



# Geothermal Wellbore Surveying Challenges

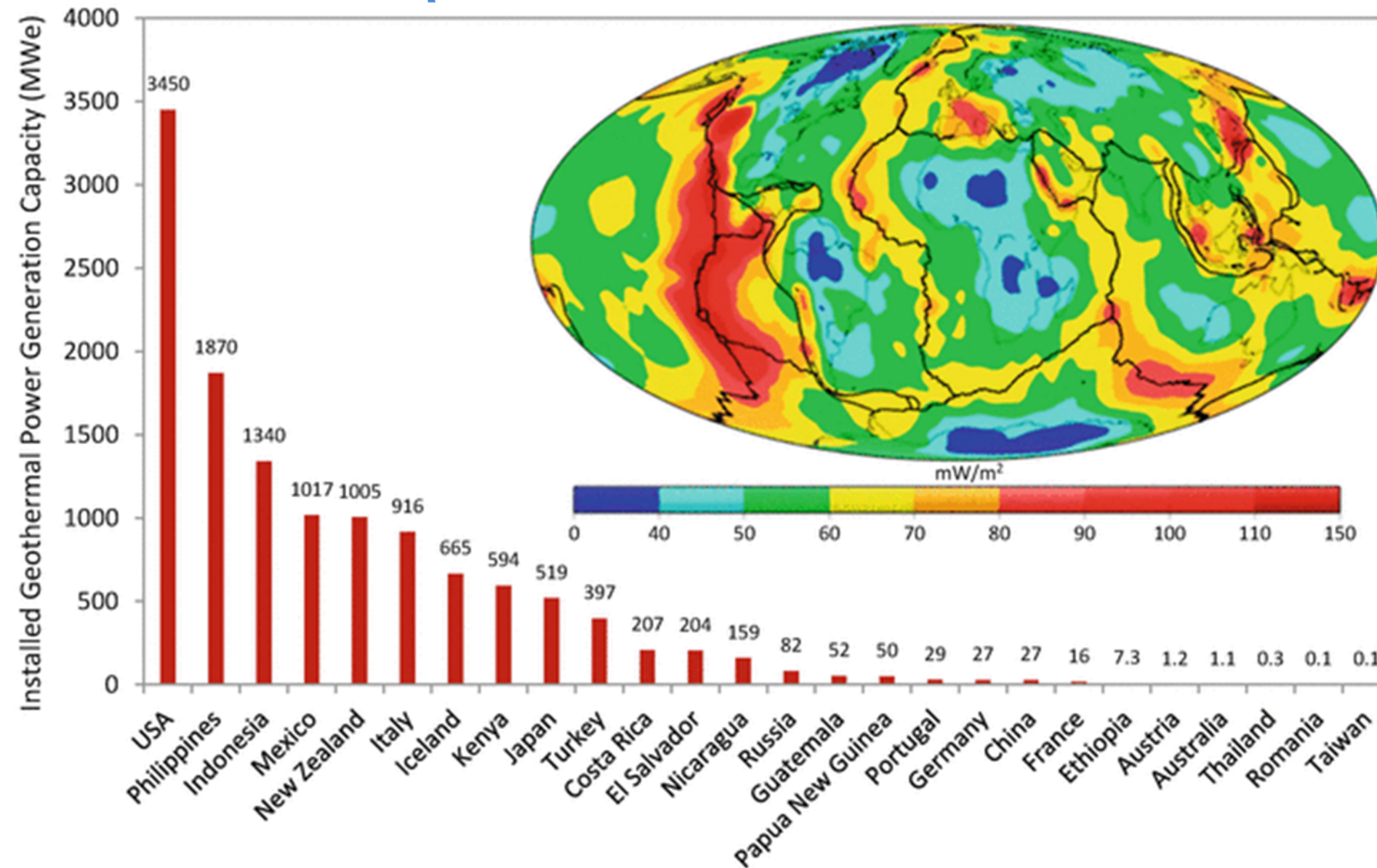
Ross Lowdon – Surveying and Telemetry Domain Head

