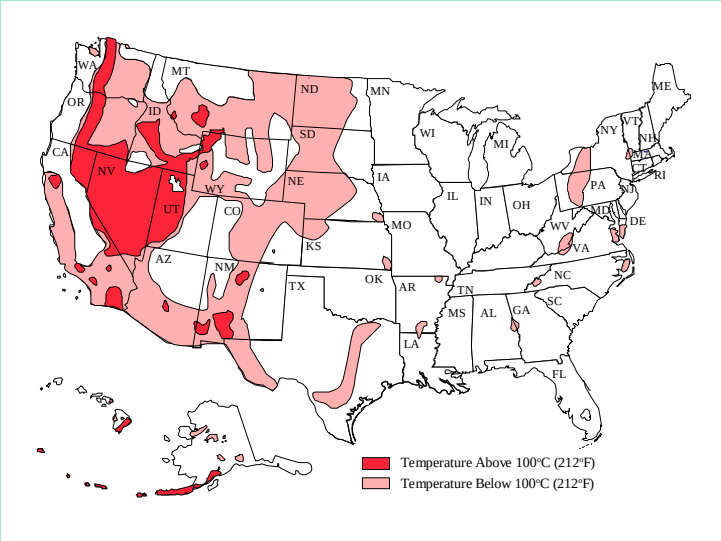
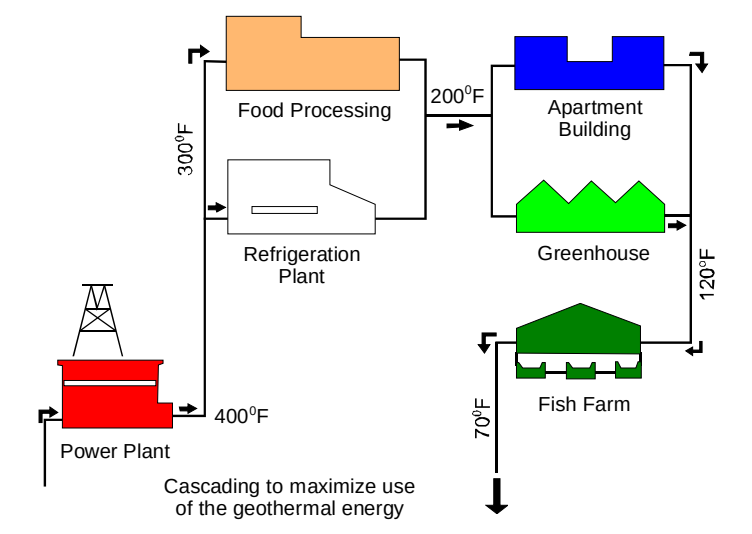
Geothermal Development at Oregon Institute of Technology and Klamath Falls

Tonya "Toni" Boyd
Assistant Director
Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, Oregon

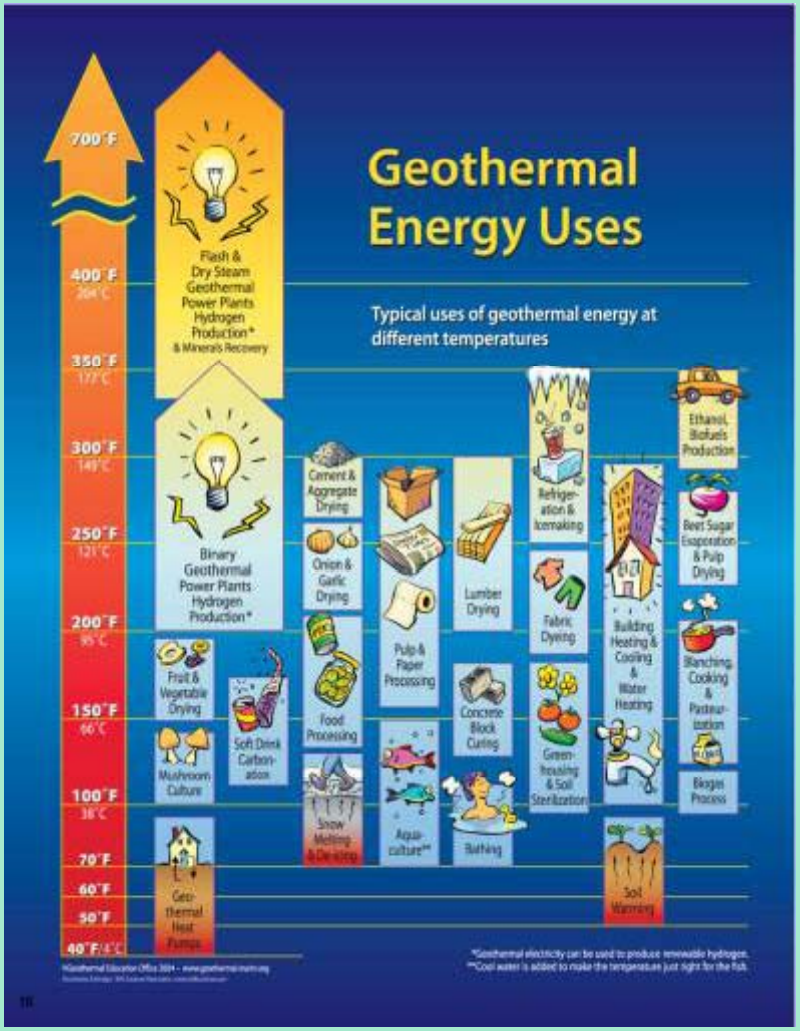
What is Happening in the Klamath Area?



