

# **An Introduction to Geothermal Resources**

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for

San Luis Valley Public Lands Center

Geothermal Public Meetings

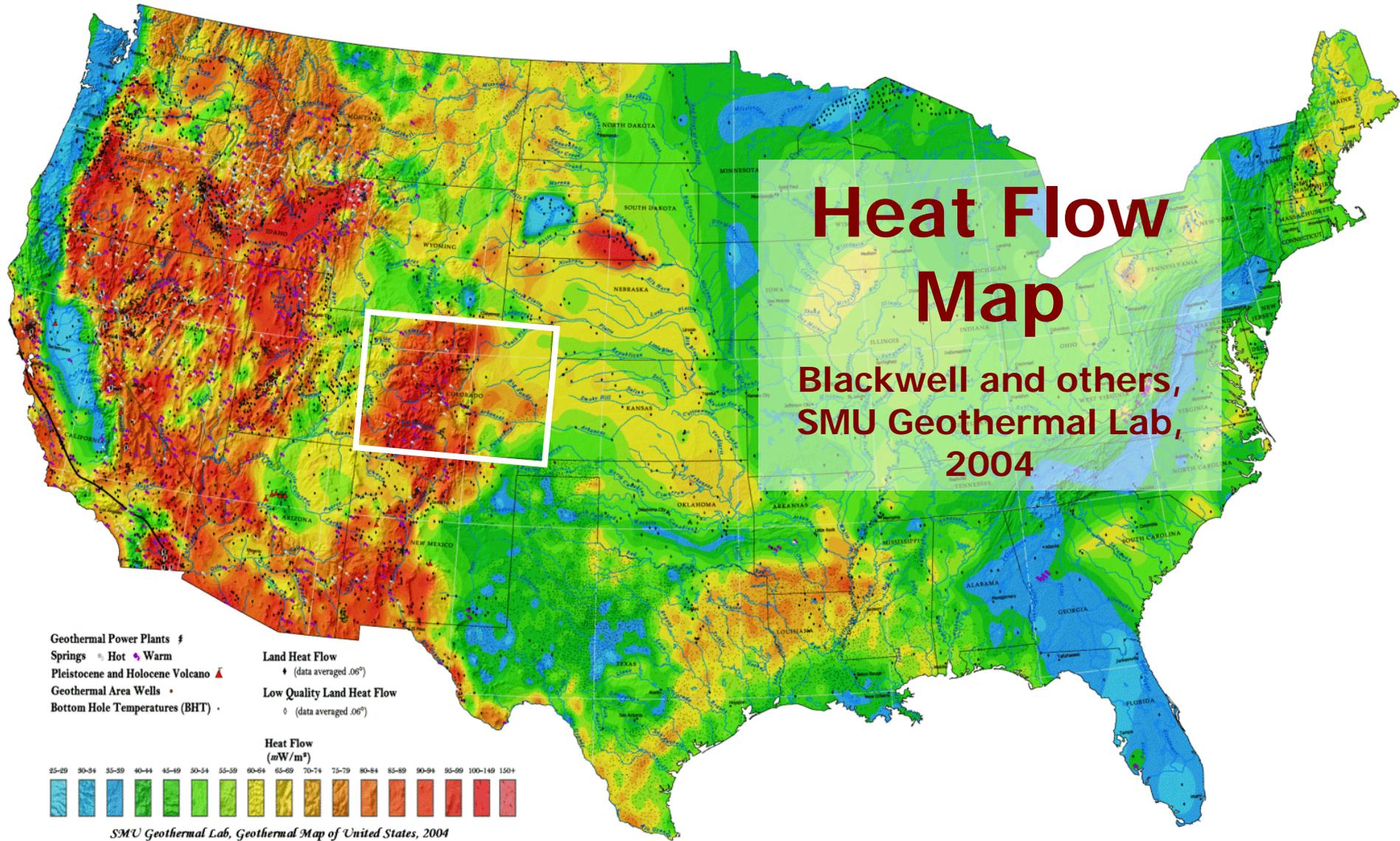
July 7 & 8, 2010

# What is a Geothermal Resource?

Thermal (heat) energy that can be economically extracted from the Earth

1. Geoexchange or Geothermal heat pumps
2. Direct use – use the heat from hot or warm thermal waters (greenhouses, spas, aquaculture, space heating, industrial heat)
3. Indirect use – Electricity generation