# Geothermal Technologies

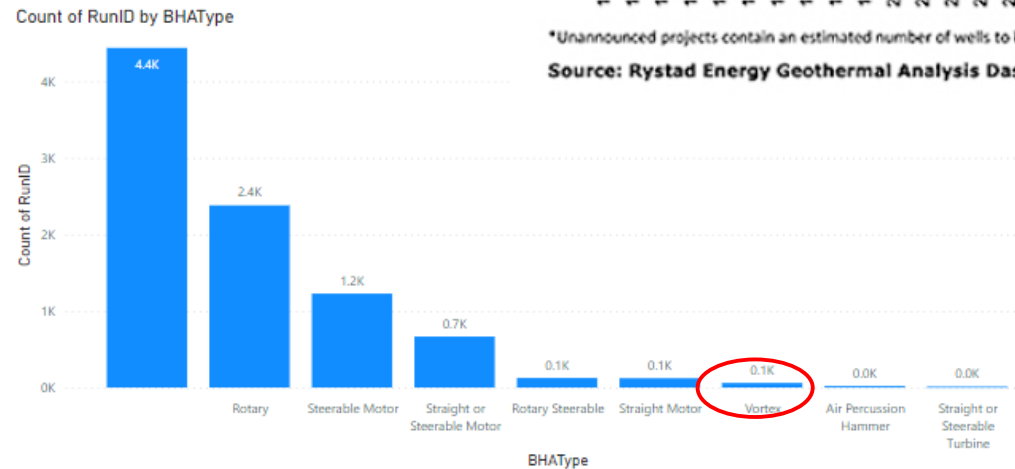
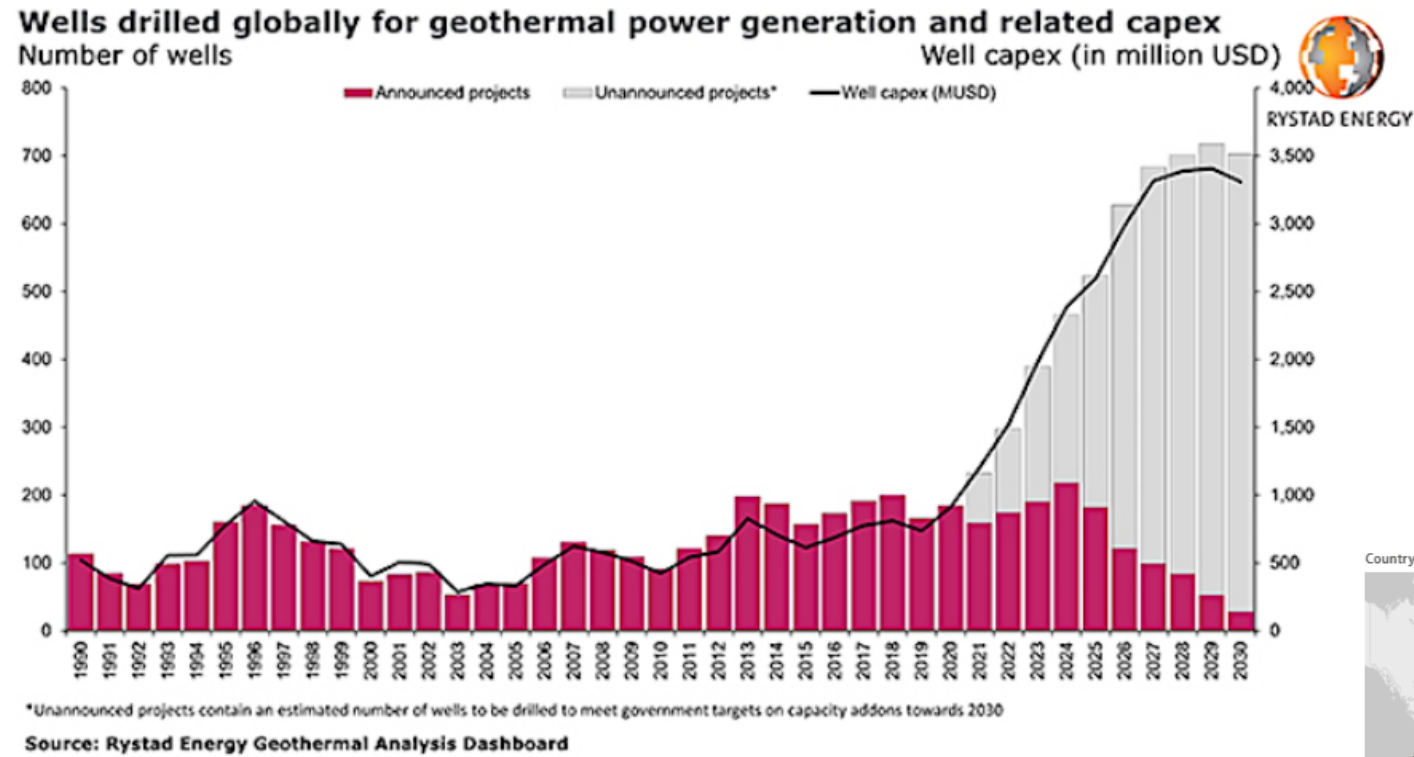