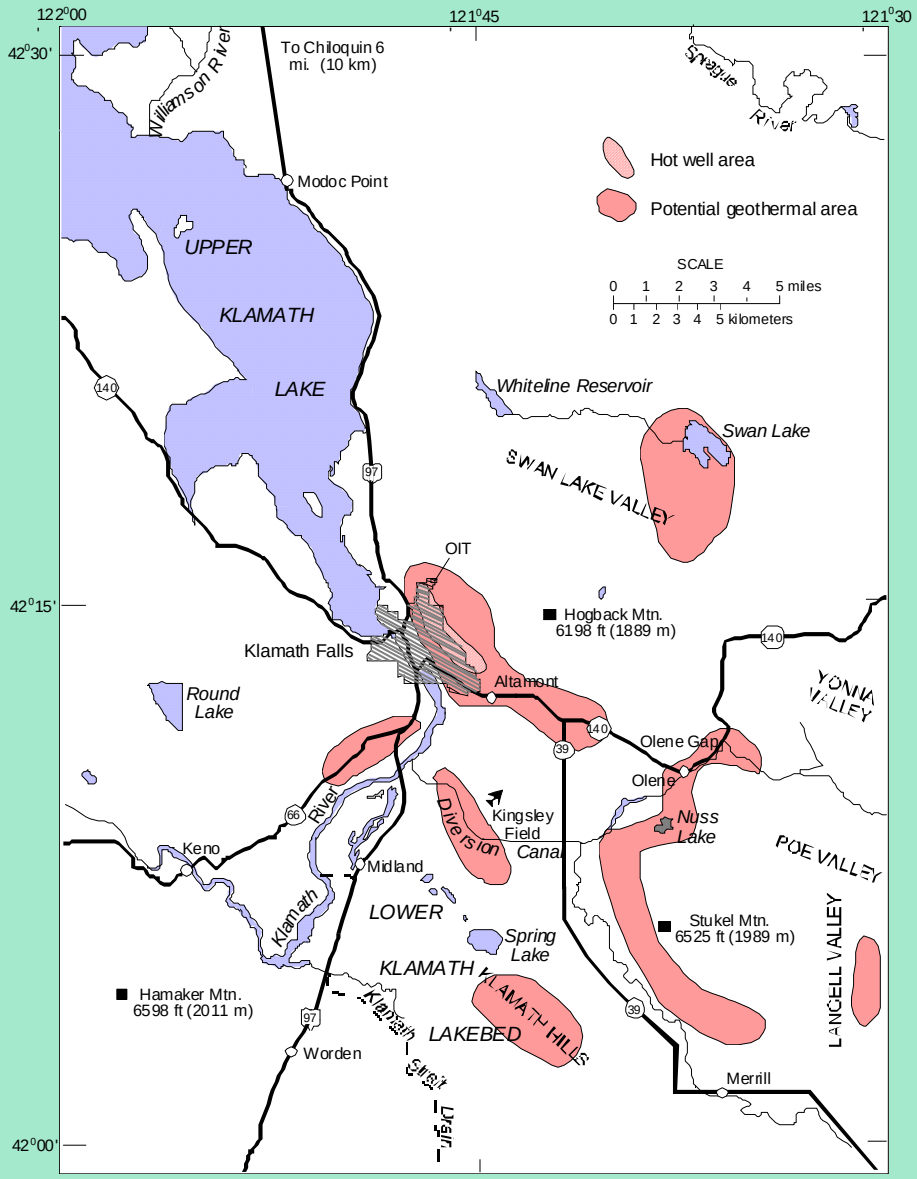
Geothermal Resources of the USA



Cascading geothermal fluids – combined heat & power



- **High temperature: Electric Power**
- **Low temperature: Direct Use**
- **Ambient temperature: Heat Pumps**



