# Geothermie Delft  Well Overview

## Leendert-Jan Ursem

- Delft Alumni Mijnbouw & Petroleum ‘85-’91
- Shell Well Engineering 1991-2007
- GM Wells Deepwater Africa
- Horizon EP, SGS, Sky Energy Partners
- Dedicated Hydreco medewerker 2019

# DAP Well History, from DAP to GTD

**Stichting DAP:**
Supports research, education, development

DAP

2007 — 2008 — 2010 — 2013 — 2018 — 2021

2007: Delft Aardwarmte Project

2008: TU Delft — Exploration permit

2010: Duijvestijn Tomaten; Ammerlaan The Green Innovator — Ammerlaan and Duivestijn projects — TU Delft, DAP

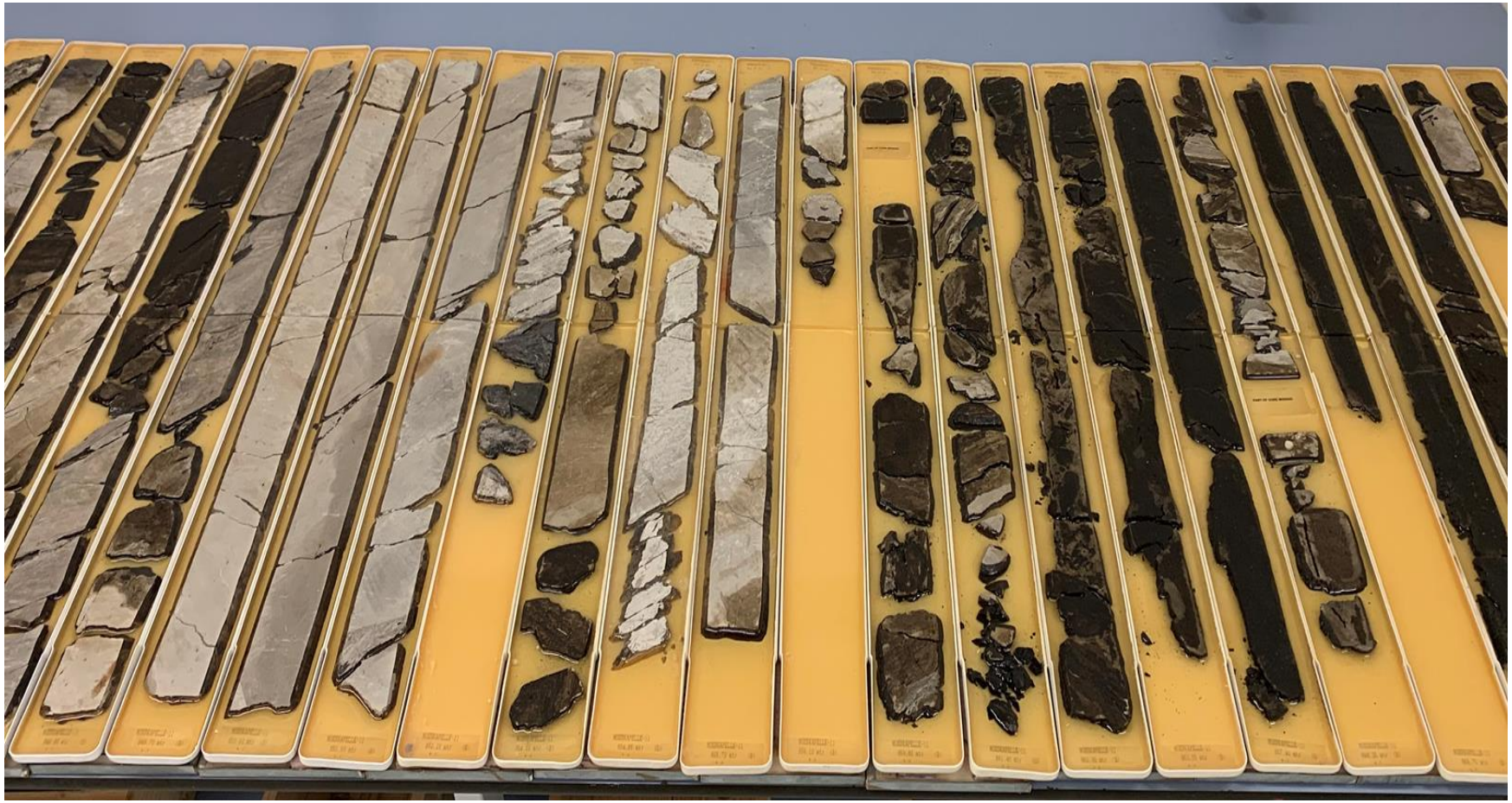
2013: Plans for (commercial) campus well cancelled

