GeoPowering the West

GEOTHERMAL ENERGY: Resources, Exploration, Drilling and Economics

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Oregon Department of Energy

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TOPICS

- Resources
- Exploration
- Drilling
- Economics

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RESOURCES

- Water heated at great depth flows toward the surface along vertical aquifers to allow access at shallow - economically drillable - depths.
- Often not all hot water from a geothermal system discharges at the surface as hot springs. At shallow to intermediate depths (up to ~2000 ft.) up-flowing hot water may disburse laterally, away from the vertical aquifer, along permeable layers.

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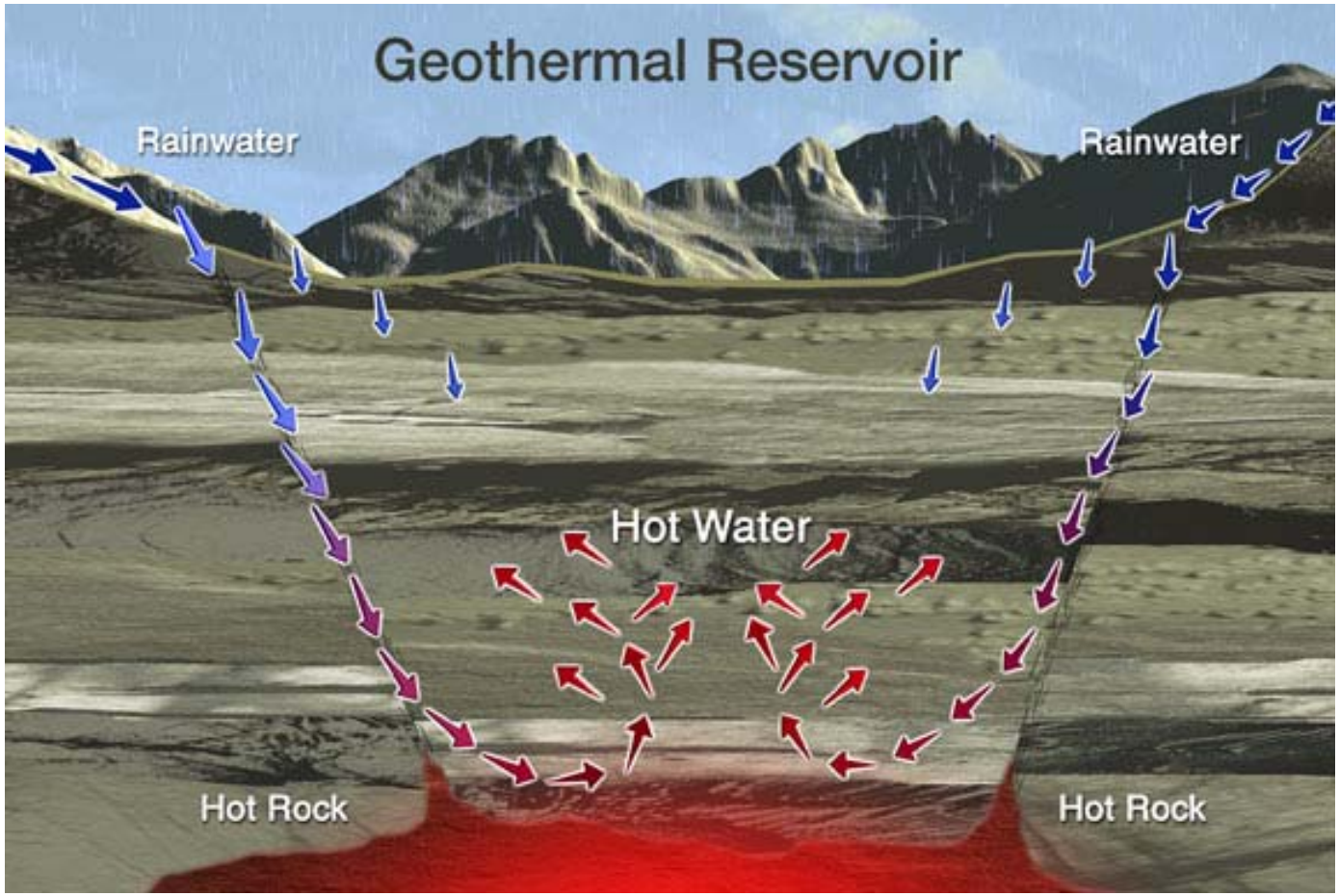

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RESOURCES

- In order to develop a geothermal resource, production wells must intersect the vertical hot aquifers directly or intersect hot lateral aquifers proximal to the up-flow zone.
- Rock permeability is a critical component of geothermal resource development. Clay and silt rich sediments, fresh fractured lava, altered lava & sand and gravel each have different.
- Water Well Reports show the productive shallow aquifers in Harney County to be sand and gravel layers.

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RESOURCES

- Geothermal water has been exploited for direct use in Harney County for heating for many years.
- Exploration for geothermal steam - capable of power generation has taken place in the lower Alvord Desert area.
- The threshold of success for these two applications is substantially different.

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RESOURCES

- Direct use heating and industrial applications require flow rates of hundreds of gallons per hour with temperatures less than 250 F.
- Power generation requires hundreds of thousands of gallons per hour of geothermal water with temperatures exceeding 350 F.

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EXPLORATION

- Literature review e.g., well logs
- Passive activities e.g., mapping
- Active exploration e.g., shallow holes
- Drilling e.g., deep wells
- It all takes $

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EXPLORATION

- A review of available geothermal data for the Harney County suggests that
  - the risk for successful exploration for a geothermal resource with 200 F water and sustained production rates of a few thousand gallons per hour is moderate, while
  - the risk for exploring for a geothermal resource capable of sustained power generation is high e.g. Borax Lake.

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DRILLING

"Classic" drill rig in Klamath Falls. Very much a water well rig.

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DRILLING

Modern truck-mounted drilling rig capable of going to significant depth e.g., 3000 feet.

Cost of $50 - $80 per foot drilled

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DRILLING

Rig used to look for steam, drawn directly from the oil & gas industry.

Blow-out prevention equipment is a critical part of this operation.

20 truckloads of equipment alone

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ECONOMICS

- GOAL of saving energy costs enough to make the operation profitable
- Energy costs are only one category: other costs – labor, transportation - must be “in the ballpark”
- Life cycle costing =
  - Pay now to reduce & control later costs

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ECONOMICS

FOSSIL/ELECTRIC

- Boiler or Furnace
- Distribution system
- Radiators
- FUEL bills for everything
- Power bills for everything

GEOTHERMAL

- Wells
- Heat Exchanger
- Distribution system
- Radiators
- FUEL bill for peaking
- Power bills for pumping

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ECONOMICS

- What you save by using “free” hot water has to be less that same operation using oil, gas or power.
- Savings then pays for amortizing well costs, heat exchange equipment, and operating costs (pumping & maintenance).

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BASIC EQUIPMENT

Here is a gas furnace retrofitted with pipes running geothermal water instead. Same end result of air heating across the coil.

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GREENHOUSES

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