Klamath County

District Heating

3 sites

Industrial

2 sites

Greenhouse

2 sites

Aquaculture

1 sites

Space Heating

Over 600 sites

Snow Melting

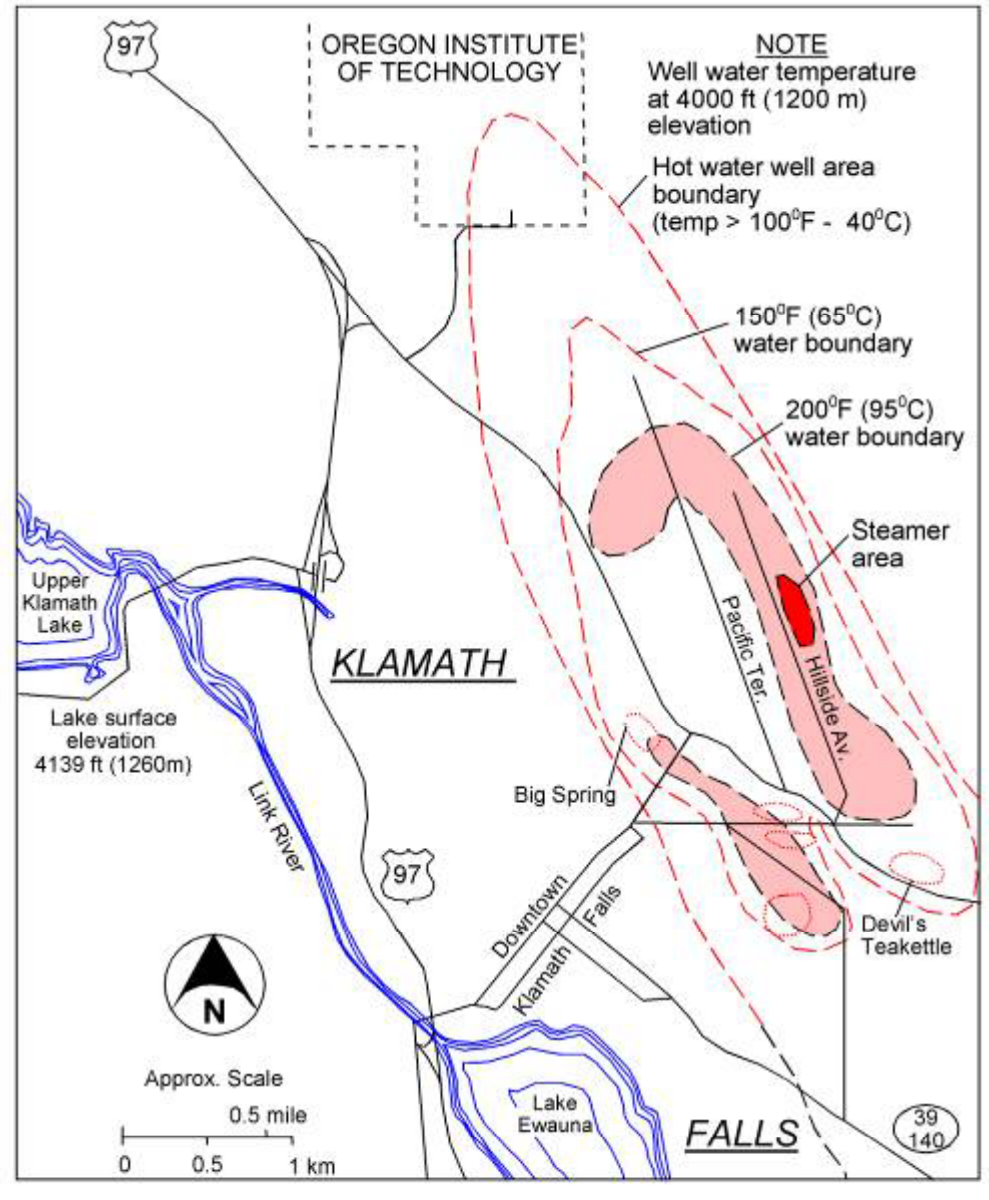
3 main areas

Resort / Spas

4 swimming pools

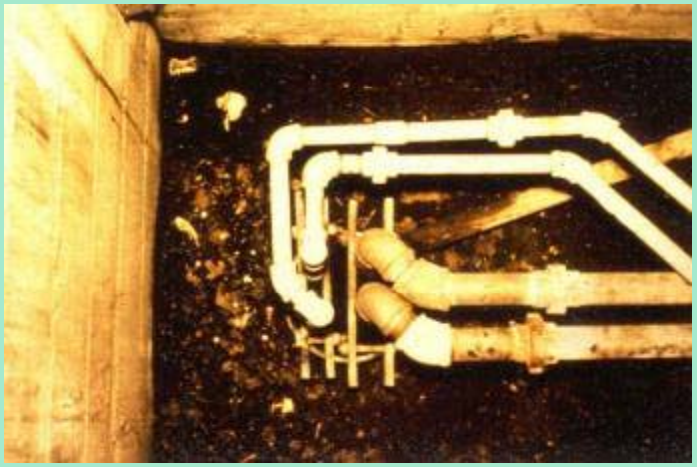
KLAMATH FALLS

- 500+ geothermal wells
- 100 to 2000 feet deep
- 100 to 220°F
- Majority use downhole heat exchangers
- City district heating system – 20 buildings
- Snow melting system
- Oregon Institute of Technology
- 86 MWt capacity, 200 billion Btu/yr
- 50,000 bbl saved per year



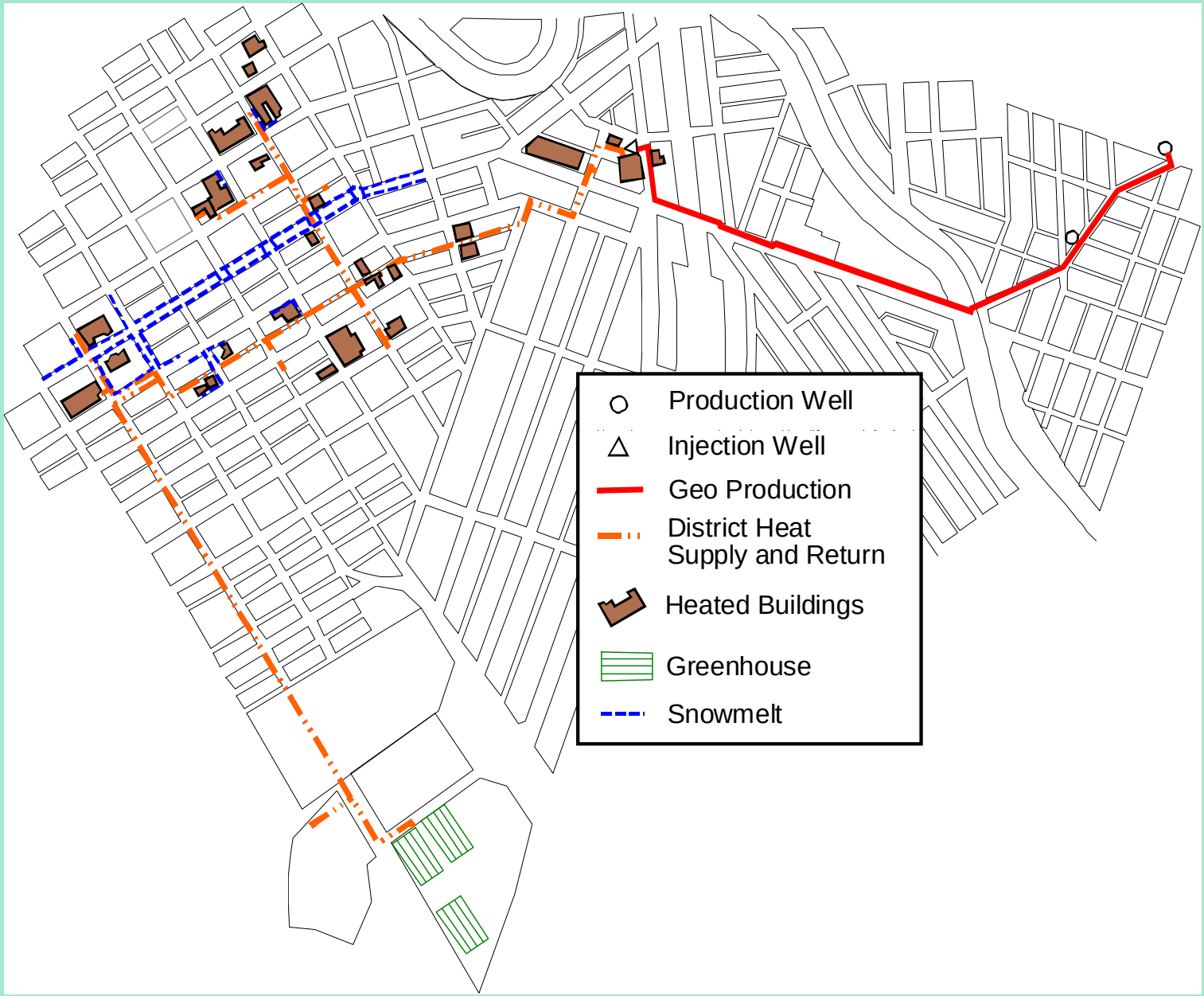
Klamath Falls

DHE



Klamath Falls District Heating System

- Klamath Creamery – only geothermally brewed beer
- IFA Nursery – 4 acres – trees seedlings
- ARRA grant for Low-Temperature power generation
- Snow melting of downtown crosswalks


Production Well
Injection Well
Geo Production
District Heat
Supply and Return
Heated Buildings
Greenhouse
Snowmelt

Liskey's Ranch

Organic vegetables

Bio-tactics - Feed stock for predator mites

Biodiesel

Power Generation?

“Gone Fishing”

