

# Heat Recovery from Sedimentary Formations

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# Motivation

- **Studies show surface area for heat transfer crucial to energy production**
  - **Sediment A >> Fracture A**
- **Existing infrastructure reduces cost**
  - **Wells, Separators, Reinjection**
- **Potential to extend “EGS” to 6-10 new states**

# Summary of Cases Studied





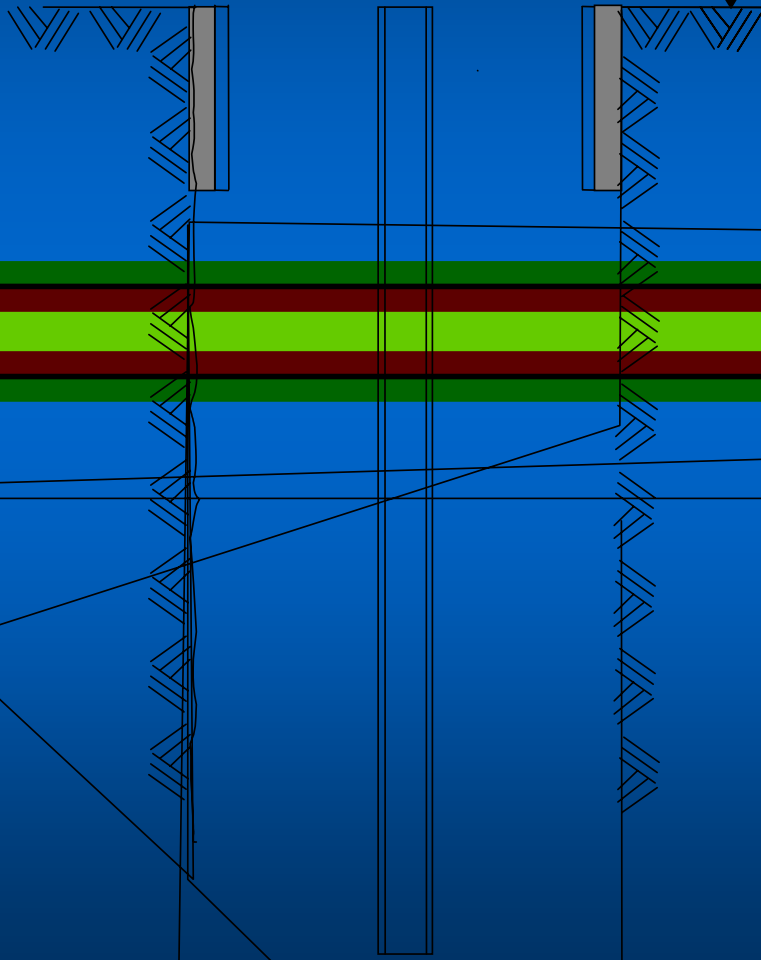
# Wellbore Heat Exchanger Model

Tubing

Insulation

Casing

Formation




**Schematic diagram of the  
wellbore heat exchanger**

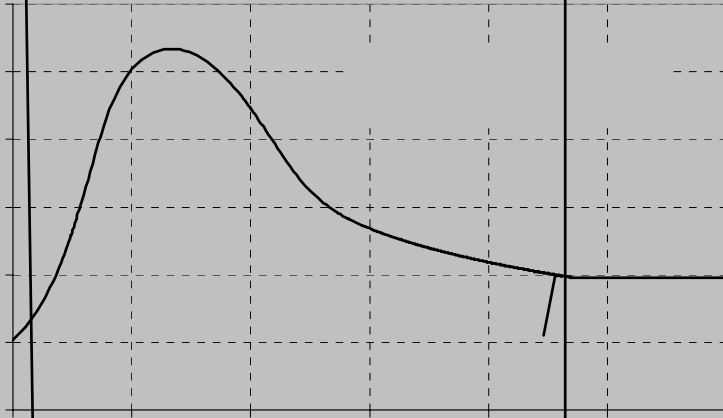
# Parametric Sensitivity Study



# Optimal Parameters from Studies

- ' **Circulation Rate**       $\emptyset$  **100 gpm**
  - ' **Wellbore diameter**       $\emptyset$
- 
- A decorative graphic consisting of five horizontal stripes of varying colors: a thick green stripe at the top, a thin dark red stripe, a thick light green stripe, a thin dark red stripe, and a thick green stripe at the bottom.