2018: TU Delft, ebn, Hydreco Geomec, Shell — DAP well => GTD Well

# Well Design: What do we need? ⟶ Design towards it!

- Delft Sandstone reservoir
- Underburden (Alblasserdam)

2100m TVD
600 mDarcy
20 % porosity
1,033 kg/l pore gradient
1,078 kg/l pore content
79 °C water
78 g/l Chlorides
$CH_4$ 1$m^3/m^3$ standard conditions
Gas = 1% of Total volume “in situ”
$C0_2$ 2 % of total gas
P90 production rate 306 $m^3$/hr
Max design rate 400-450 $m^3$/hr



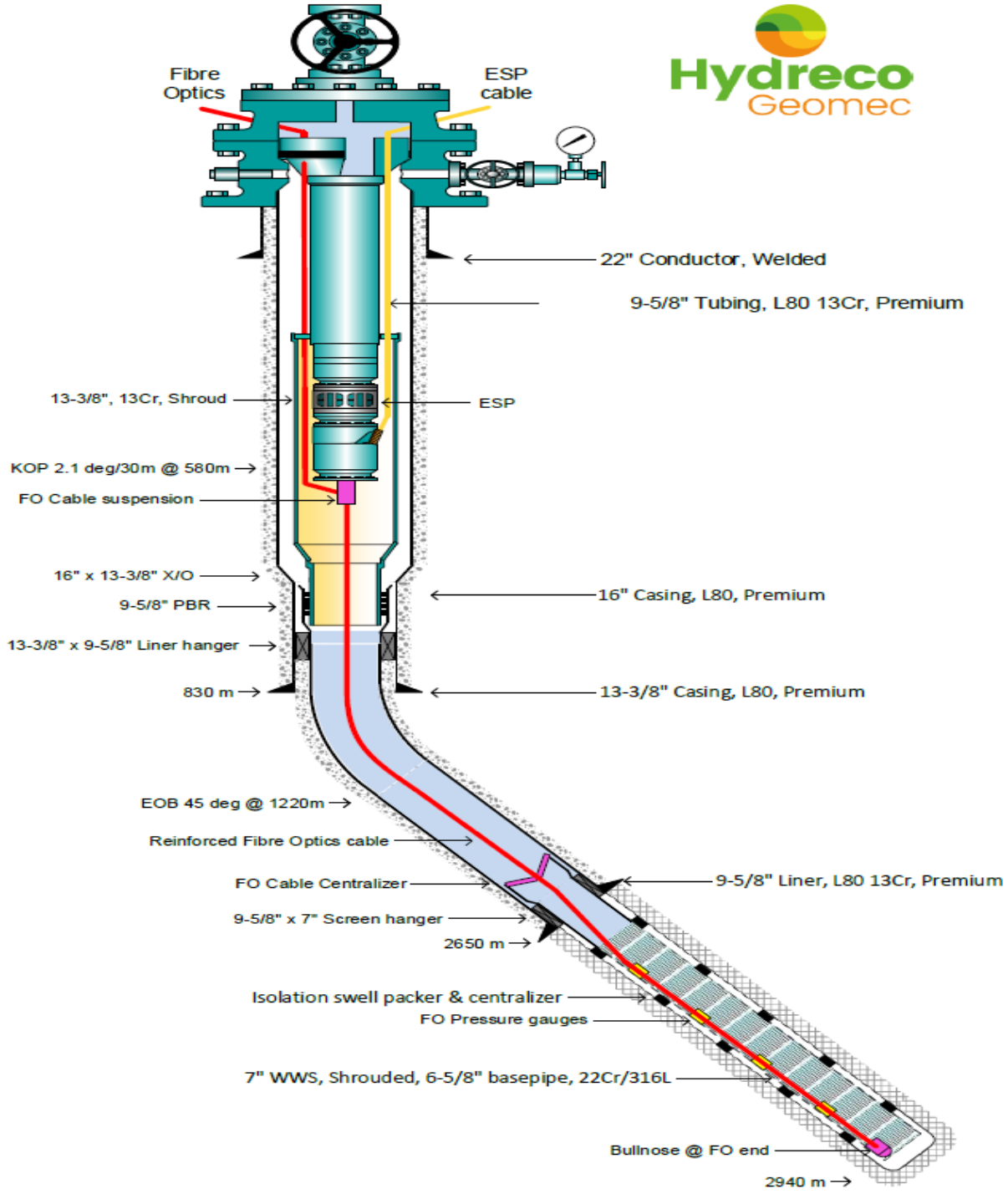
Delft Sandstone is very heterogeneous, not just one layer