- Conventional
  - Hydrothermal systems
    - Ring of fire and Iceland
    - 300° C
    - Highly Fractured
    - Pump water in – superheated water out
    - Run steam turbines or similar
    - Losses and pollutants
- Unconventional
  - Low temperature Geothermal
    - Enhanced Geothermal Systems
    - Advanced Geothermal systems
    - Deeper wells
    - Usually twins
    - Requires more technology

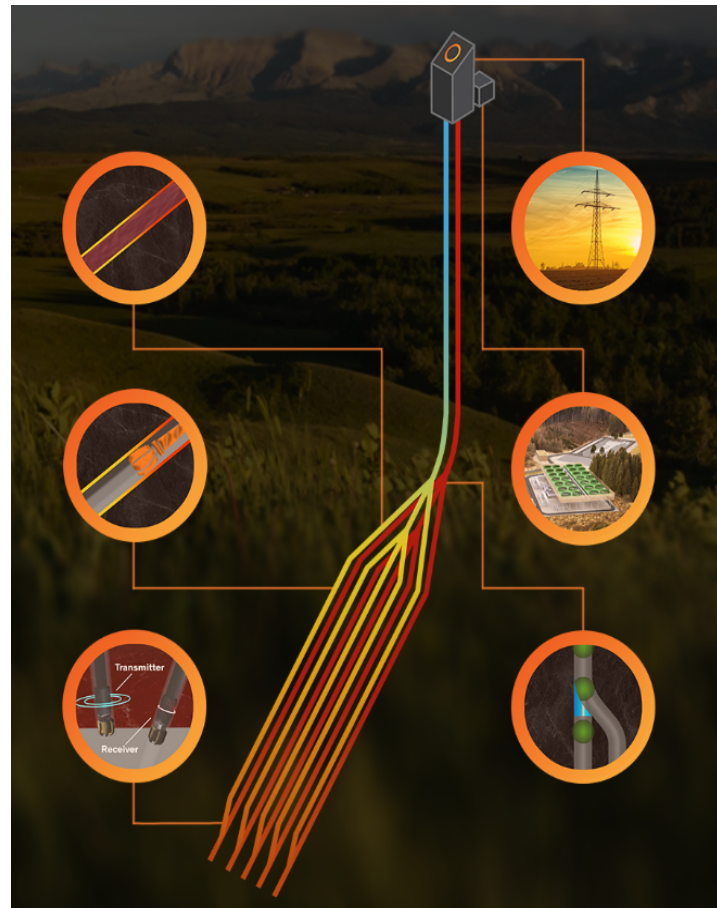
# Geothermal Landscape



# Geothermal Trends



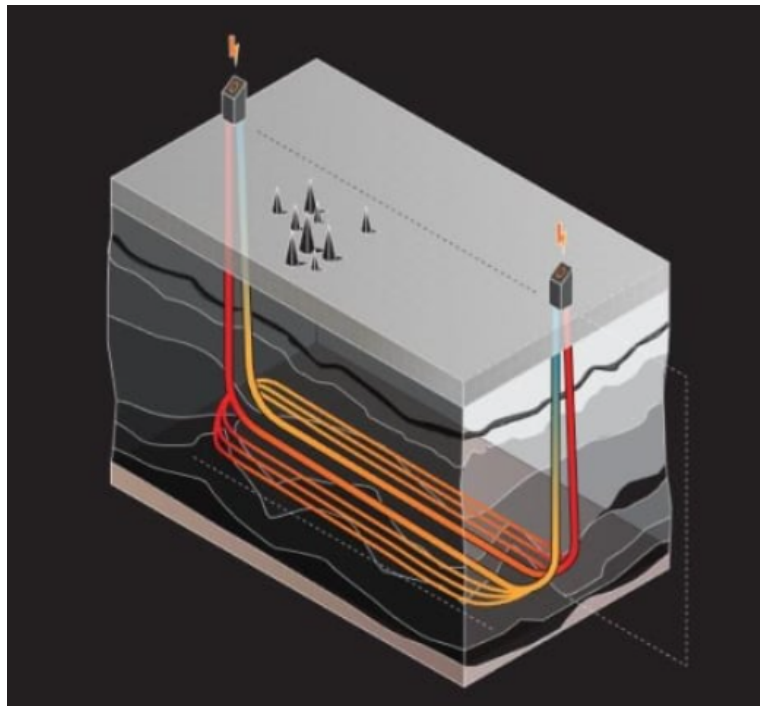
# Closed loop Geothermal



Source: Eavor

- Un-Conventional
  - Low temperature Geothermal
    - Advanced Geothermal systems
    - No Fracking
    - No GHG emissions
    - No earthquakes
    - No water use or produced brines
    - No aquifer contamination

