

Planning & Drilling Geothermal wells



KAUST

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The energy for a better life.



Introduction & agenda

- **General** considerations / pro cons
planning & executing GT projects
- **Learnings** from 1-2 projects in Austria
 - logging
 - cost
 - drilling & completion
- **Ideas** & suggestions for applications in KSA

Pro / Con

- Utilizes renewable energy - available 365 d/yr
- Heating & cooling possible
- Low running costs
- lowest water requirement per MWhr (times 50 for coal, oil, nuclear)
- 12% of emissions of coal
- Low footprint of plant
- Release of GHG
- Instabilities & earthquakes
- 2x expensive than HC wells
- Location specific
- Complex fluid management required (t/ prevent losses)

Heat

Fluid

Perm

Considerations

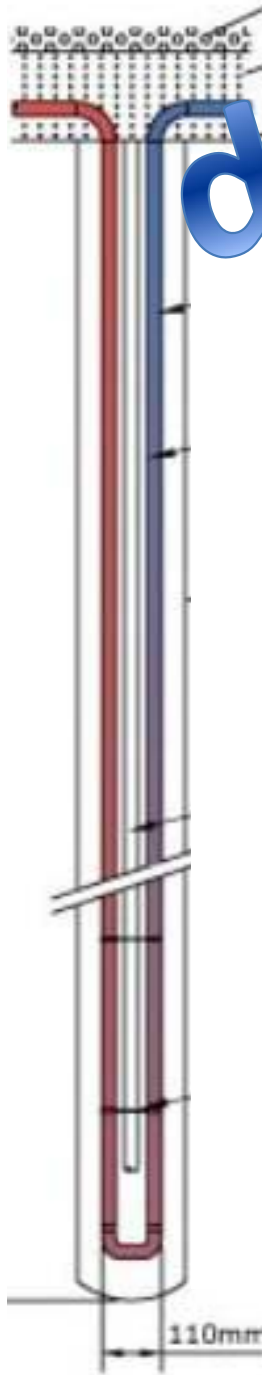
Learnings

Ideas

de-risk

prerequisites

- Planning of geothermal water wells requires a hydrogeological-tectonic model
- The accuracy of the model will have a direct impact on planning uncertainties
- 3D models have become state of the art
- Offset wells, seismic cubes, gravimetrical data and a fault model are often used as input
- Sequence stratigraphy has proven to be valuable to verify input
- Core material help to describe reservoir properties & Identify project/well type
- Incorporate geomechanics & fault pattern



Considerations

Learnings

Ideas

Planning GT

Suggest

- Preplanning
 - Reduce uncertainty
 - Licensing
 - Authorities
 - environment
 - Well design
 - Fit for purpose/yet flexible (fiber CSG?)
 - Flow rates/dimensions (ESP)
 - Thermally shielding cement
 - Corrosion & scaling
 - Factory drilling
 - **Well execution**
 - Reduce rig time
 - DWOP
 - Logging & testing
 - Minimum
 - Consider life cycle of project
 - In production setting
 - timing
- *Definition of interfaces*
 - *Develop portfolio + KPIs*
 - *predefined objectives*
 - *Process controlled workflow*
 - *Key documents*
 - *Milestones*
 - *reviews*
 - *Utilization of standard sizes & equipment*
 - *Timing (oil price)*
 - *Rig acceptance*
 - *Batch drilling*
 - *Pilot hole / appraisals*

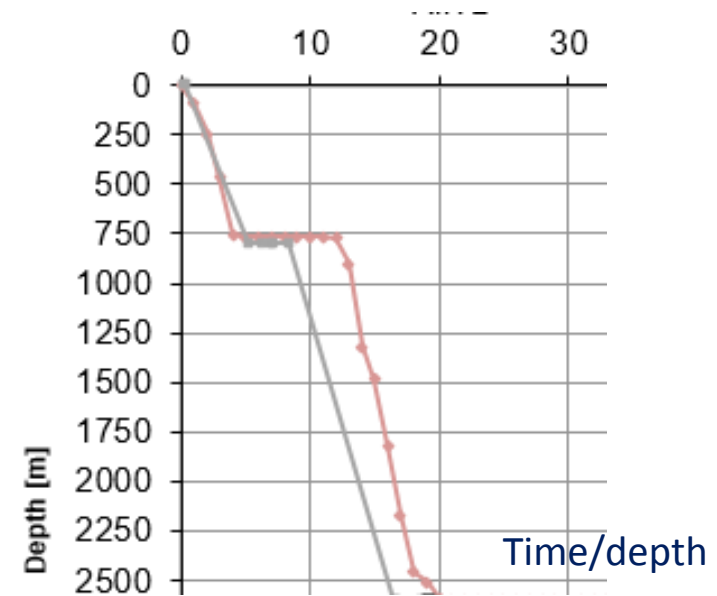
Considerations

Learnings

Ideas

well execution

- Contractual setting
 - Equipment tests
- Rig acceptance
- Lump sum work
- Value of information – RT?
- Surface/ DH logging
 - Measurement of thermal conductivity on cuttings
- On site/off site decision
- Products & services used
 - Mud program
 - logging