# Optimised Well Design

## Smarter, Slimmer and Lower cost

## Bottoms up Design

- Chrome sand screens with large OH inflow area
- Large but lean intermediate section in 9 5/8” CRA (13Cr)
- Oversized top hole with 16” premium Casing
- Innovative enclosed Shroud section
- Double casing design with Ann. monitoring to 800+m
- Permanent Magnet Downhole pump
- Integrated Horizontal Xmass Tree/Wellhead
- Use of a spoolable deployed FO cable
- Use of a velocity string to test without an ESP
- Low OPEX to replace the Fibre Optic Cable

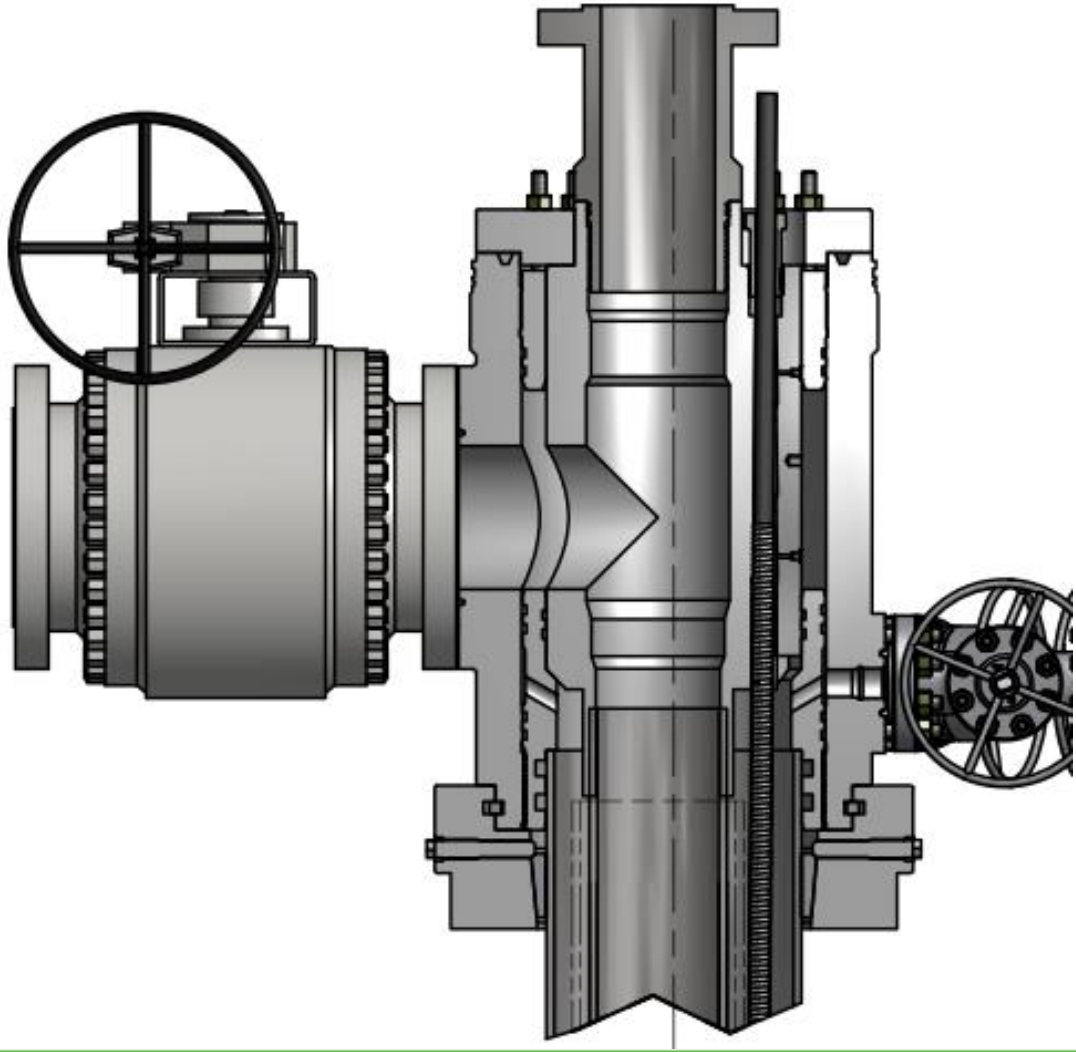