African Cichlids

Tilapia

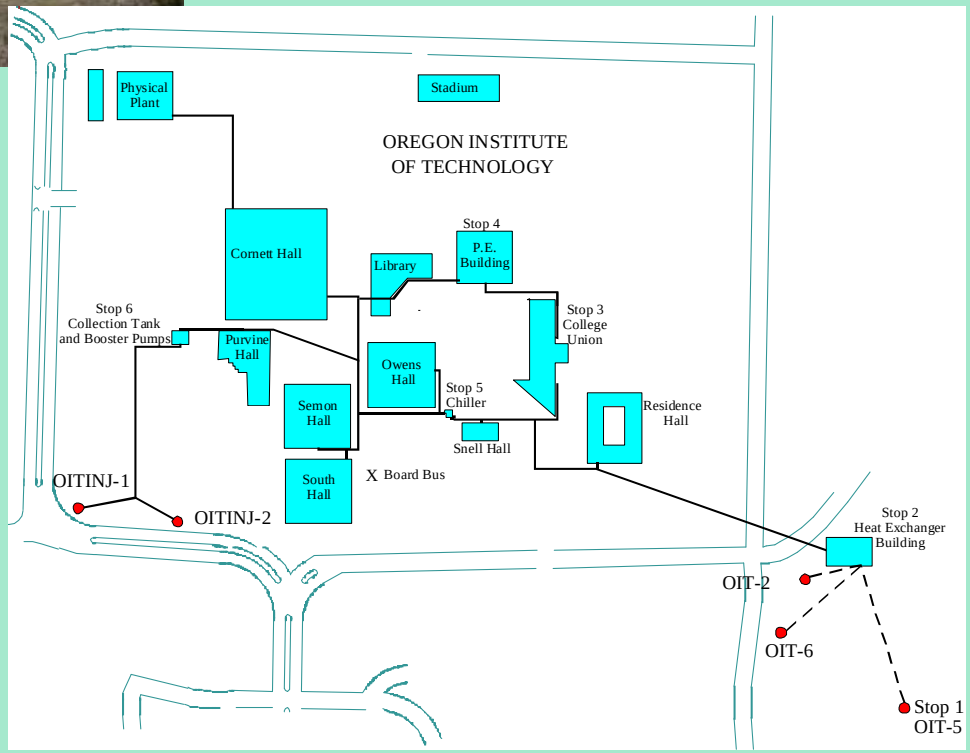
Developed Wetlands

Expanding Operation

Olene Gap

- **Several owners have been in contact with us exploring geothermal power possibilities**

Oregon Institute of Technology

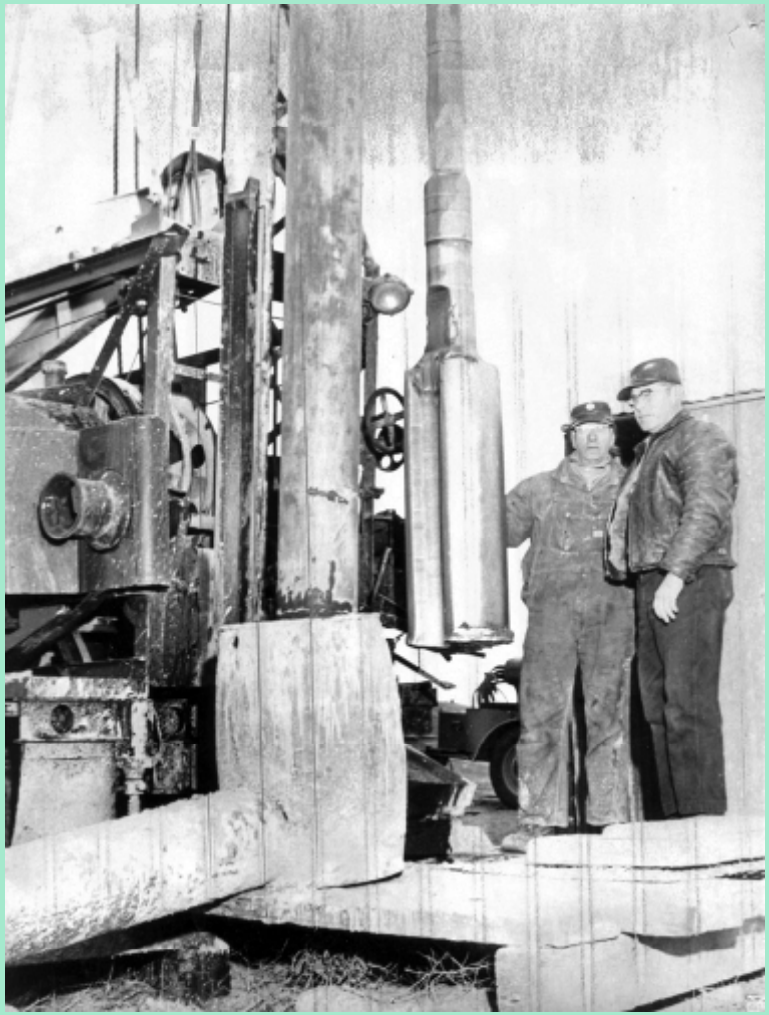


Past and Present

- Original location was a military facility
- Original campus (1947 – 1960) spent $100,000/yr for heating
- Appropriation of $150,000 for exploration for a new campus for OIT – late 1950s
  - Used for master plan
  - Exploration to determine availability of geothermal water for space heating

Well Drilling

- OIT #1 – 1959
  - Depth 1,200 ft produced 510 gpm of 78ºF water – used as domestic water now
- OIT #2 – 1960 further west and south of OIT#1
  - Depth 1,220 ft producing 170 gpm of 176ºF water
- OIT#5 and 6 – 1963 – area close to OIT#2
  - Depths 1,716 and 1,800 ft producing 442 and 250 gpm of 191ºF water



