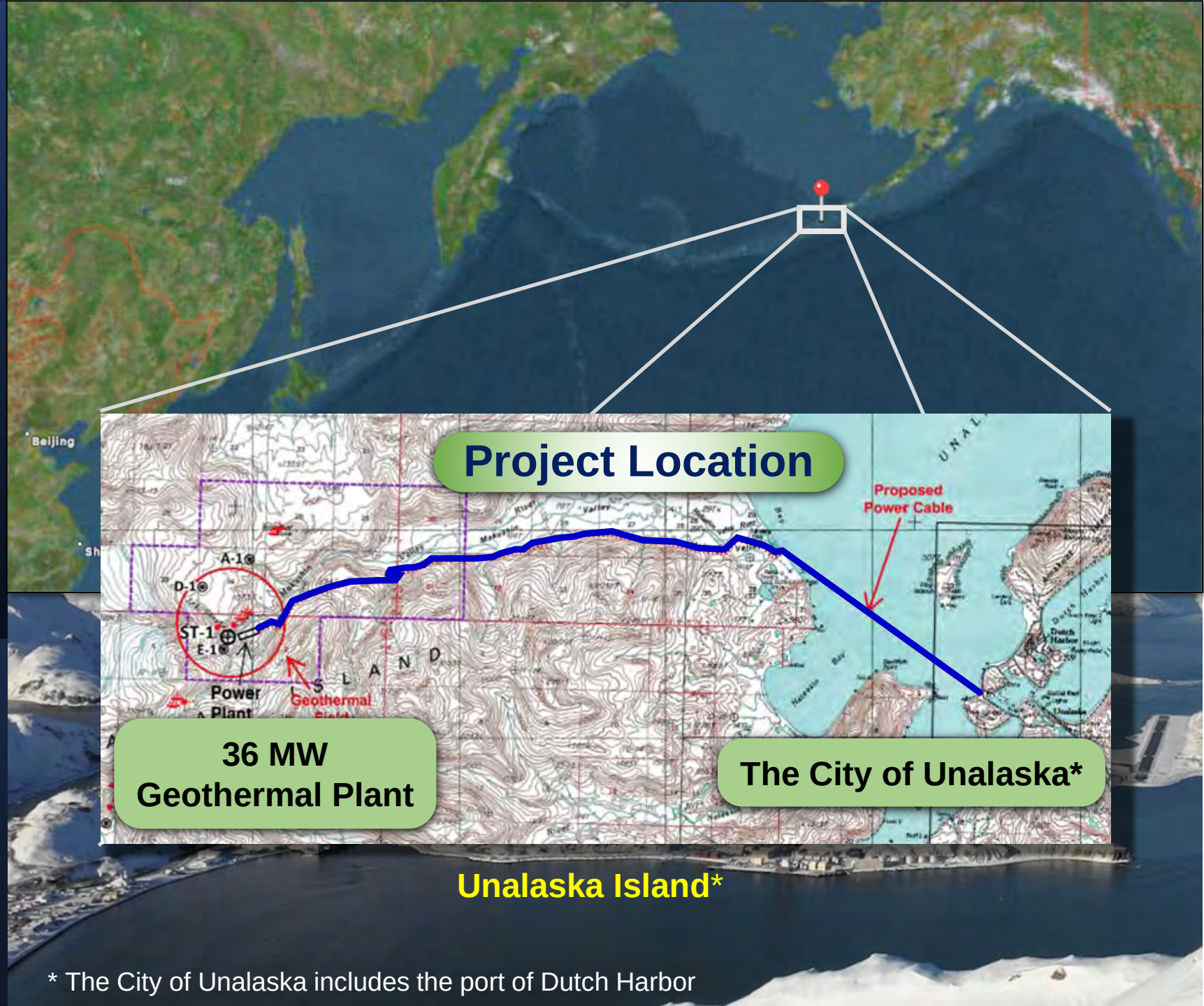
Unalaska is Strategically Located in the Aleutian Chain



Unalaska is the largest deep water fishing port in U.S. and it's a globally significant and strategic shipping location.