# Distribution of Areas Prospective for Geothermal Resources in the US



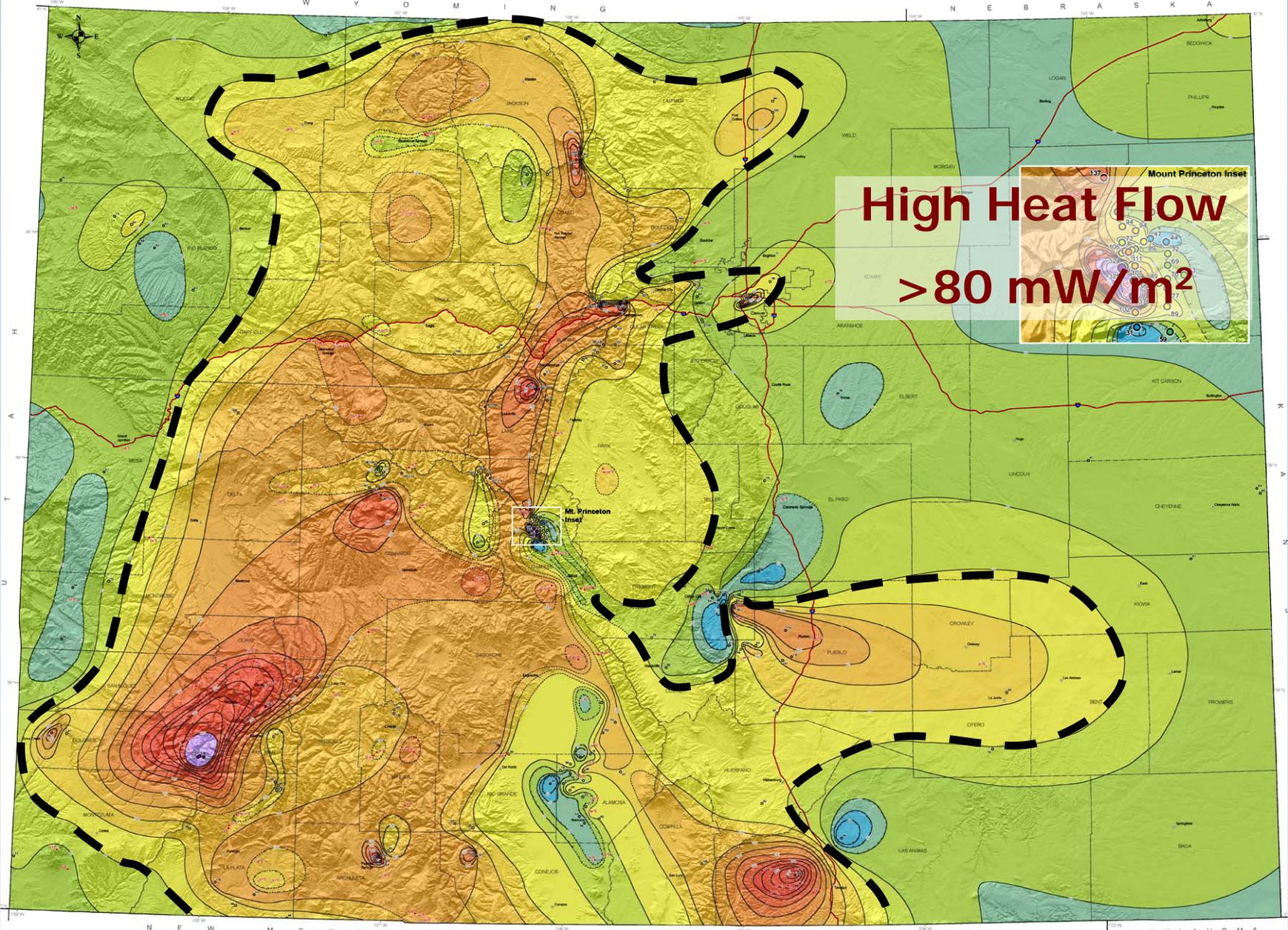


# COLORADO HOT / WARM SPRINGS

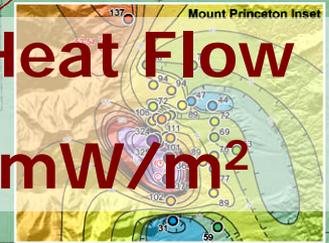


### EXPLANATION

- Pagosa Springs** – Hot Spring (>35° C)
- (H) 57°/1,286 – Temperature (C) / Flow (Liters/ min)
- Dotsero** – Warm Spring (<35° C)
- (W) 32°/3,200 – Temperature (C) / Flow (Liters/ min)