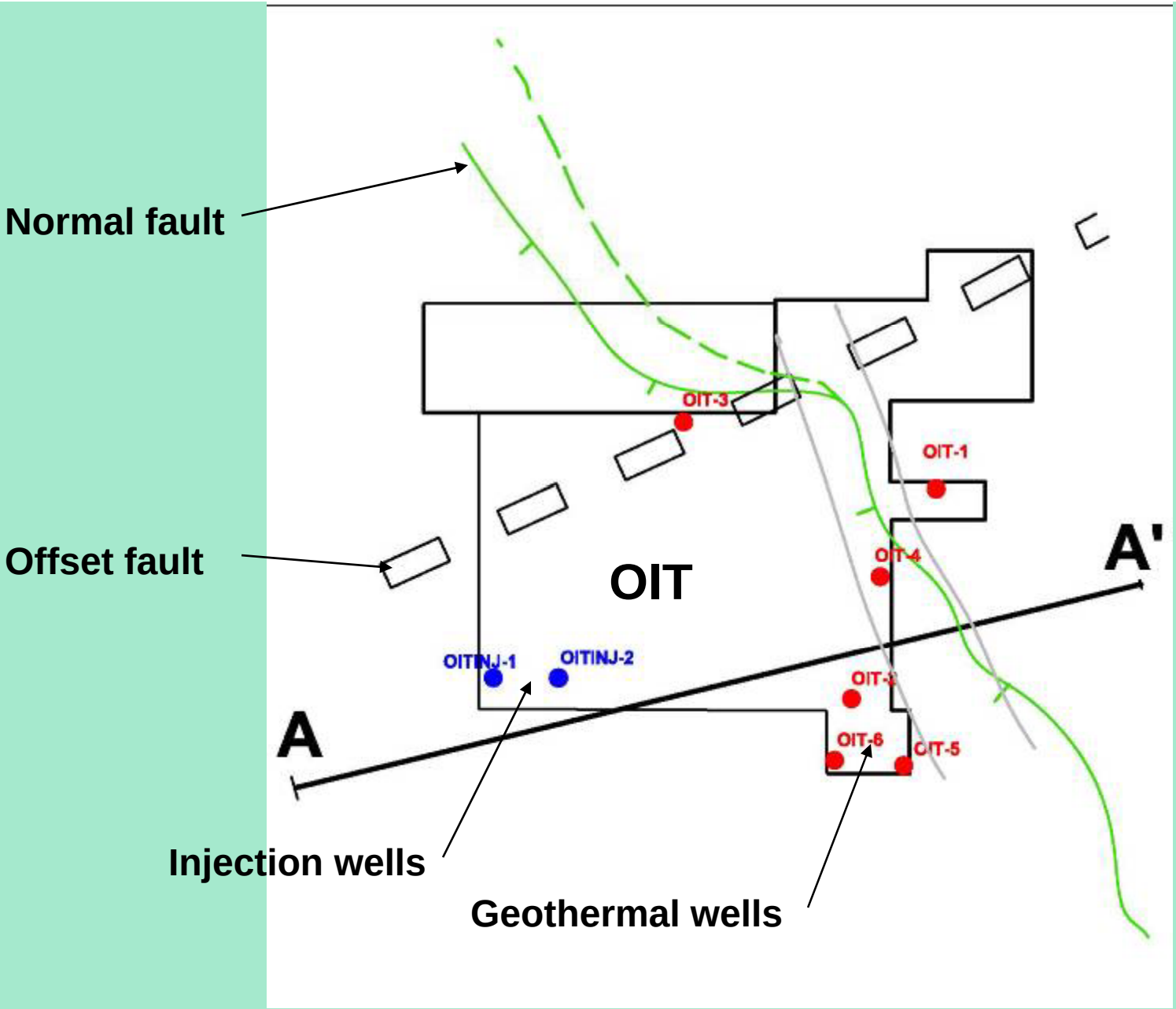
Well Drilling 2

- OIT#1 drilled into the up-throw of the normal fault
- OIT#2, 5 and 6 drilled in the down-throw side of the fault thus tapping the outflow zone of the fault
- Cost to drill the deeper wells - $32,000 or $18 per ft.
- Well penetrated a mixture of volcanic ash and diatomaceous earth then various layer of basalt, andesite, clayey tuffs, broken lava and cinders

Oregon Institute of Technology - Faults

Past and Present

- Grew from 4 buildings to 16 buildings
  - 812,000 ft^2 of heating space
  - 5 buildings added in last 3 years
- Problems with the geothermal
  - Pumps, heating system, distribution, injection
- Only completely geothermally heated campus in the US



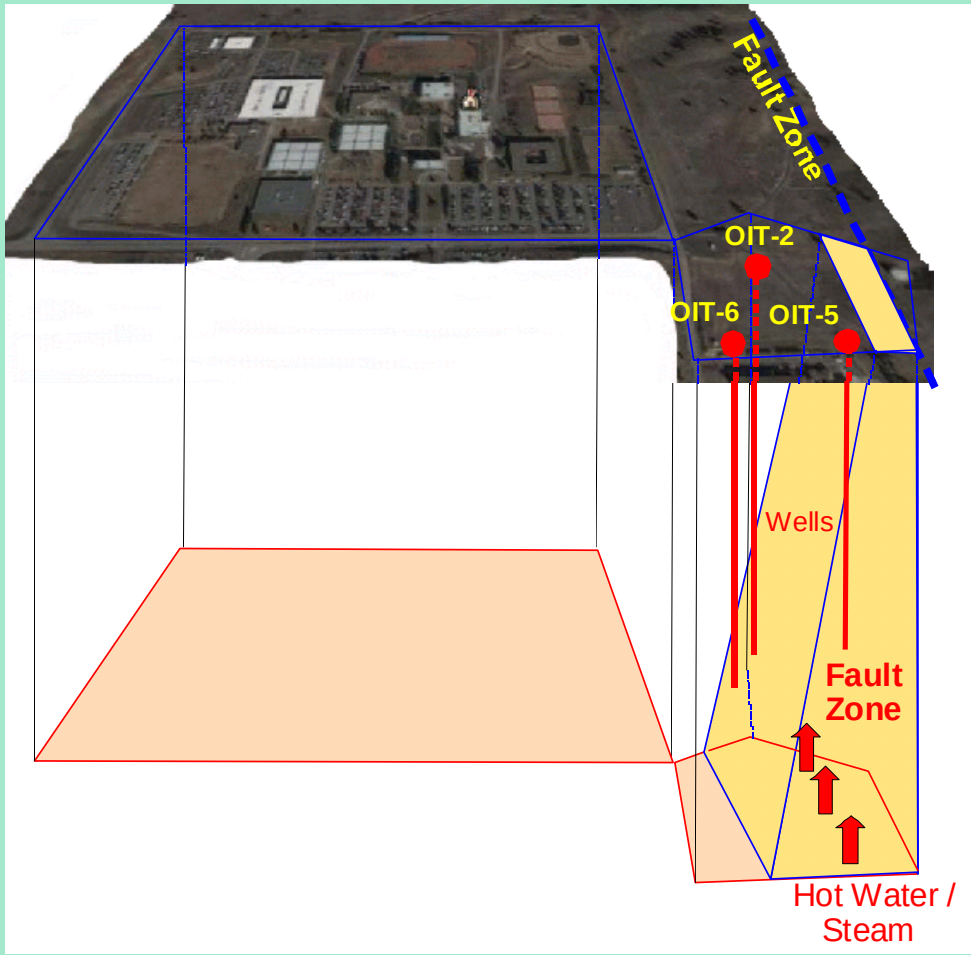
Normal fault system on the east side of campus

Projects

- Small Scale Power Plant
  - Completed
- Deep Well Drilling Project
  - Completed
- Medium Scale Power Plant
  - Development stage
- Incubator Greenhouse Facility
- Incubator Aquaculture Facility

Small Scale Power Plant

- Use existing wells at approx. 600 gpm
- Take 15ºF off the top
  - actually is 27ºF – to campus around 165ºF
- Remainder adequate to heat campus
- Binary (organic Rankine cycle) power plant – 280 kW gross (85-140 kW net)
- During warmer periods temperature can take 42ºF (23ºC) off the top