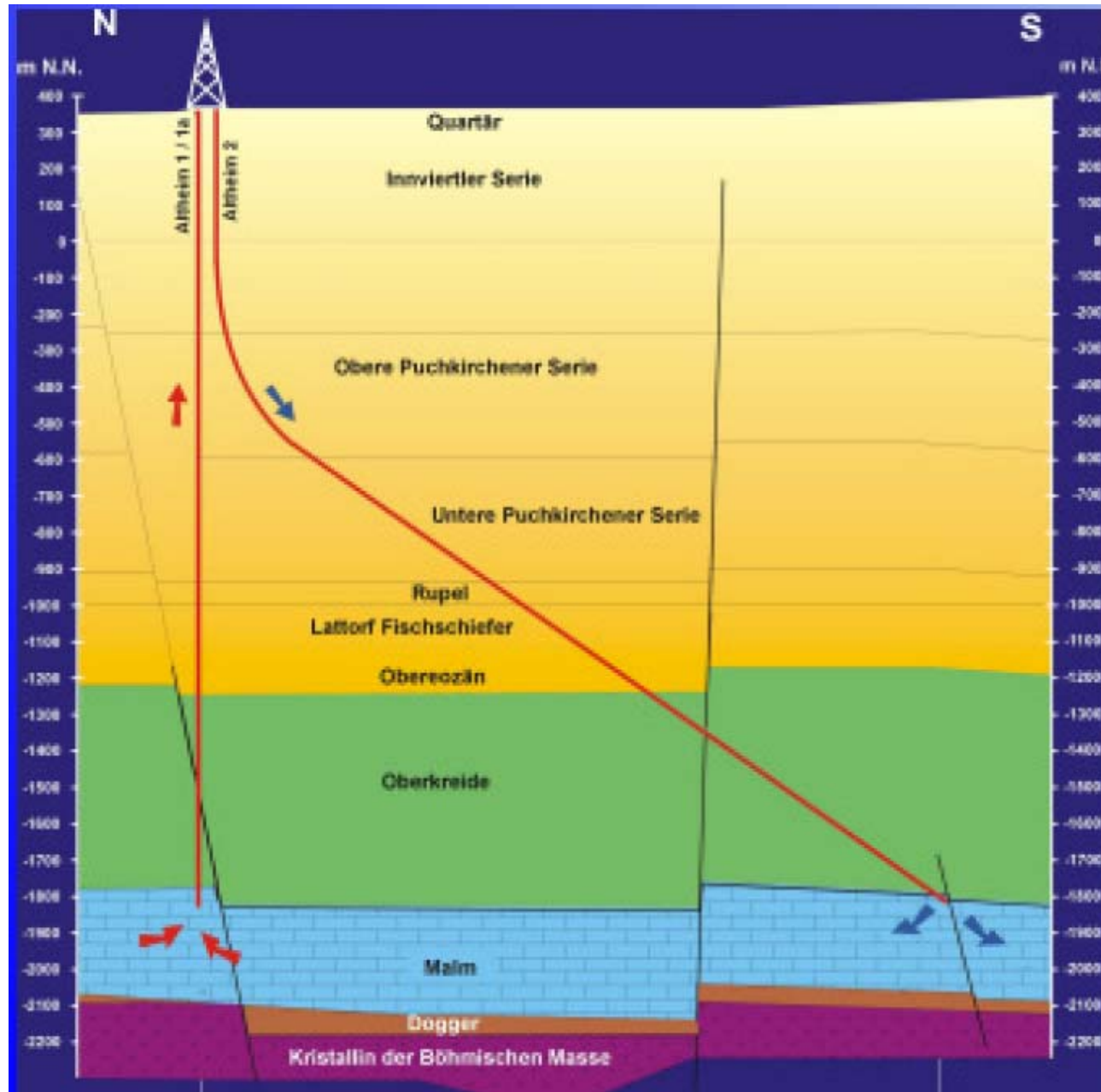


Considerations

Learnings

Ideas

Altheim

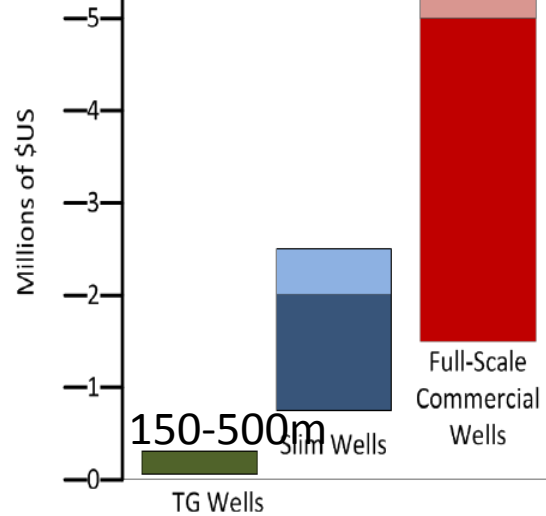


- 2165m TVD
- 3078m MD
- 1700m offset
- 100l/sec FR
- ID 6 ¼"