# Integrated Horizontal  Wellhead and Tree

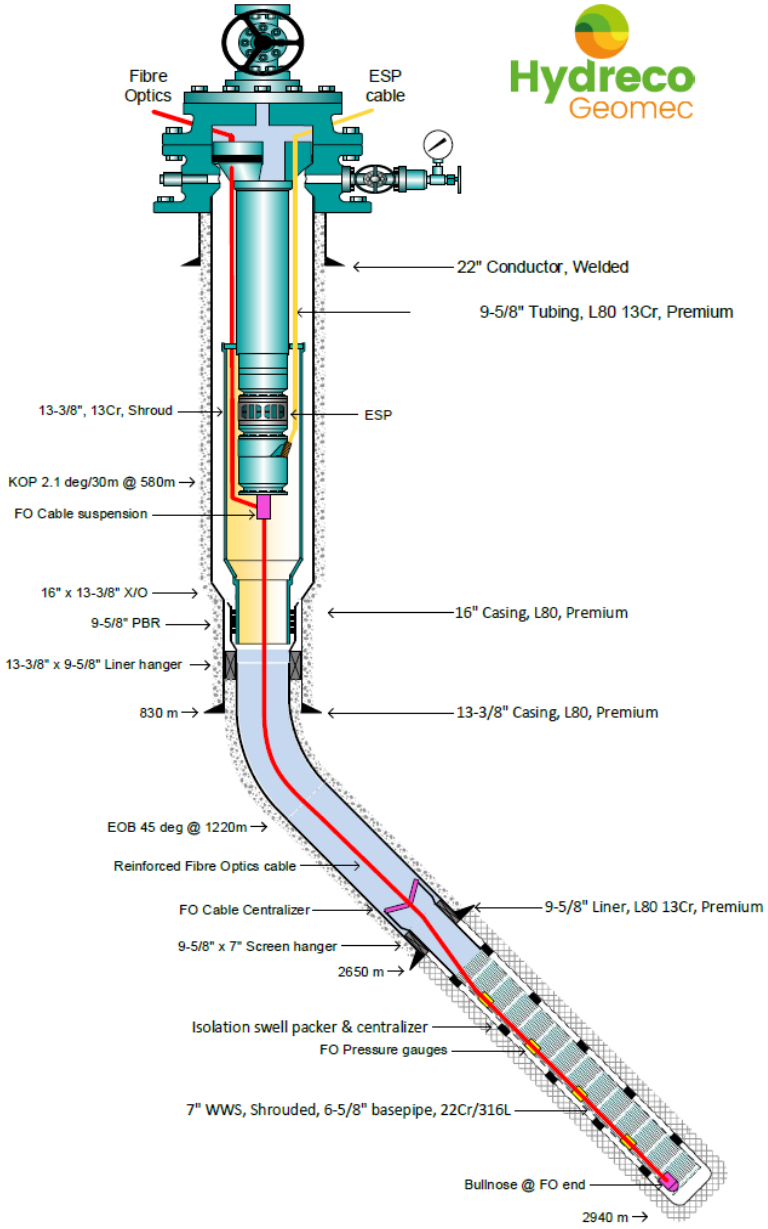
## Compact and Underground

- 20 ¾” 3000 psi rating (200 Bar)
- Lockdown system for thermal loads
- 1,20m height (WH+ Tree!)
- 7” Ball Valve (Single valves for “Niet Spuitende putten”)
- Injector hanger is concentric, Producer hanger is eccentric
- FN6M Material = 13% Cr+
- Cable feed through without making splices

- Pull completion without disconnecting flow line
- Clear location floor, see next slide



# Material Choices




Wellhead
Solid FN6M (Cr 13+)