* The City of Unalaska includes the port of Dutch Harbor

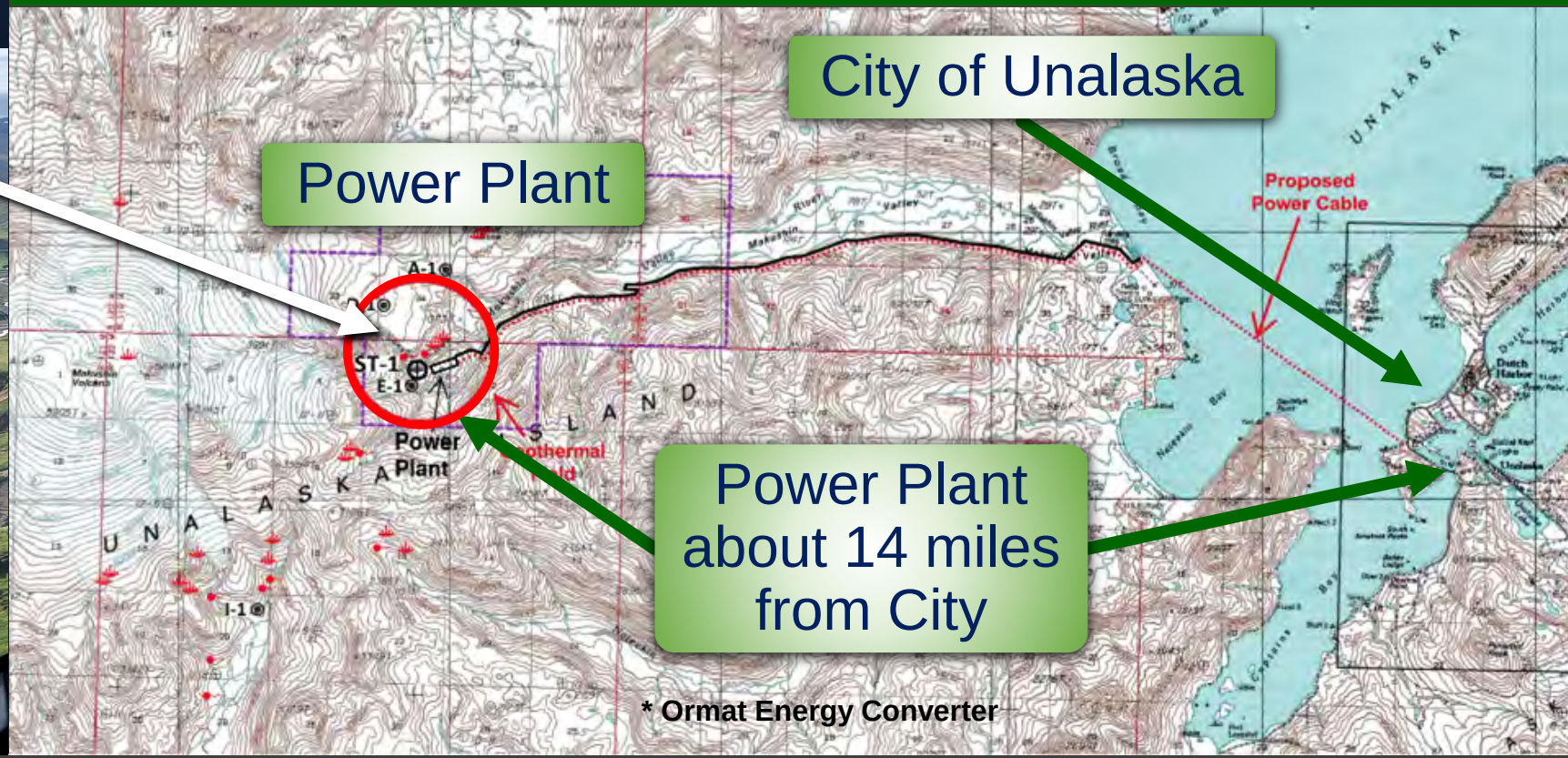
What is the Makushin Geothermal Project?

Makushin Geothermal Project (MGP) is a 100% renewable energy 30MWe geothermal power system:

- Powerplant utility corridor and three production/injection wells,
- Modular geothermal plant with multiple, cascading OEC* units,
- Power transmission/communications lines on land and underwater connection to City of Unalaska's power grid, and
- Automated controls and integration scheme with power grid.