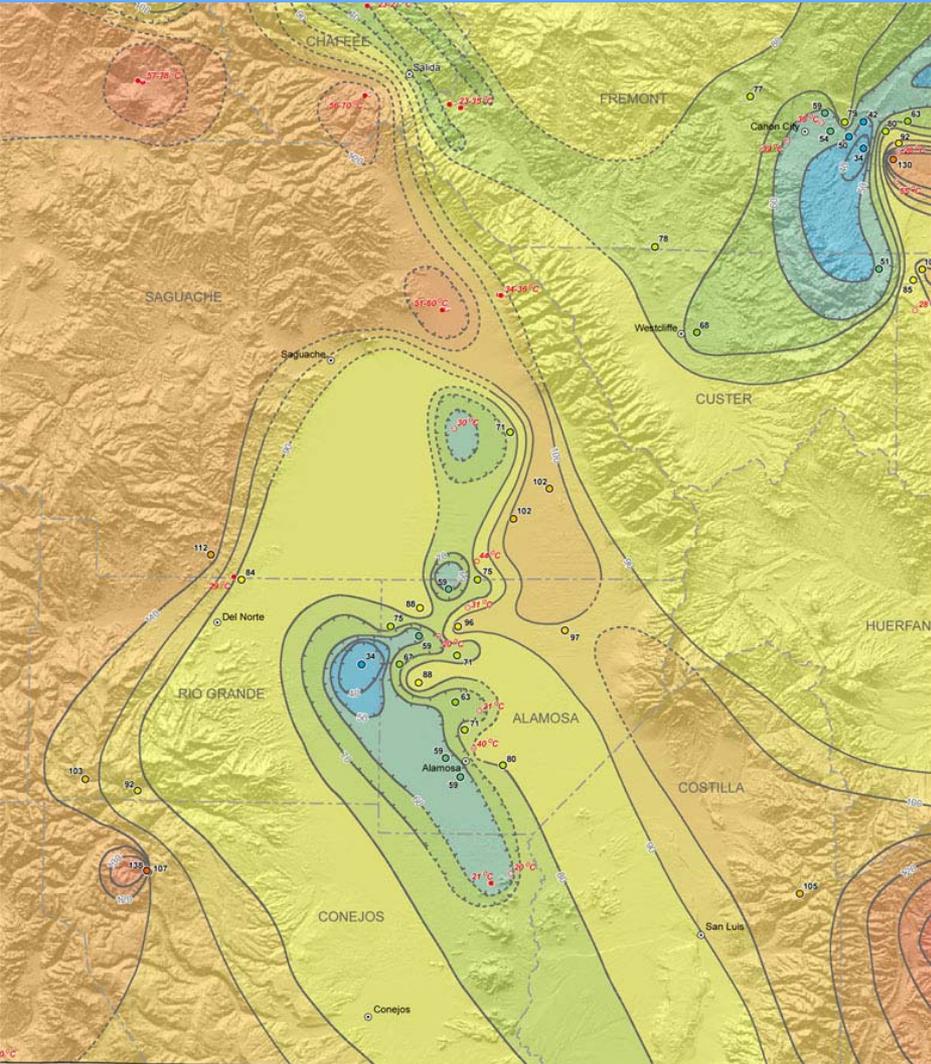


**High Heat Flow**  
**> 80 mW/m<sup>2</sup>**

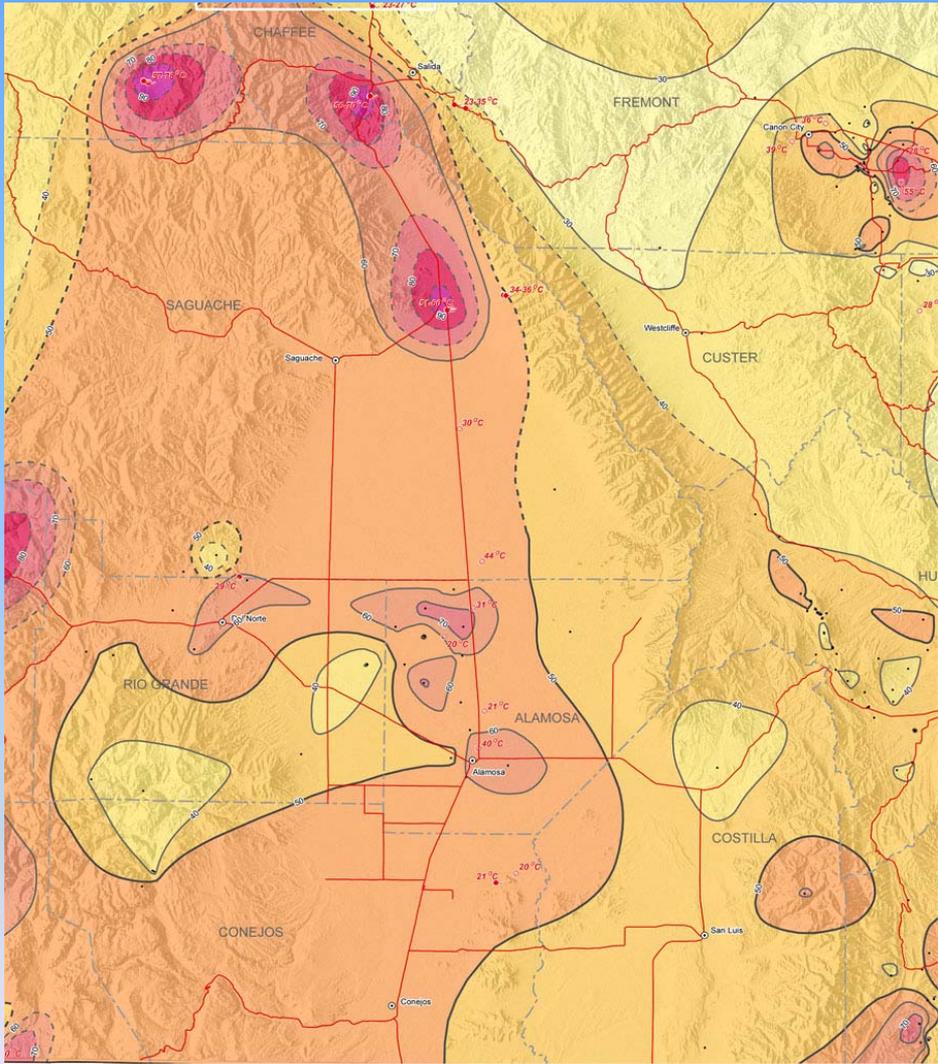


# South-Central Colorado

## Heat Flow



## Geothermal Gradient



# Why is Colorado (the State) Interested in Geothermal?

- Potential for geothermal in Colorado high
- Geothermal is:
  - ✓ Clean (no emissions)
  - ✓ Safe (no mining, no transportation)
  - ✓ Environmentally friendly (little to no water consumed)
  - ✓ Sustainable (Renewable)
  - ✓ Distributed (covers >1/2 state)
  - ✓ Economical (high upfront costs, but low operating costs [no fuel] = competitive rates)