# Best Case Results

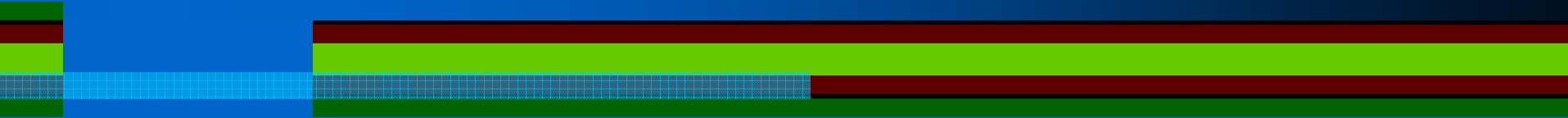




# Summary and Conclusions

- **Comprehensive sensitivity study conducted**
- **Best Case below existing plant performance**
- **Wellbore heat exchanger not viable even with ideal energy conversion**

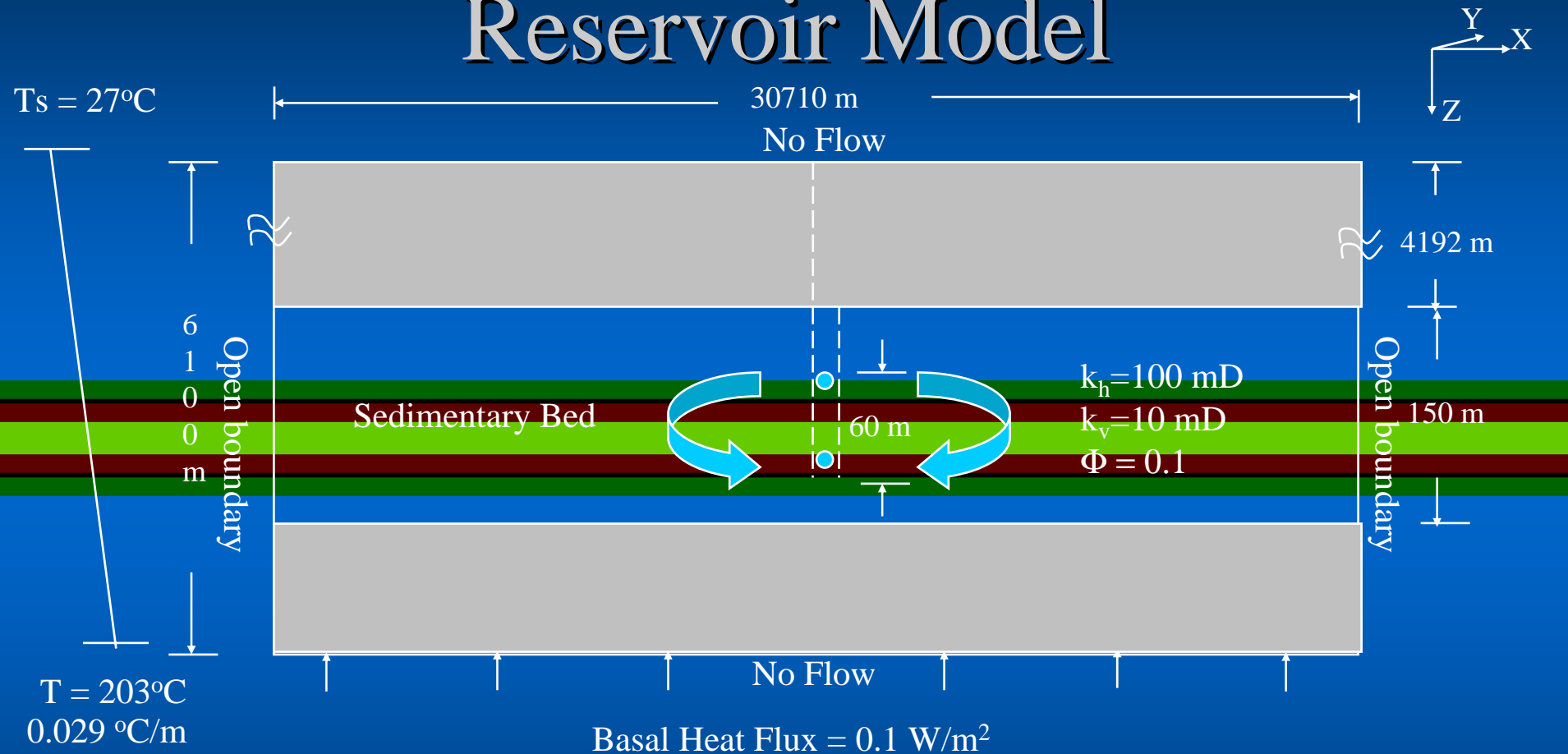
# Engineered Geothermal Systems using Advanced Well