Power Plant Site

Makushin Valley looking West



* Ormat Energy Converter

OCCP Aleutian Vision Summary

- Starts on Unalaska Island and Makushin Volcano's thermal energy.
- Next, the larger Makushin Geothermal Resource (MGR) and then the complete Volcano itself.
- Next, a move to Adak island to replace diesels.
- Finally, Aleutian volcanoes, more than any other place on Earth, are tapped for large-scale, industrial businesses such as green H_2 production and green ore smelting.

Eventually, eleven commercial business ventures are visioned with numerous OCCP-1 (30MWe) size power plants or much larger for heavy-use offtakers for a total of over 1 GW of capacity and attracting almost $13B in power plant and facilities investment capital.

Hope You Enjoyed Alaska's Geothermal Resources

Thank You!

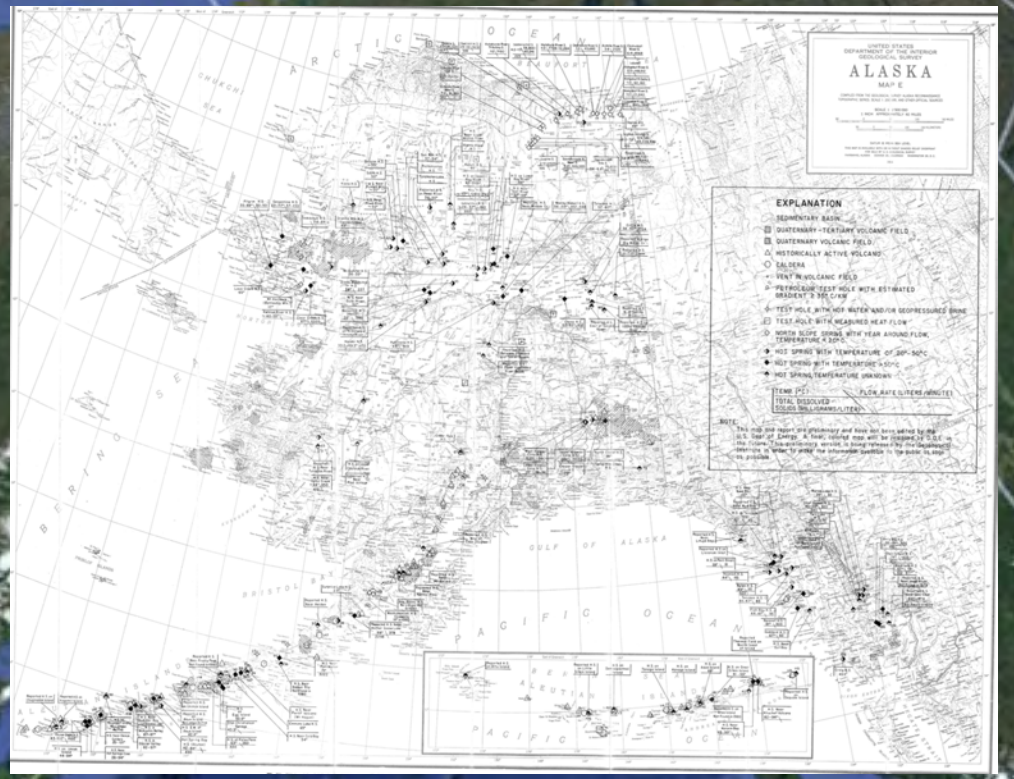
b.karl@chenapower.com

https://www.alaskageothermal.info

Additional Slides

Brief History of Geothermal Resources Work in Alaska

In 1954, a comprehensive survey of geothermal resources of Alaska sponsored by DOE and performed by the University of Alaska at Fairbanks (UAF), was released, *Preliminary Geothermal Energy Resources Map of Alaska by Turner, et al.**