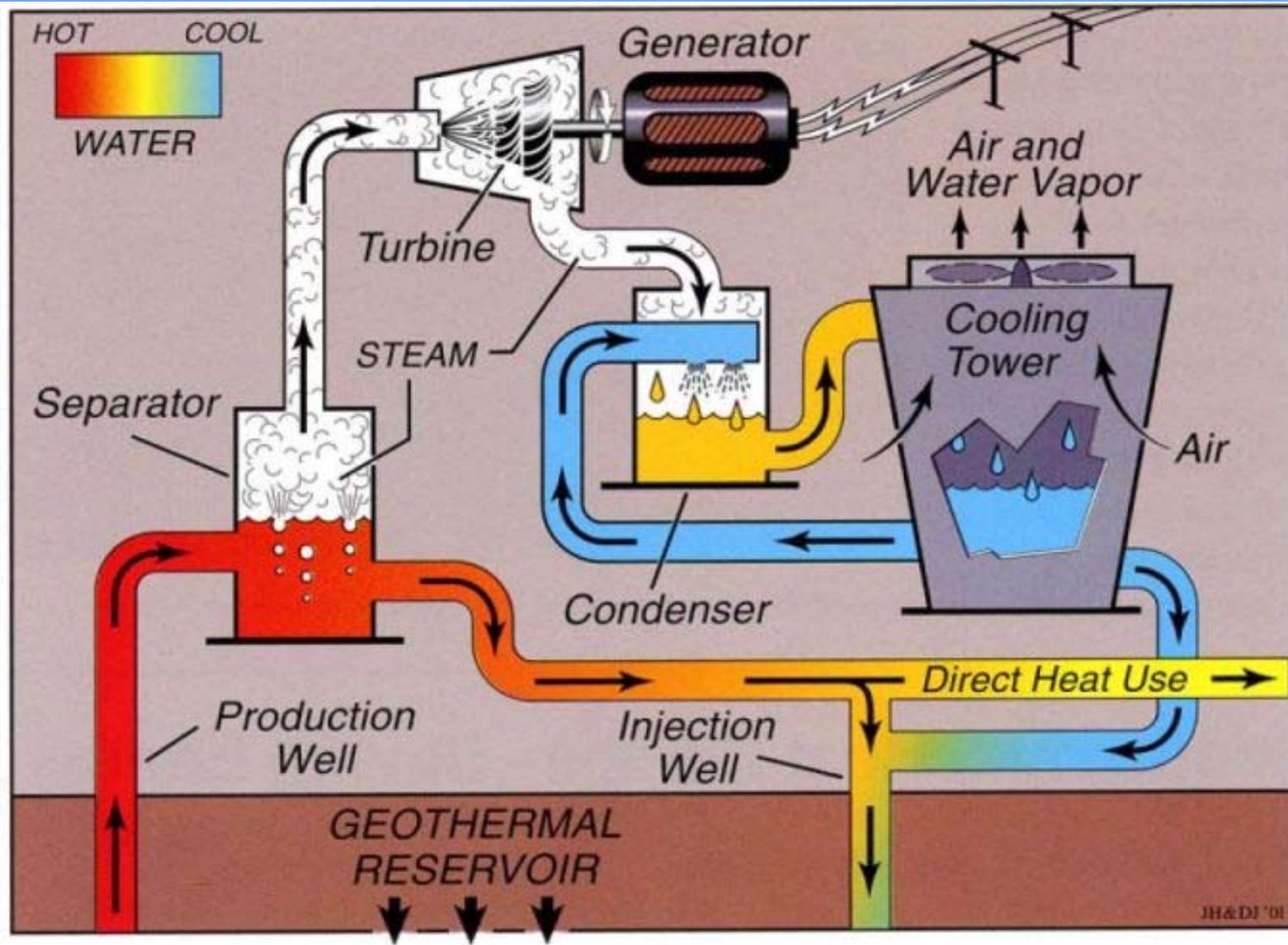
# Benefits to the Local Community

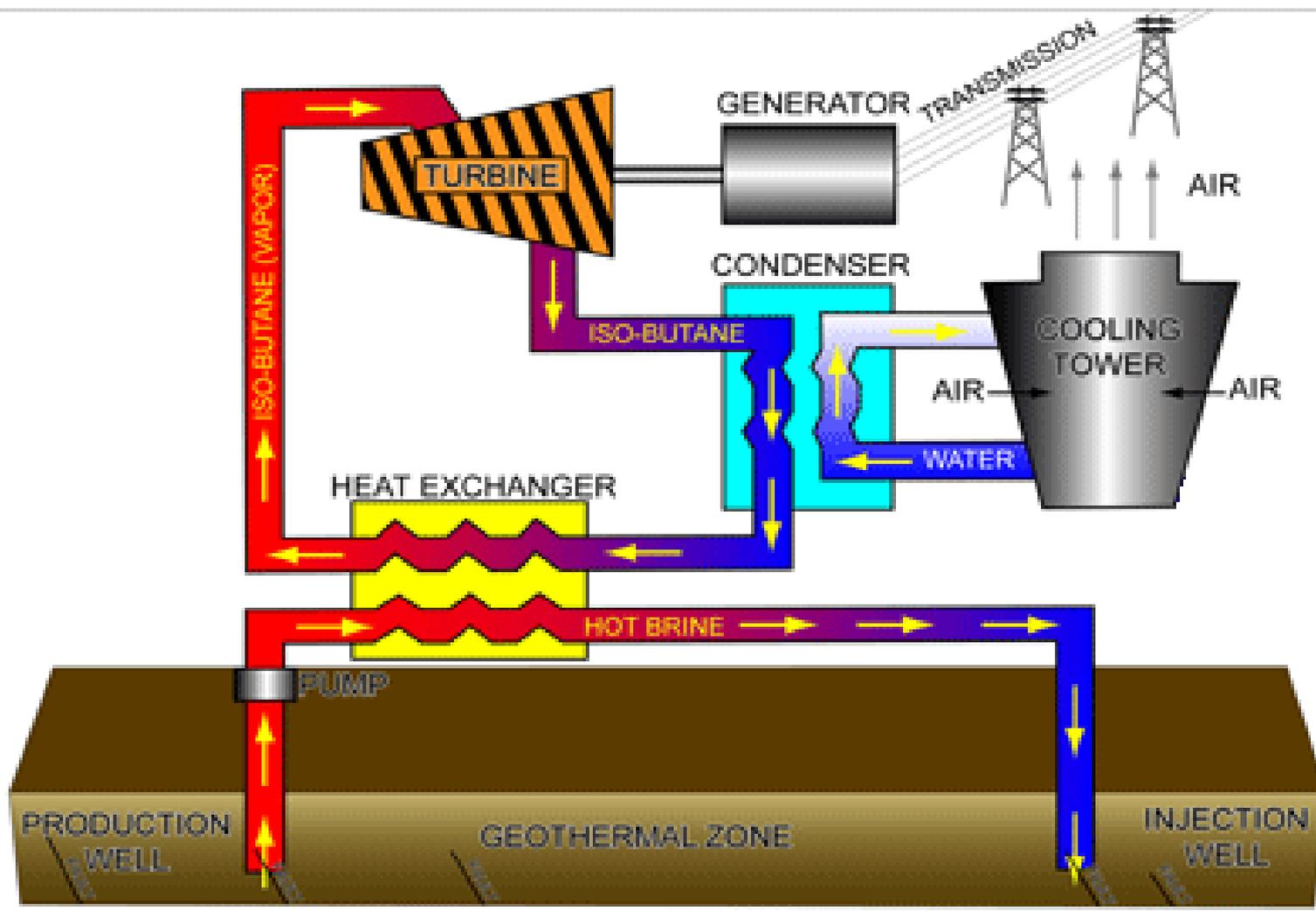
- Reliable local power source:  
Geothermal power plants have a very high capacity factor, >95%
- Local employment in construction, then operation
- Geothermal fluids may be cascaded:  
after heat extracted for power plant, more heat may be extracted for direct use

# Geothermal Power Plants

- Geothermal electricity generation is a mature technology that started in Lardarello, Italy in 1904
- It also has some experimental aspects – none of the experimental technology is likely to be used in the Colorado mountains
- Geothermal power plants are simpler, smaller, and can be made less visible than other generating plants.