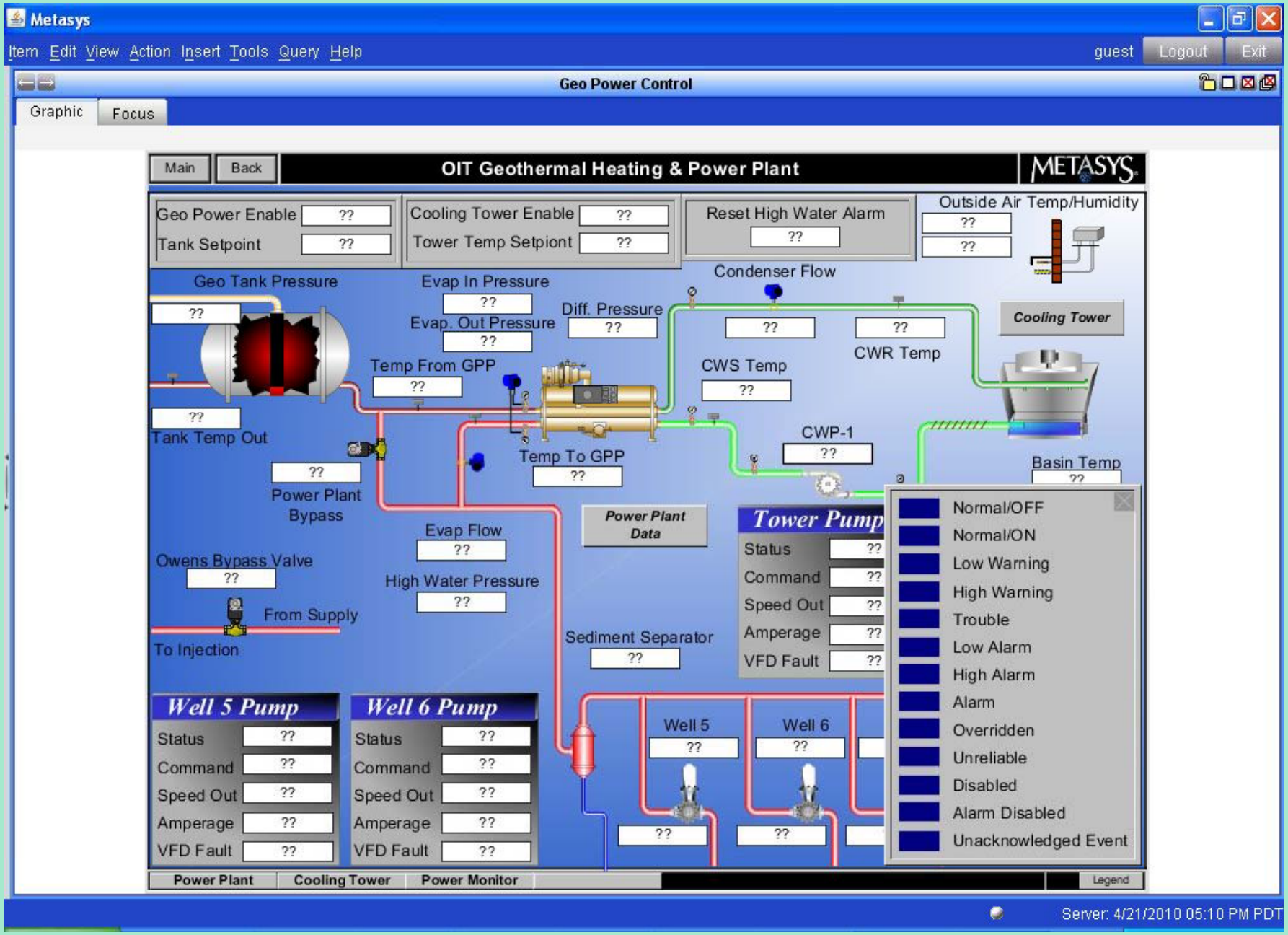
Small Scale Power Plant 2

- Single cell cooling tower with 70ºF (21ºC) cooling water
- Average net output ~150 kW
- Provide 10% of electrical energy use
- Demonstration site and student laboratory
- Real time monitoring will be available

Small Scale Power Plant 3

- Delivered March 2009
- Operational Feb 2010

Installing the 280 kW geothermal power plant


Metasys
Item Edit View Action Insert Tools Query Help
guest Logout Exit
Geo Power Control
Graphic Focus
Main Back
OIT Geothermal Heating & Power Plant
METASYS
Geo Power Enable ??
Tank Setpoint ??
Cooling Tower Enable ??
Tower Temp Setpiont ??
Reset High Water Alarm ??
Outside Air Temp/Humidity ?? ??
Geo Tank Pressure ??
Evap In Pressure ??
Evap. Out Pressure ??
Diff. Pressure ??
Condenser Flow ?? ??
CWR Temp
Cooling Tower
Temp From GPP ??
CWS Temp ??
Tank Temp Out ??
CWP-1 ??
Temp To GPP ??
Basin Temp ??
Power Plant Bypass ??
Power Plant Data
Tower Pump
Status ??
Command ??
Speed Out ??
Amperage ??
VFD Fault ??
Evap Flow ??
Owens Bypass Valve ??
High Water Pressure ??
From Supply
To Injection
Sediment Separator ??
Well 5 Pump
Status ??
Command ??
Speed Out ??
Amperage ??
VFD Fault ??
Well 6 Pump
Status ??
Command ??
Speed Out ??
Amperage ??
VFD Fault ??
Well 5 ??
Well 6 ??
Normal/OFF
Normal/ON
Low Warning
High Warning
Trouble
Low Alarm
High Alarm
Alarm
Overridden
Unreliable
Disabled
Alarm Disabled
Unacknowledged Event
Power Plant
Cooling Tower
Power Monitor
Legend
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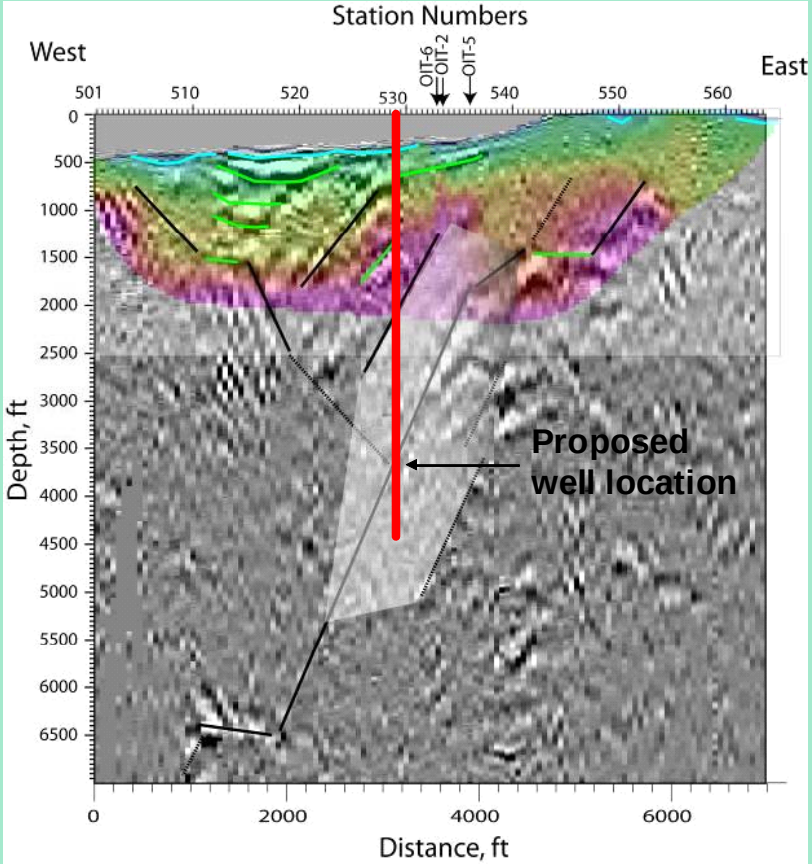
Deep Well Drilling Project