# Closed Loop Geothermal design

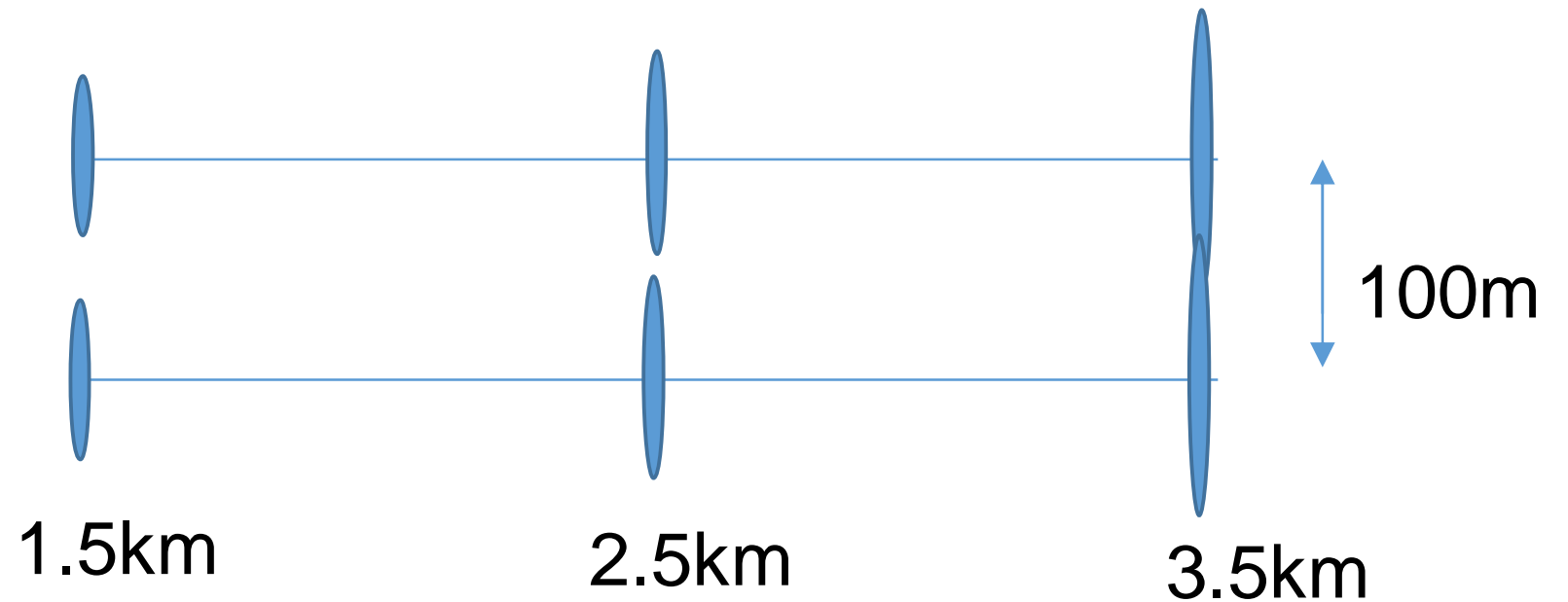


Source: Eavor

- 2 wellbores
- Multilateral
- Join to close the loop
- Use Thermal convection
- Heat drives surface 'engine'
- Local power distribution

# Geothermal Conventional Surveying Errors

Horz section length	Lateral error	TVD (Vertical) error
1.5km	35m	16m
2.5km	43m	21m
3.5km	60m	26m





# Geothermal Surveying Challenges

- Vertical Spacing
  - Temp difference drives power
  - Higher offset = more power
- Lateral Spacing
  - Maximized Thermal recovery per site
  - No poaching
  - No stranded 'reservoir'
- Connecting wells
  - Must have hydraulic connection