Considerations

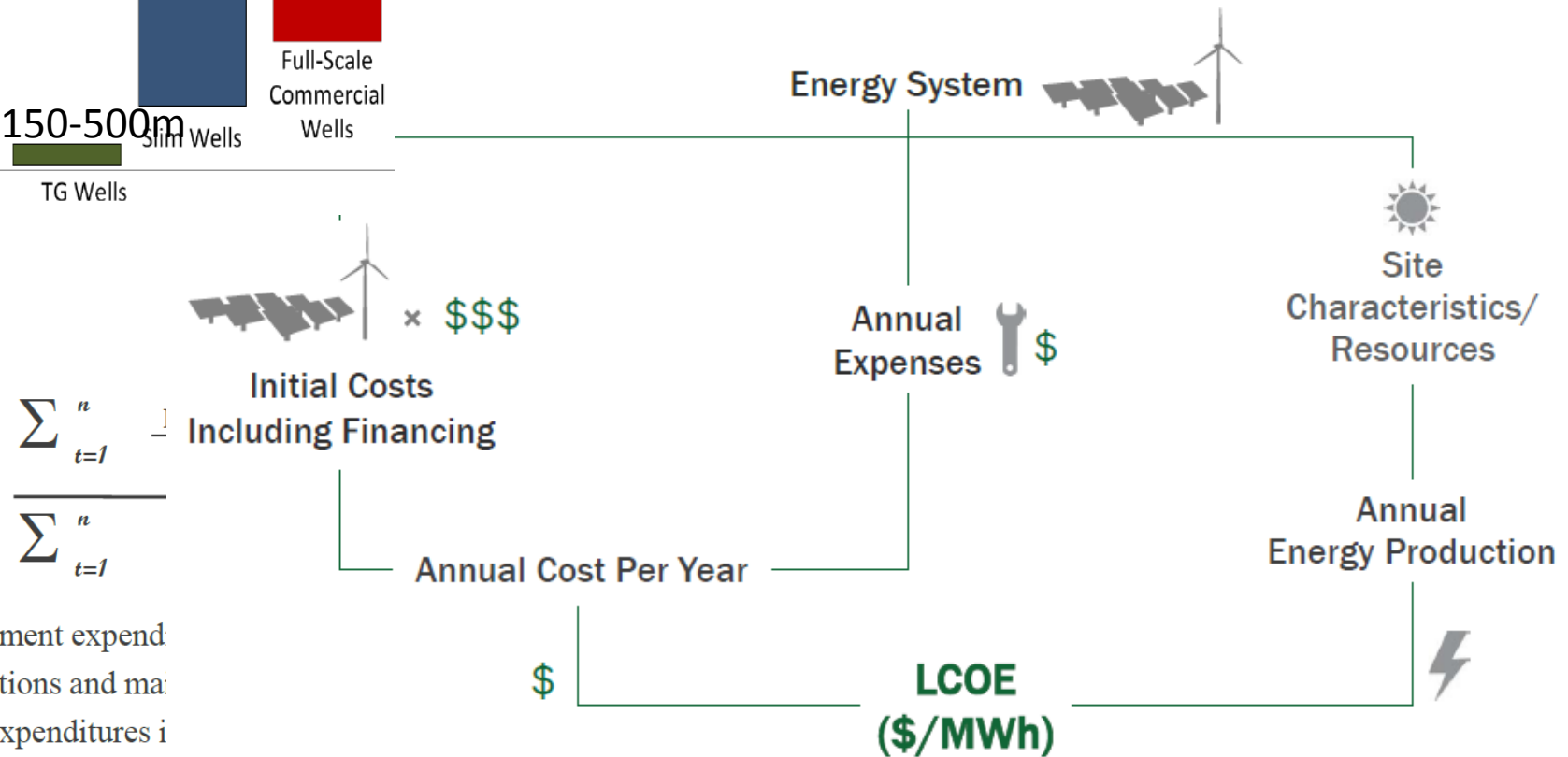
Learnings

Ideas



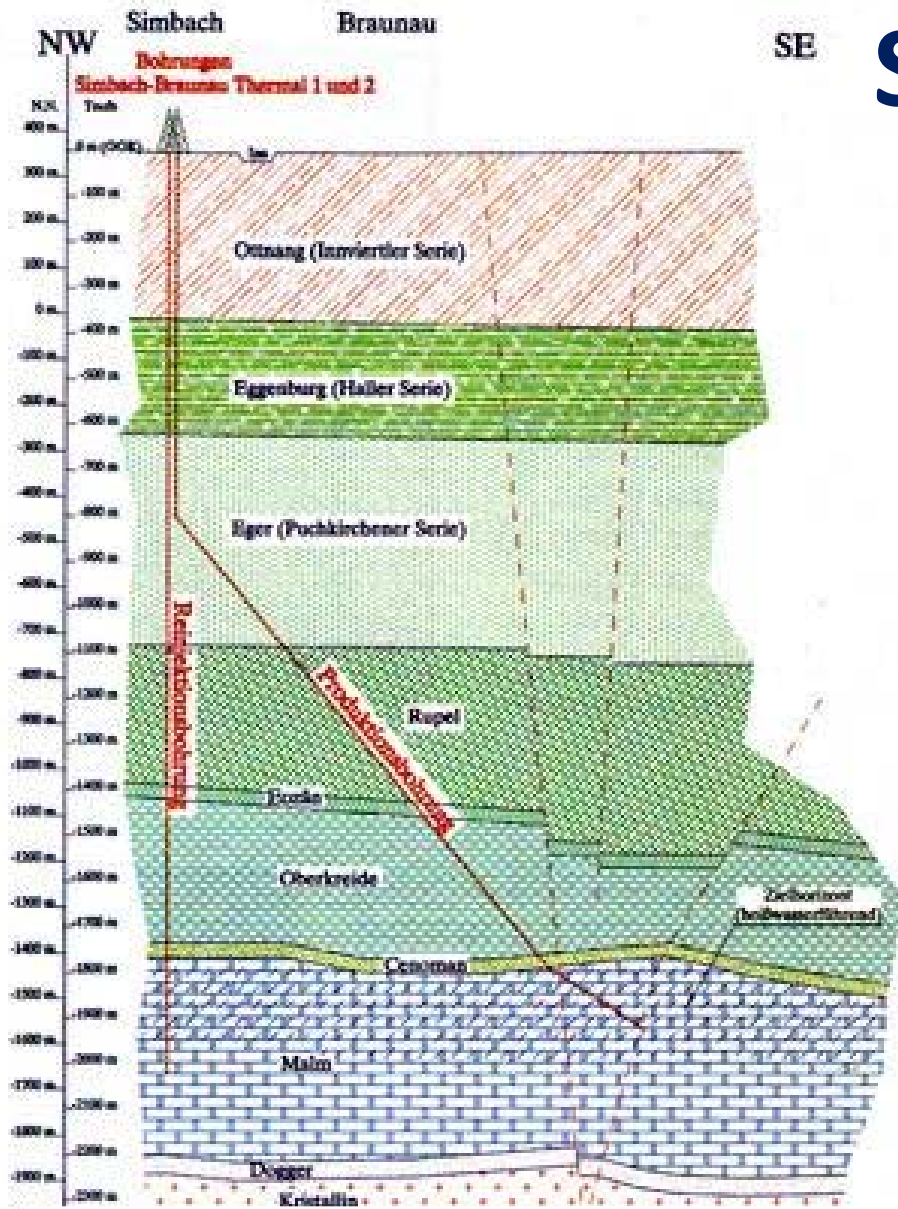
Economics

Cost per meter: 1250-1500 EUR

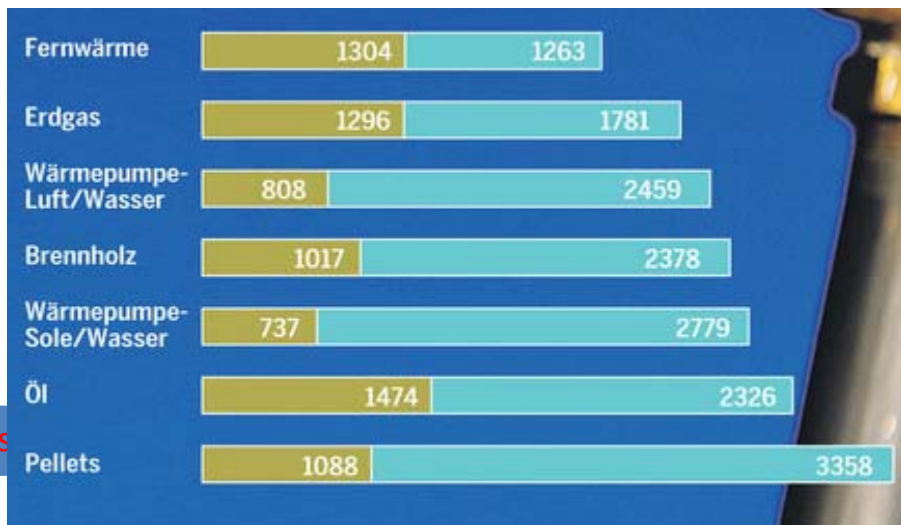