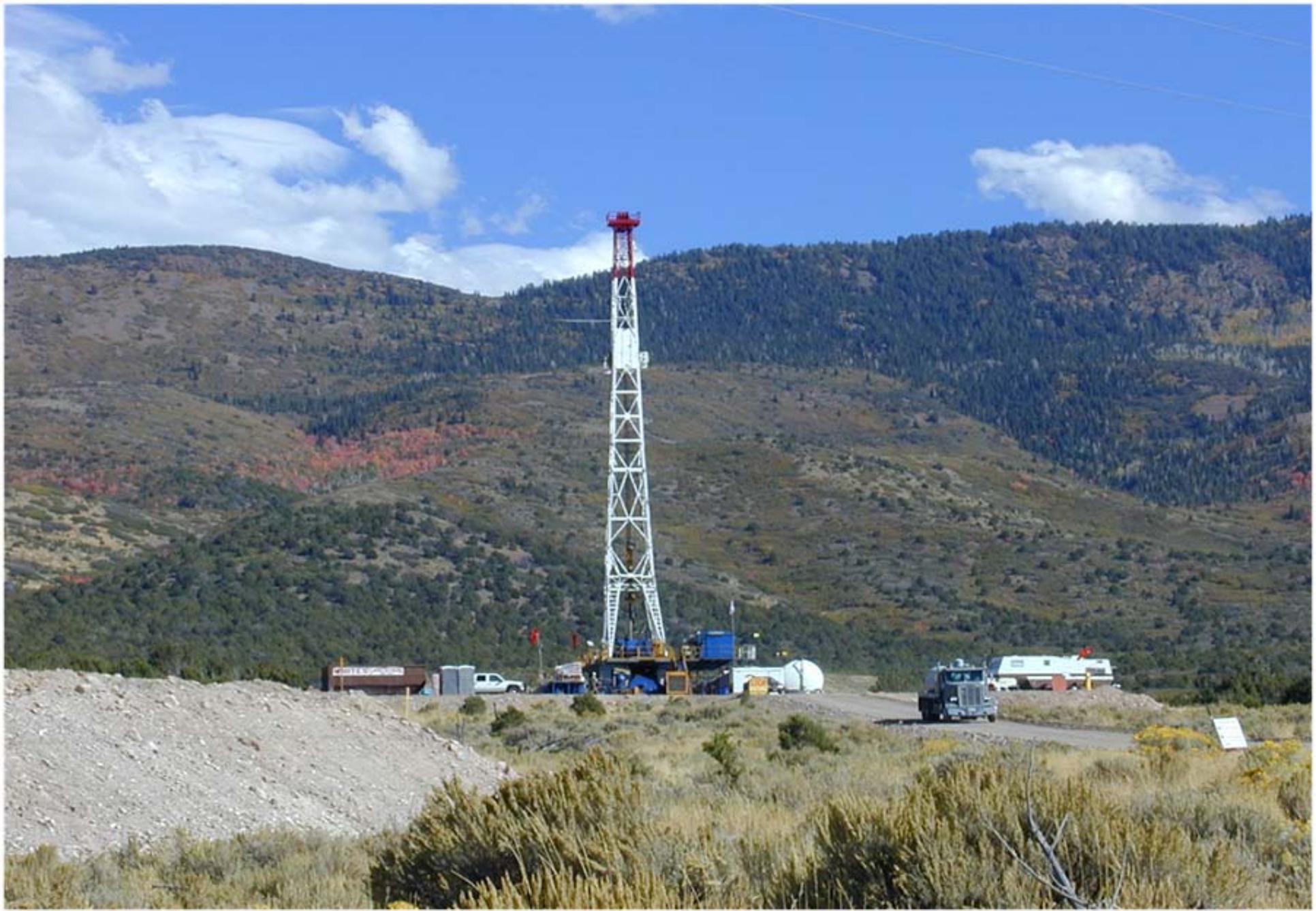
# Flash Power Plant – Unlikely to be used in Colorado