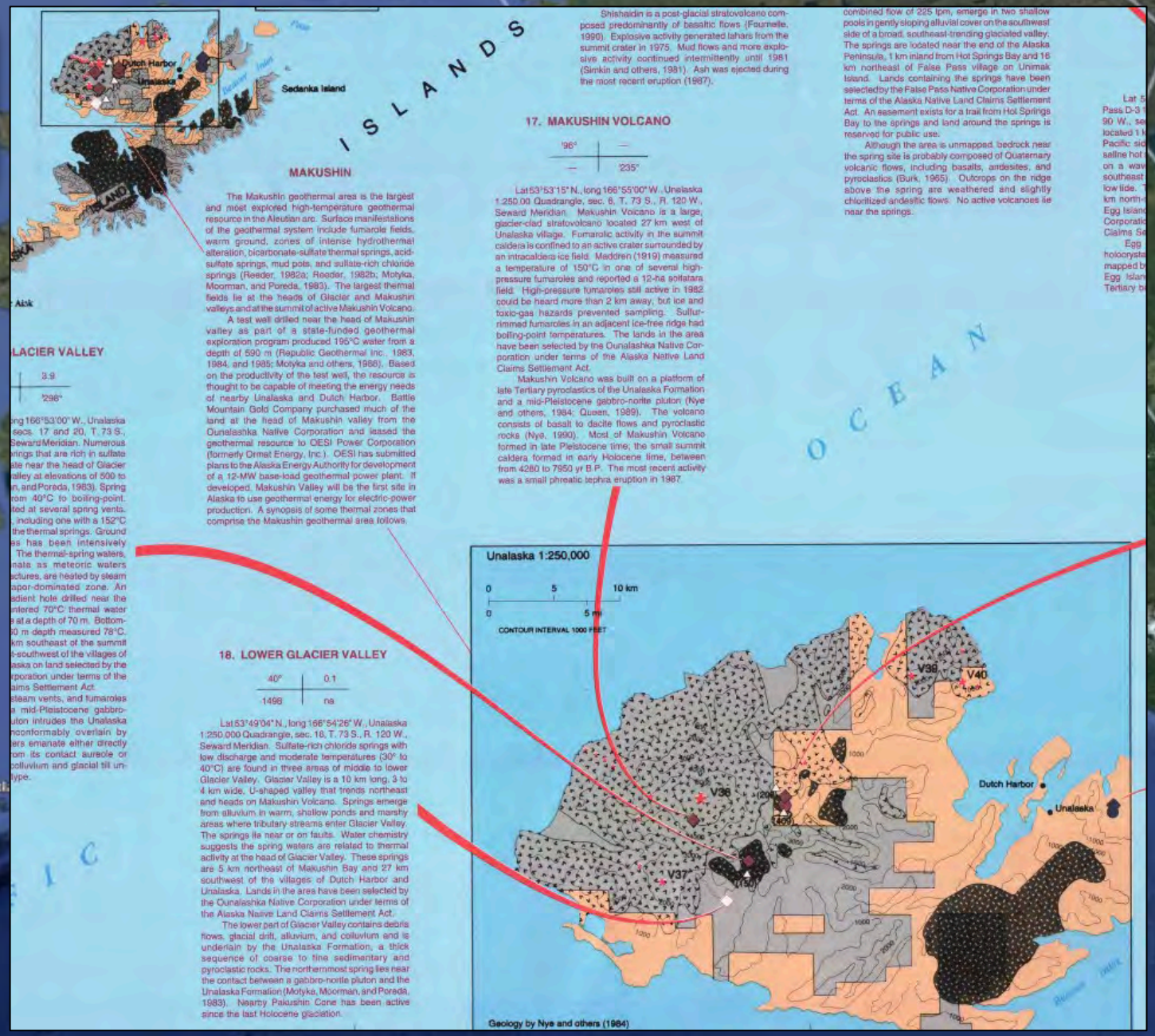


In 1980, Reeder et al., published as part of DNR/DGGS, *The State of Alaska Geothermal Program* where a program and methodology were outlined that "…will lead to immediate geothermal energy development in Alaska." A regional hot spring reconnaissance project and 15 proposed site-specific hydrothermal projects were identified. Pilgrim Springs, Chena Hot Springs, and the Northern part of Unalaska Island were on the list.

* Previous work, a 1917 report titled, *Mineral Springs Of Alaska*, Gerald A. Waring, USGS Water Supply Paper 418.

Aleutian Geothermal Resources

In 1993, a detailed survey of geothermal resources of the Aleutian Islands was performed by Motyka et al., at ADDG*. Three meticulously crafted maps with detailed information offered up-to-date information on Aleutian geothermal resources. The Makushin resource had the most comprehensive and informative information.



* *Maps of Geothermal Resources of the Aleutian Arc, Alaska,* Motyka, Liss, Nye, and Moorman, ADGGS, part of Professional Report 114.