- I_t = Investment expend
- M_t = Operations and ma
- F_t = Fuel expenditures i
- E_t = Electricity generation in year t
- r = Discount rate
- n = Life of the system

Simbach Braunau



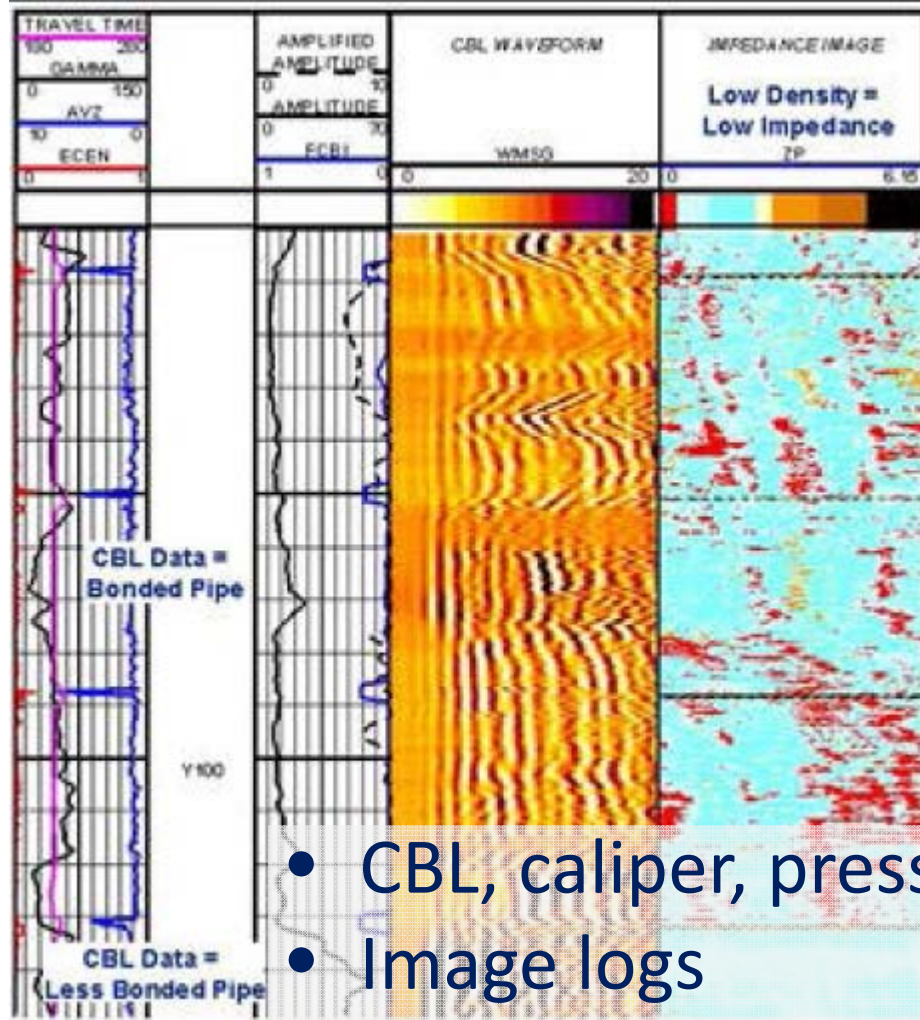
- Spud 1999
- ~110m dolomite (Malm)
- ~90 l/s
- External support 8mn EUR
- 9+ MW
- Heat distribution to 28 000 inhabitants
- 2/3 covered by GT