Absolute position ✘  
Relative position ✘  
Absolute + Relative position

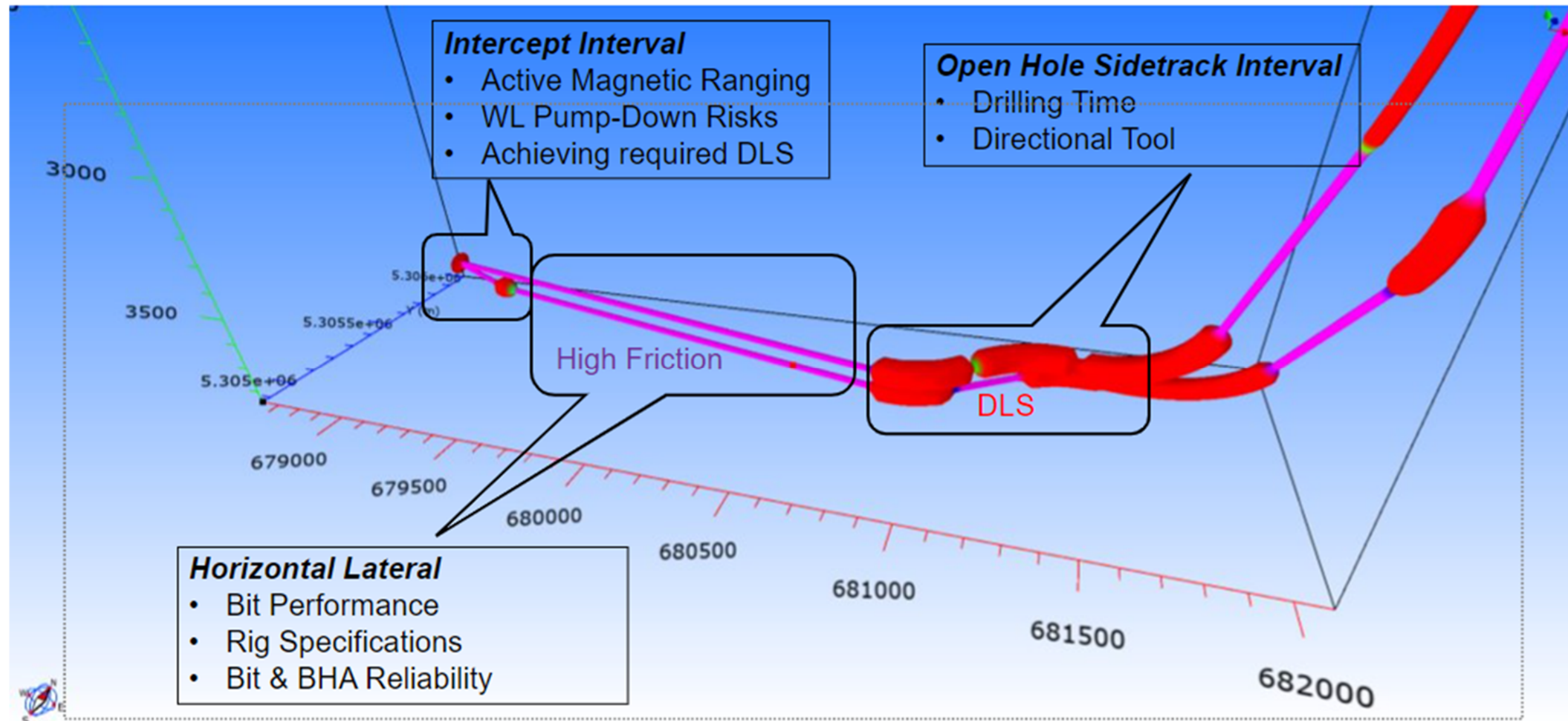




# Wellbore Surveying - Ranging

Technique	Conveyance	Detection Range (m)	Dependencies	Ranging time @ 4500m MD
PMR	MWD	15	Single offset wellbore	4-6 hours
AMR	WL	100	Formation resistivity	30 hrs
AAR	WL	70	Formation Slowness	15hrs
ARR	LWD	60	Formation resistivity	Near Real time
<b>RMRS</b>	<b>WL</b>	<b>75</b>	<b>Rotating magnets in offset well</b>	<b>Depends on MD</b>
CPMR	MWD	20	Single offset wellbore	Near Real time

# Geothermal Drilling Challenges





# Closed Loop Geothermal Surveying & Drilling Development

- Real Time ranging tools
- Improved survey accuracy
- Improved RSS trajectory control
- Improving Drilling performance
- Process automation
- ???



# Conclusions

- Advanced Geothermal will be a game-changer
- Advanced Geothermal is challenging and needs proving
- Best in class Wellbore surveying required
- Adapted Oil and Gas technologies
- New techniques and technology to be developed
- Huge opportunity for the drilling industry



# Thank You