- Drilling up to 6,000 ft to intersect high angle normal fault
- Already tapped with existing wells to 1,800 ft. (550 m)
- Surface water chemistry predicts 300°F at depth
- Hoped to produce 1500 gpm of 300°F water (95 l/s, 150°C)

Deep Well Drilling Project 2

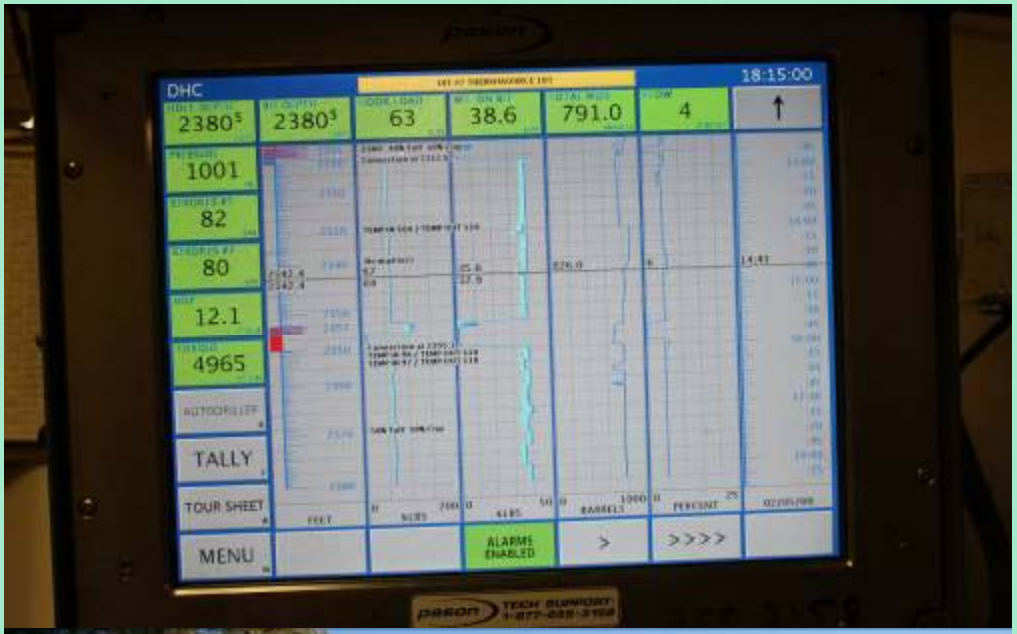
- Completed a reflection seismic survey
  - Optimum drilling target 3,000 to 4,000 ft
  - Drill site in southeast corner of parking lot
- Completed Environmental Assessment
- Looking to intersect and follow the main normal fault = upflow zone



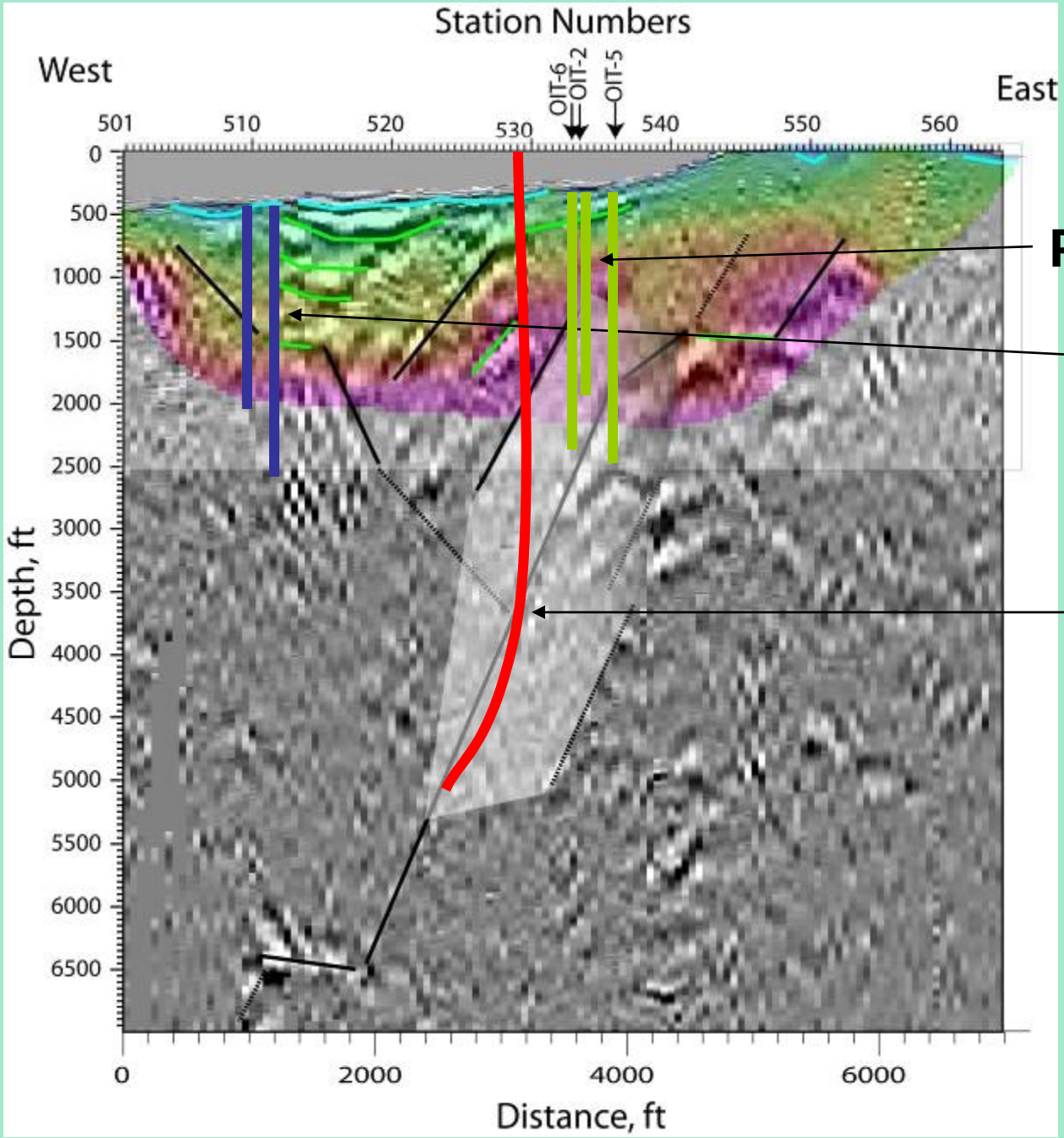
Deep Well Drilling Project 3

- Drilled to 5,300 feet in 37 days
- Deviated after intersecting the fault
- Could not case or probe for temperature last 300 feet
- Preliminary temperature profile indicated well is isothermal at 196°F
- No real complaints on the noise just the lack of parking spaces
- Test pumped to 1,500 gpm with 24 feet of drawdown – at 2,500 gpm estimated drawdown estimated at 71 feet.