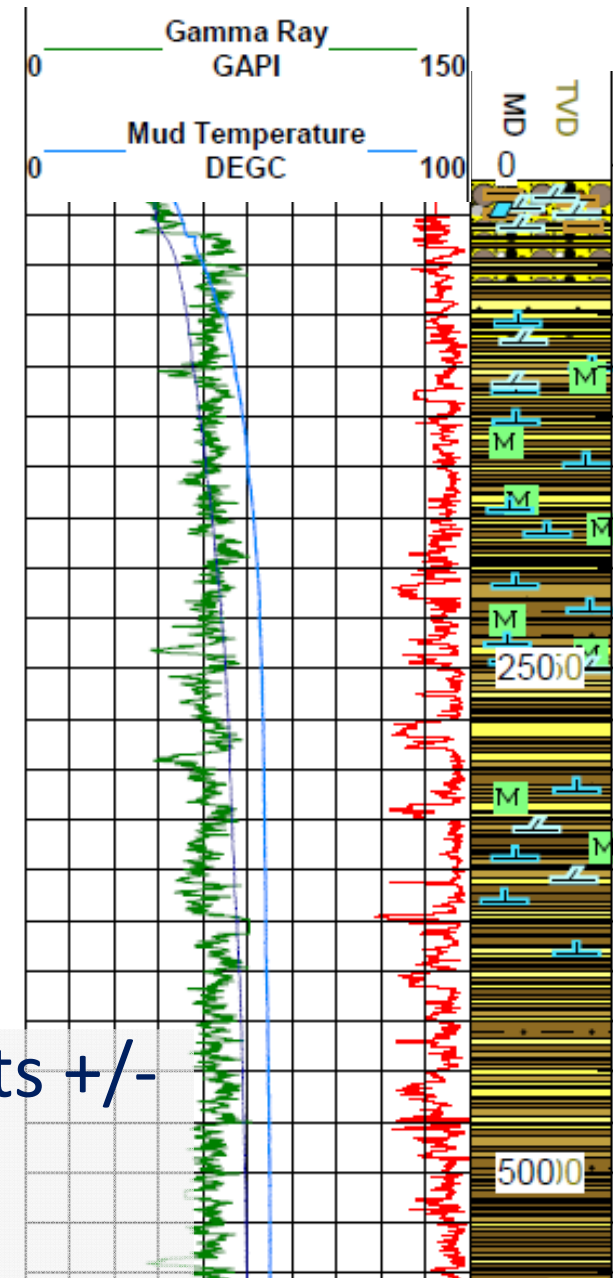
Considerations

Learnings

Logging & testing 1



- CBL, caliper, pressure tests +/-
- Image logs
- temperature

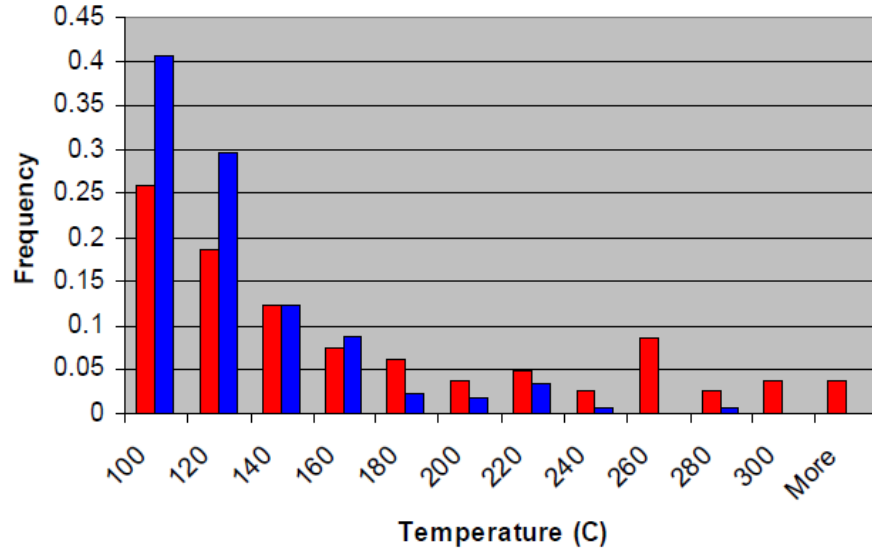


Considerations

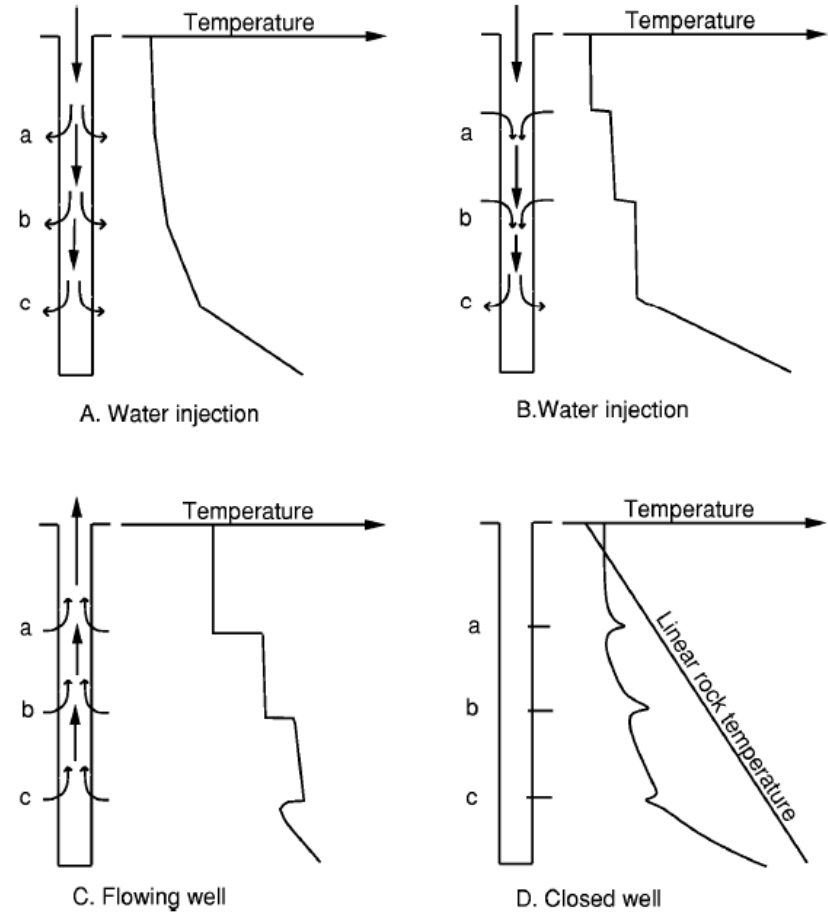
Learnings

Ideas

Logging & testing 2

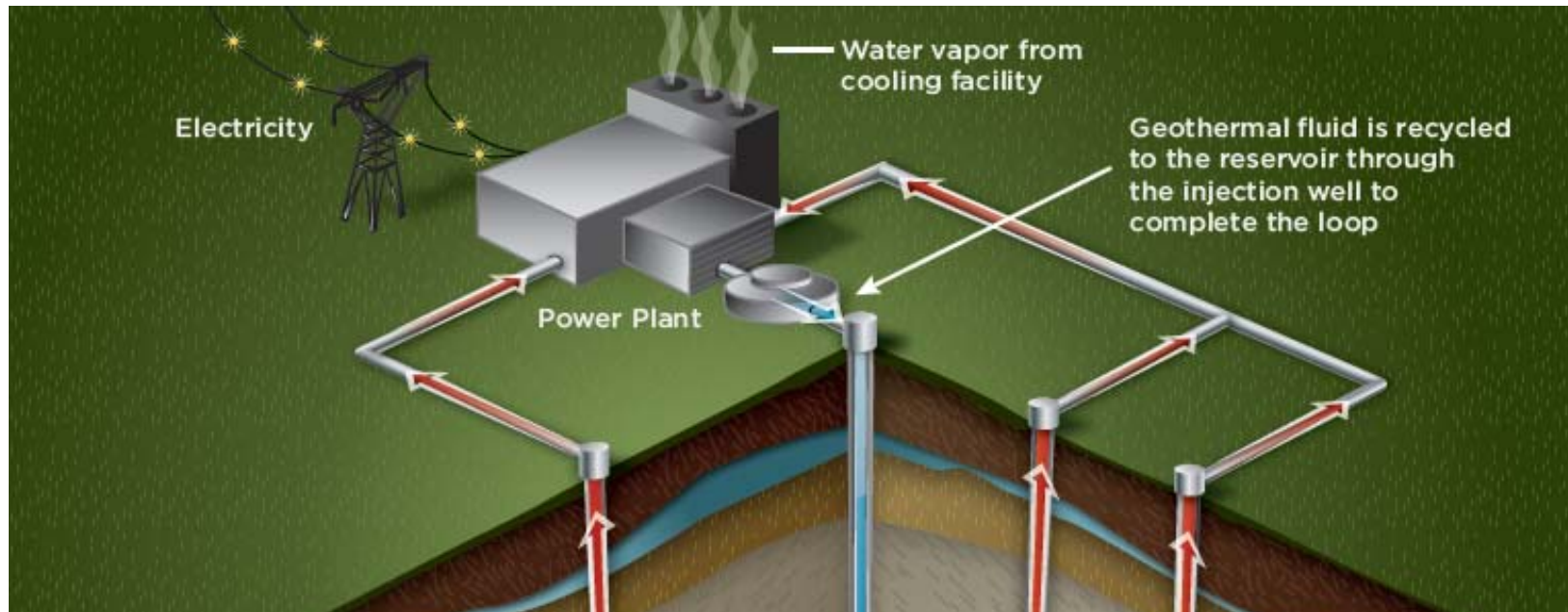


- About 70% of known geothermal reservoirs are below the 150C temperature limit for conventional logging tools; Most are below the 260C limit for hostile environment tools. (red = magmatic, blue = non-magmatic reservoirs).
- Tendency to „over-test“, seek OH logging reduction