SOURCE: MHA Environmental Consulting 2008

# Binary Power Plant: Air Cooled



# Soda Lake II, NV, 12 MW



Puna, Hawaii. Ten 2500 kW units, Total 25 MW



# Mammoth Pacific's Award Winning Facilities - 40 MW

Location: Mammoth Lakes, CA

12 production wells

Binary/air cooled

Plant size: 10 acres

6 injection wells

Awards: California State Assembly

U.S. Forest Service

California Department of Conservation

Eastern Sierra Advocates Network

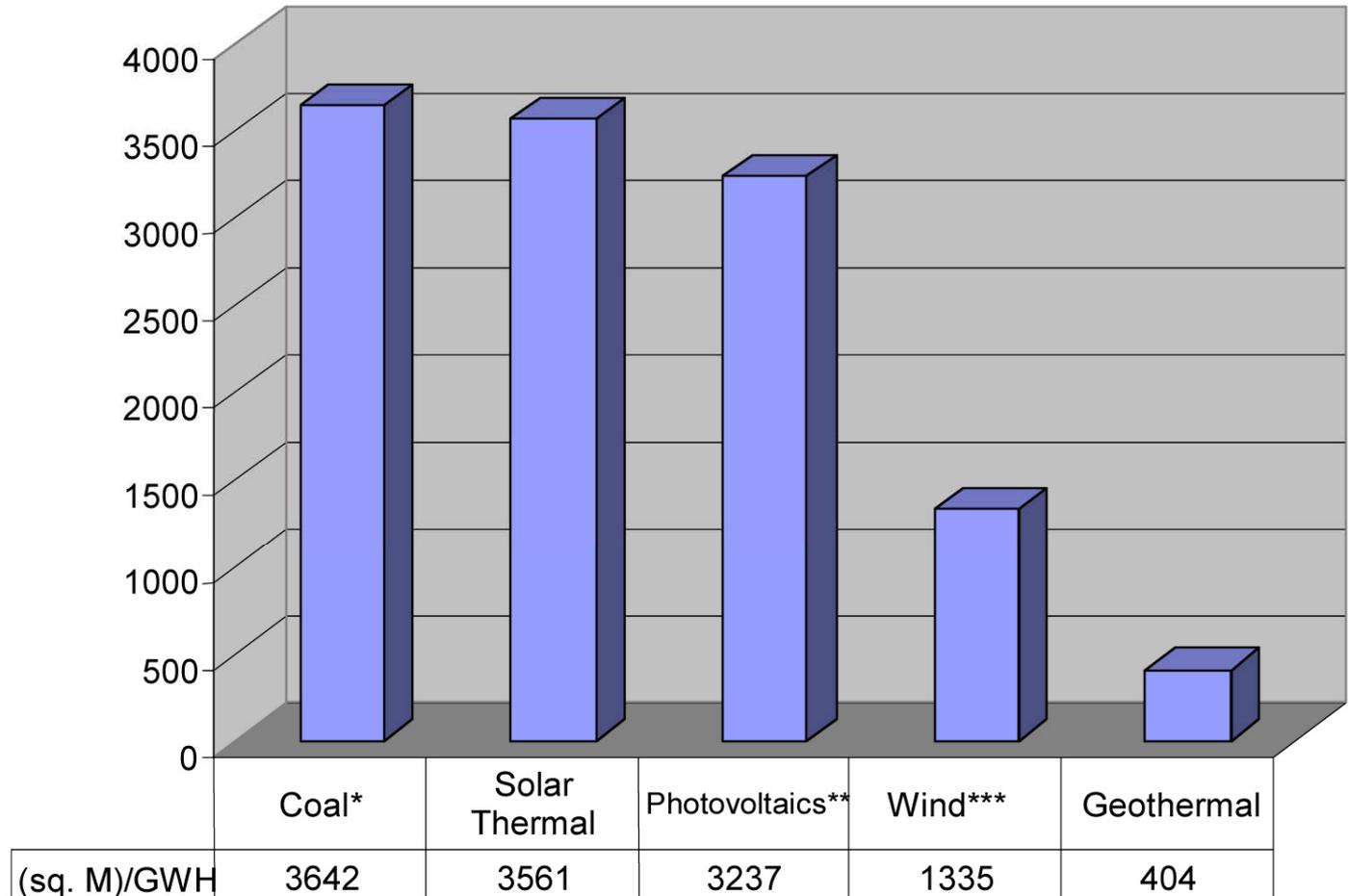
The Governor's Environmental &

Economic Leadership Awards

Geothermal Resources Council



# 30-Year Land Use



\* Includes mining.

\*\* Assumes central station photovoltaic project, not rooftop PV systems.

\*\*\* Land actually occupied by turbines and service roads.

Data Source: Geothermal Energy Association, April 2007

# What is a Geothermal Resource Legally?

1. On Federal Land it is a mineral resource
  2. On Colorado State Land it is a mineral resource
  3. On All Other Land in Colorado is a water resource
- ❖ However on Federal and State Land, the medium that brings the heat to the surface is water, regulated as a water resource!
  - ❖ Federal and State agencies are working together on Colorado to remove regulatory barriers caused by these different definitions

# Geothermal/Water Rights

- For most purposes geothermal resources are managed in the same manner as subsurface water in Colorado: where groundwater is designated as tributary water, geothermal waters are a public resource, the rights to which are subject to State appropriation procedures
- These rights are managed by the State Engineer and administered through the Division of Water Resources
- A geothermal permit, in addition to a water use permit, should be obtained for use of a geothermal resource

# Senior Rights

- First in time, first in right applies:
  - a. to quality and quantity if you have a senior water permit, including a domestic well permit
  - b. To quality, quantity, and temperature if you have a senior geothermal permit
- However, the State Engineer has a mandate to ensure best use of the geothermal resources of the State and may control the quantity of geothermal fluids extracted through the establishment of a *Geothermal Management District*

# More Information

**Colorado Geological Survey web page:**

<http://geosurvey.state.co.us>

Follow the geothermal link on the home page

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**Division Water Resources web page:**

<http://water.state.co.us/>