# Vertical Well Dual Perforation (DP) System

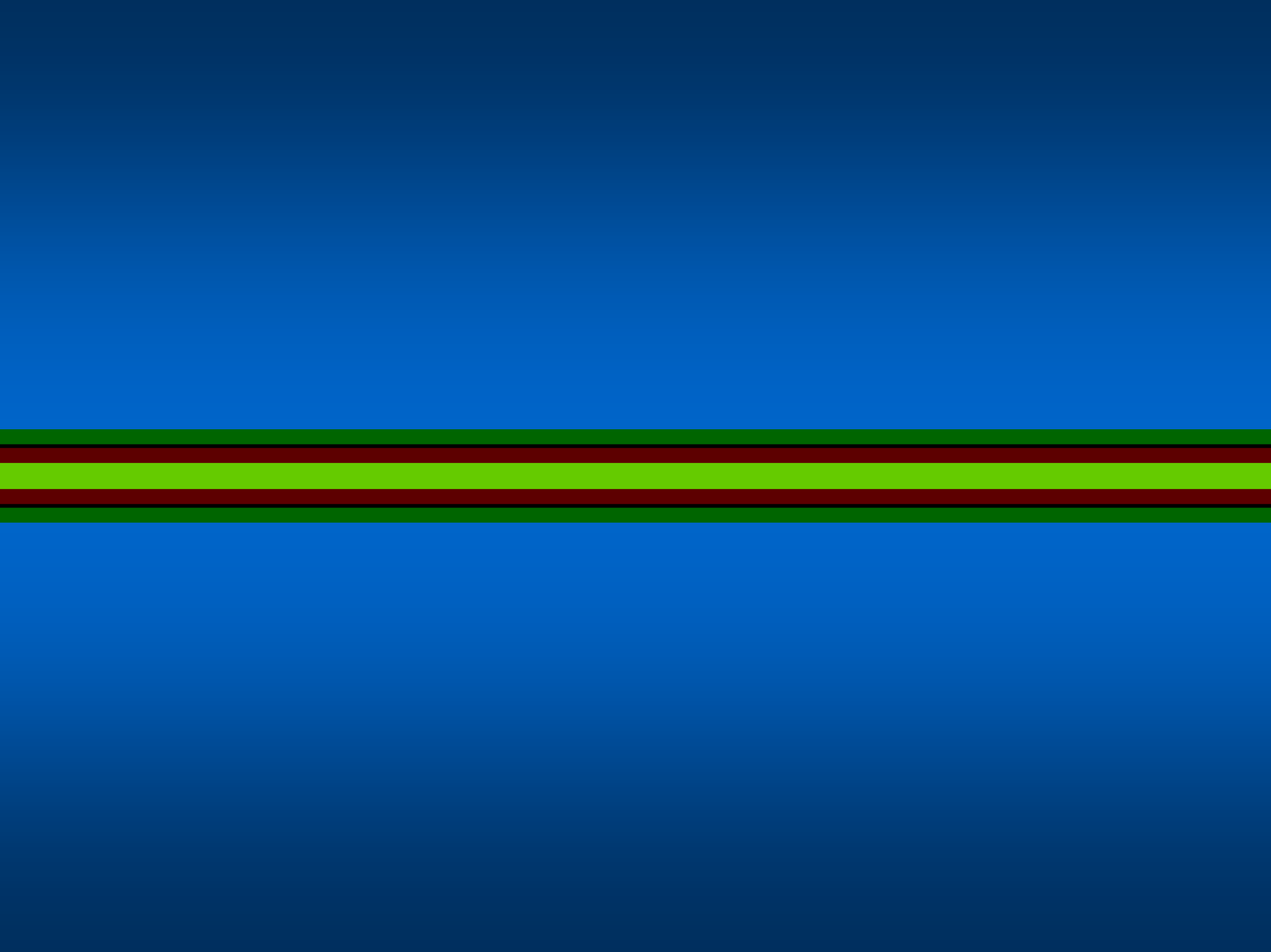


# Reservoir Model



- **Circulation rate = 6.31 kg/s**
- **Injection Temperature = 27°C**



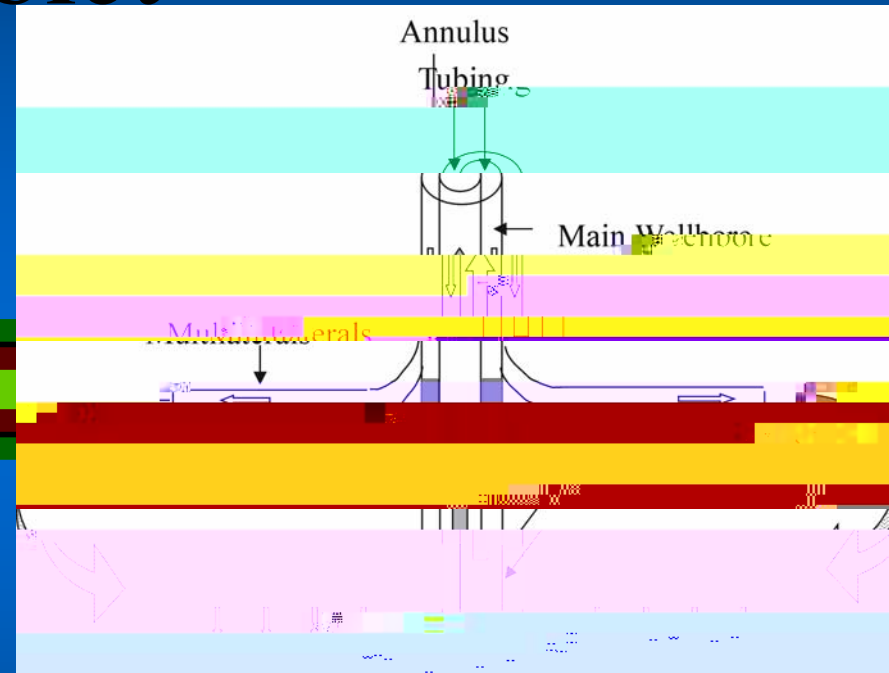


# Vertical Well Dual Lateral Doublet

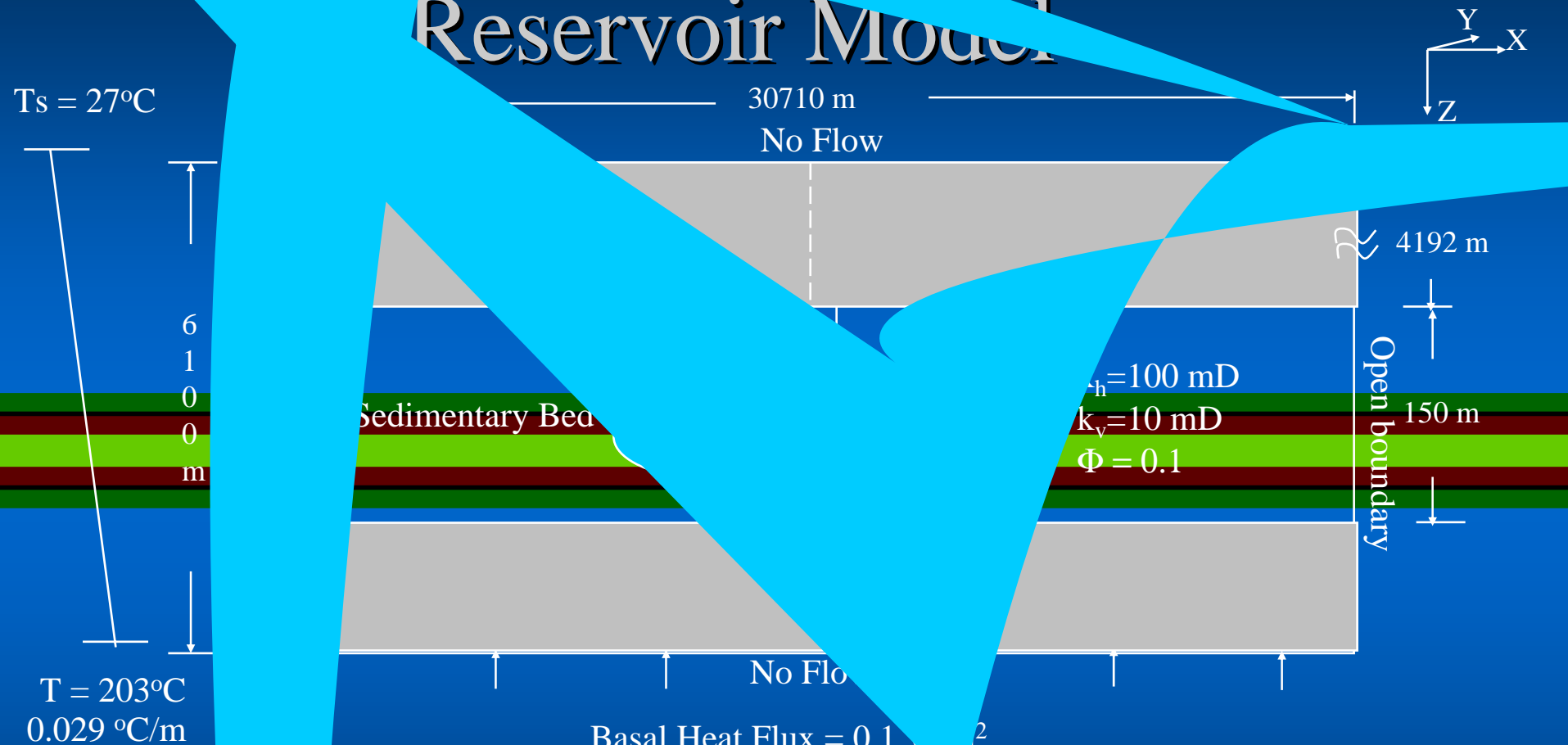
## Geometry

- Vertical well
- Dual lateral doublet

Improved wellbore  
productivity and  
increased reservoir  
exposure



# Reservoir Model

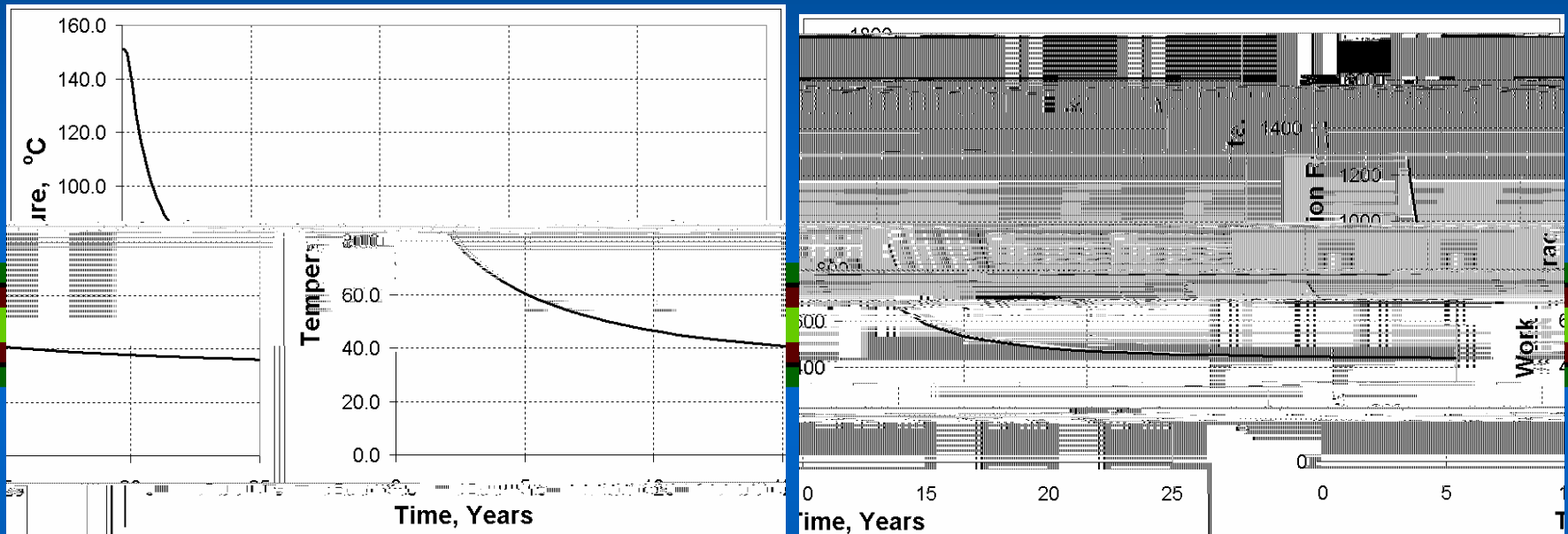


**Circulation rate = 6.31 kg/s**

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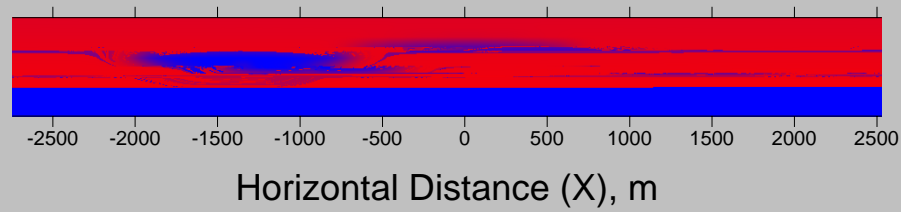