Logging temperatures after Steingrímsson

Enhanced (or Engineered) Geothermal Systems (EGS) or "hot, dry rock" reservoirs.



Widen existing fracture network by injecting cold water from surface



Considerations

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Conclusions 1

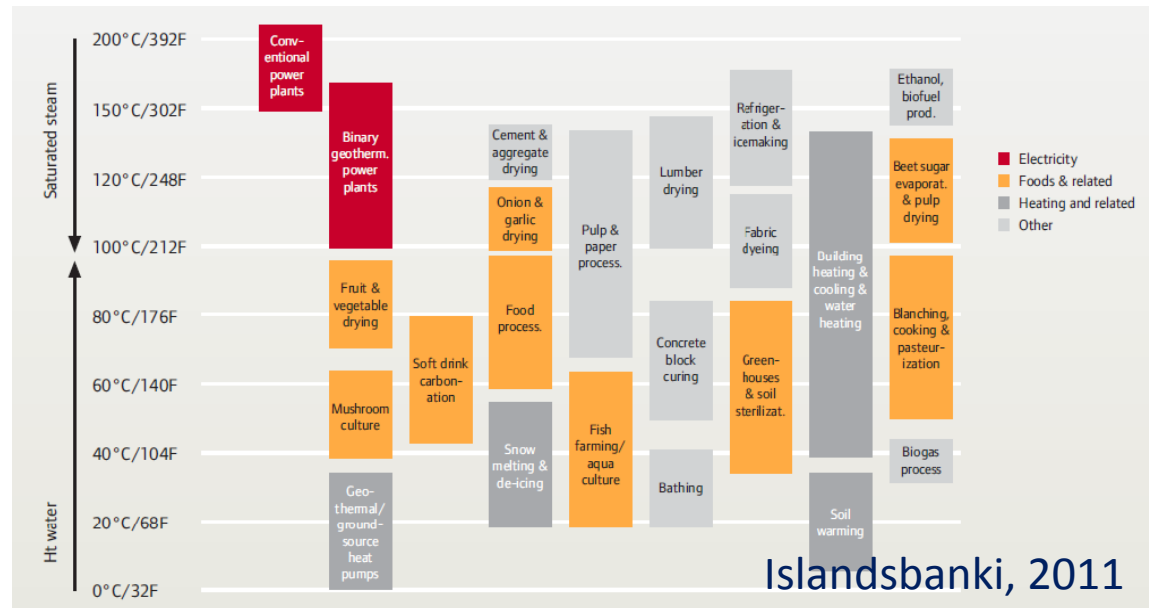
- GT drilling projects can learn from O&G
- Planning is about waging & controlling risk
- Drilling project is the biggest cost factor
→ all attempts to constrain this!
- Networking & increase of interaction within the “GT community” will reduce cost (portfolio, knowledge share..)

Considerations

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Ideas

Conclusions 2



- Close look on temperature window
- radon concentrations - open fractures
- Cross-finance during start up
- Technologies for hot & arid areas available

Considerations

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Ideas

A photograph of a sunset over the ocean. The sun is a bright, glowing orb in the upper center, casting a shimmering path of light across the dark water. A small sailboat with three sails is visible in the lower center, its reflection on the water. The sky is a mix of orange, yellow, and dark blue, with a few wispy clouds.

Thank you