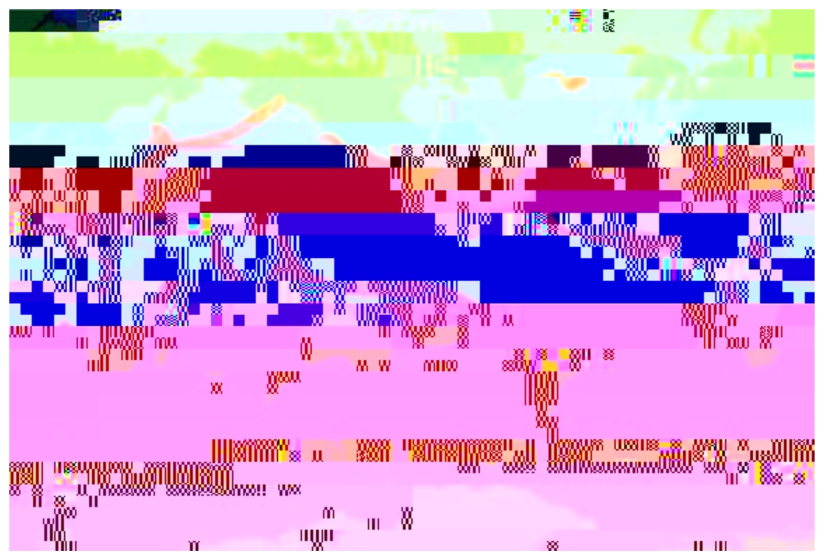
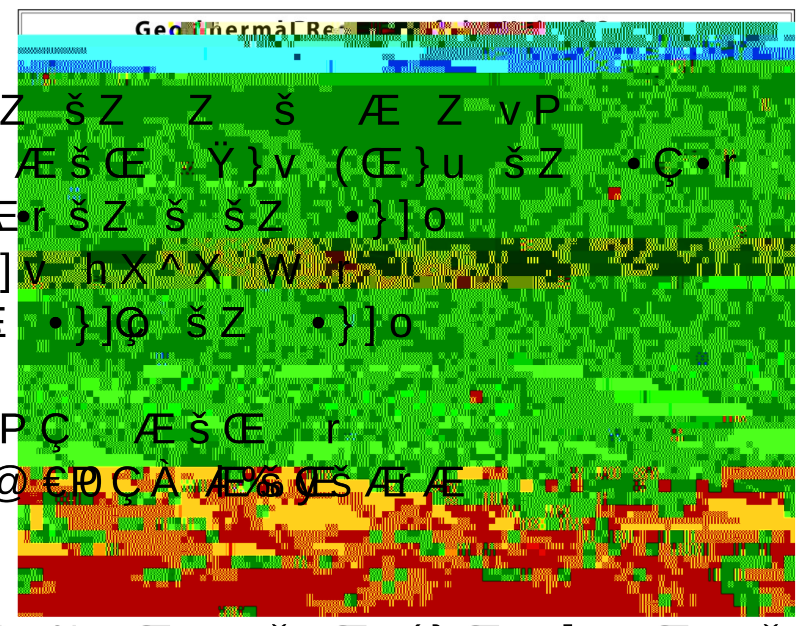




Specific Objectives

- Develop mathematical model to estimate heat extraction from closed-loop geothermal systems that are characterized by
  - Large aspect ratios, i.e., large length-to-diameter ratios, presenting challenges to numerical calculation
  - Time scale of years
  - Complex physical properties

Case Study: InnerGeo, U.S. Patent 8,991,488 B2

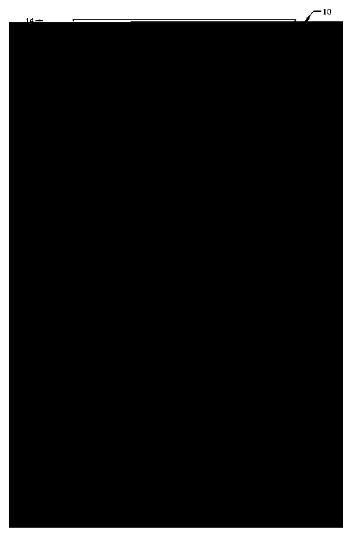


Table 1. Summary of Geometric and Operating Parameters

Geometry
- Well diameter: 17 in
- Injection tube: 8 in
- Production (heated water) tube: 3 in
- Heated tube section (horizontal): 5280

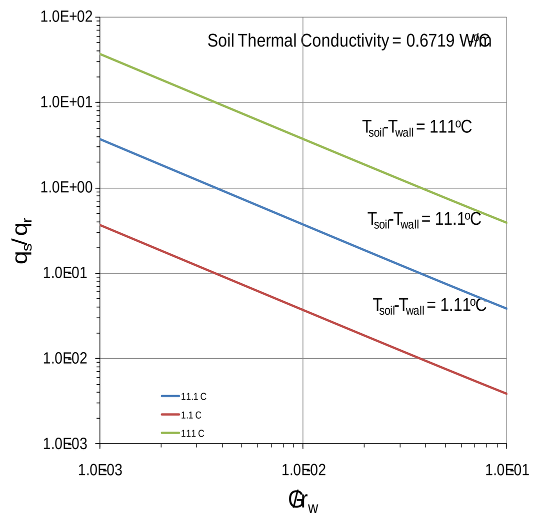
Operating condition
- Feed water: 200 F
- Production water: 350 F
- Flowrate: 1000 gallon/min

Quasi-Steady State Water-Side Heat Transfer

- Water-side heat transfer
  - Heat-load and overall heat transfer coefficient needed
    - = 20.4 MW_{th}
    - = 201.3 W/m-°C
- Tube heat transfer coefficient: water properties
  - = 2,117 *W/m-°C* >> 201.3 *W/m-°C*
- Water-side can deliver heat transfer needed

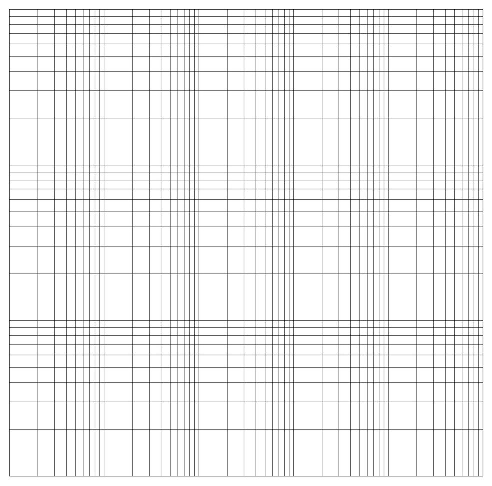
Quasi-Steady State Soil-Side Heat Transfer

- Soil-side
  - Heat transfer from soil to wall
  - Thermal penetration length
    - *delta = r_p*



Line Source Analysis

Soil Temperature Requirements



decreases with increasing heat rate extraction

heat rate extraction