# Best Case Dual Lateral Doublet Results



- Best case – Extraction Temperature : 60.4°C & Ideal Work Rate : 536 kW at 5 yrs
- Doesn't incorporate the temperature gain by conduction while flowing down
- Better technology than Dual Perforation for EGS

# Thermal/Fluid Swept Region





# Summary & Conclusions

## Advanced Well Technologies Evaluation

- Preliminary study conducted
- Potential means of achieving EGS goals

## Vertical Well Dual Perforation System

- Limited by sedimentary bed thickness

## Vertical Well Dual Lateral Doublet System

- Better than Dual Perforation System but still limited sedimentary bed thickness

## Horizontal Wells

- Unconstrained spacing → longer residence times, more rock-fluid contact area and higher temperatures
- Horizontal well multilateral doublet is promising technology for EGS

# Single Well Energy Production

**Xina Xie**

**K. Kit Bloomfield**

**Greg Mines**

**G. Michael Shook**

# *Governing Equations*

- Single Phase, PSS, inflow equations
- Pump efficiency and parasitic load

$$P_I - P_{wf} = \frac{q\mu}{2\pi kh} \frac{1}{2} \ln \frac{4A}{\gamma C_A r_w^2} + \frac{2\pi kt}{\phi\mu cA} + S$$

# Example of Analysis Results

- Depth = 6 km

  - $T = 175^{\circ}\text{C}$

- Reservoir properties

  - $r_e = 4000 \text{ m}$  ( $V_p = 250 \text{ E6 m}^3$ )

  - $k > 50 \text{ md}$

  - $h = 25 \text{ m}$

- $\Delta P = 540 \text{ Bar}$

  - $P_I = 1005 \text{ bar}$

  - $\cong P_{HS}$  at 12 km

# **Injection/Extraction Energy Production**

- ' **Primary production**
  - Offshore production platforms
- ' **Watered out (mature) fields**
- ' **Ongoing waterfloods**