Dedication – Jan. 24, 2009



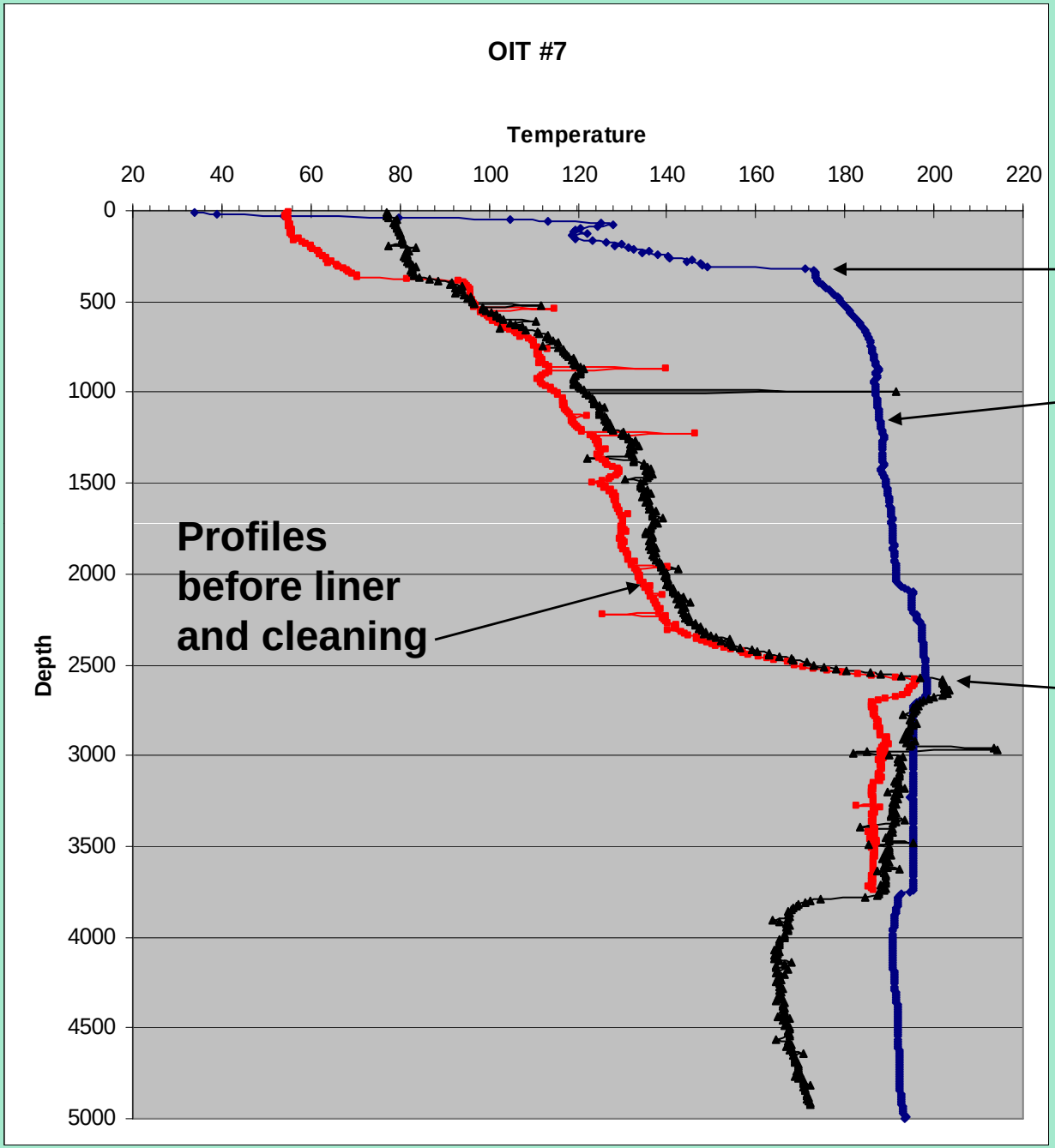
Drilling the deep well



Production wells

Injection wells

Well location



Temperature profiles of deep well

Deep well pump test – 1,500 gpm @ 196°F

Medium Scale Power Plant

- Probably a binary power plant – 1.2 MWe gross – 800 kW net
  - **Based on a flow of 2500 gpm and 200ºF**
- Will provide about 60% of campus electrical needs
- Reject water can be used to supply additional heat to campus and to surrounding buildings
- Used as a demonstration site and student laboratory

Medium Scale Power Plant 2

- Pipeline is complete up to heat exchange building
- Pump test completed in July
  - Water Rights
  - Injection well
  - Specify pump
- Injection Well RFP at DOJ
- Power Plant RFP??
- Starting on an Interconnection Agreement
- Complete pipeline from power plant to injection well
- Combining a couple of our meters to use power internally
- Hopefully operational by late 2012

Oregon Institute of Technology
Geothermal High Temperature
Power Project
Injection Wells
Drill Rig at the
Production Well
Existing
Geothermal
Wells
Geothermal
Power Plant

INCUBATOR SITE
Greenhouses and Aquaculture Facility

- Several 6,000 ft^2 (560 m^2) greenhouses with different heating systems
- Several 3,000 ft^2 (280 m^2) aquaculture ponds with building enclosing fiberglass tanks
- Research and demonstration site for students in cooperation with KCC and OSU Ag. Extension Office
- Incubator site for potential commercial spin-off facilities in the Basin
- Cooperation with Klamath Country Economic Development Association
- Similar to those at New Mexico State University

Conclusions

- OIT is the first campus to receives all of its heating energy from a geothermal resource under campus
- OIT has the first geothermal power plant on a university campus and the only one operating in Oregon
- We are approaching a 100% “green” campus – PV, wind and biomass will be added in our Sustainable Energy Park.
- With our Renewable Energy Engineering BS program – we are a training facility in all forms of geothermal energy use – as well as a demonstration/tour site.

Thank you