Shroud and replaceable pipes
All 13Cr, depends on lifetime ESP
Less Lead scaling

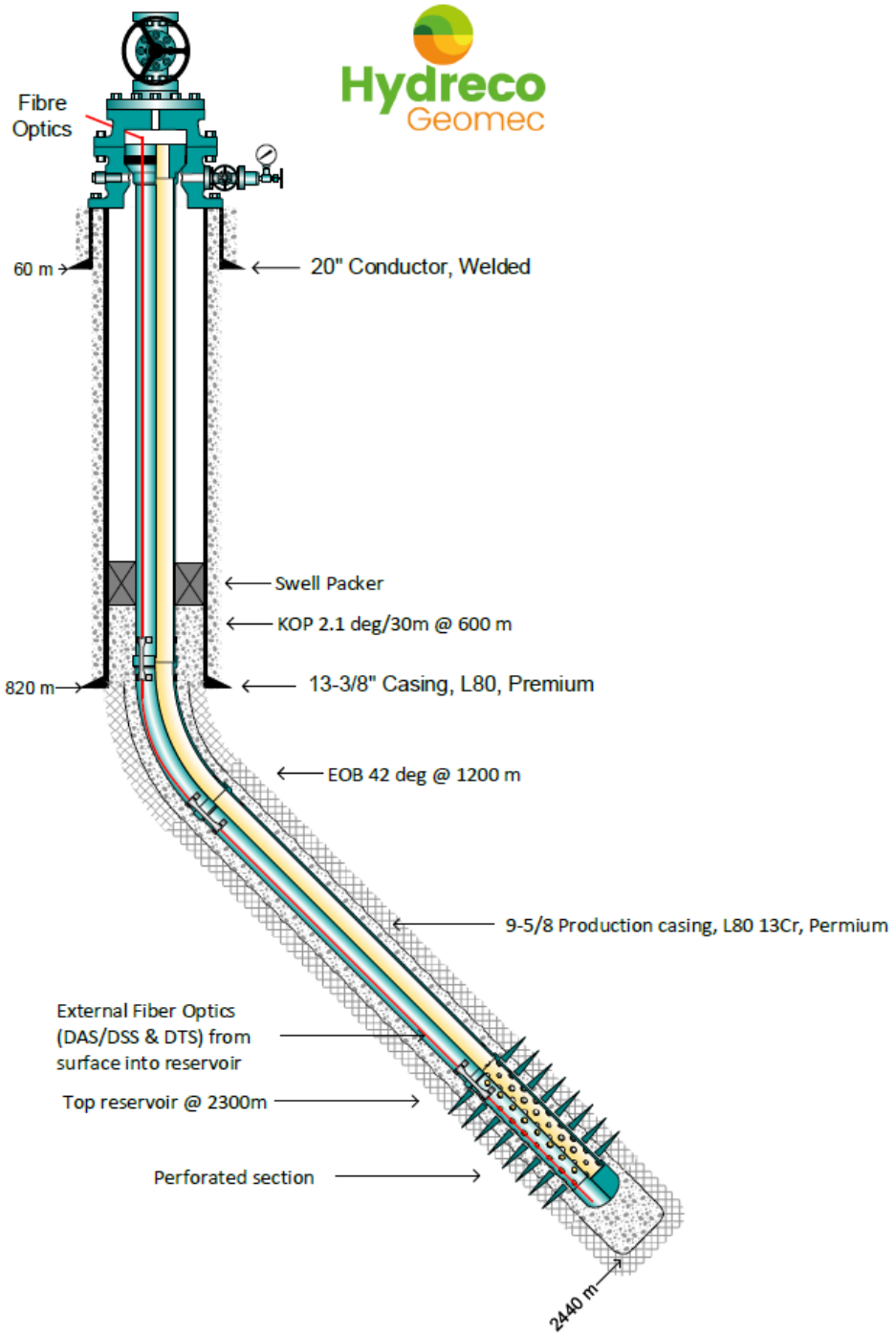
Intermediate section  Producer
13% Chrome

Full string Injector
13% Chrome

Liner hanger (set in smart X-over)
13 % Chrome

Outer 16” surface string L80 Premium

Screens Cr13/316L



# Material Selection

## 13 Chrome chosen over GRE

NaCl Level in SW NL are high but acceptable

$CO_2$ partial pressure is low

Margin up to 150 °C temp

Or up to 180 g/l NaCl

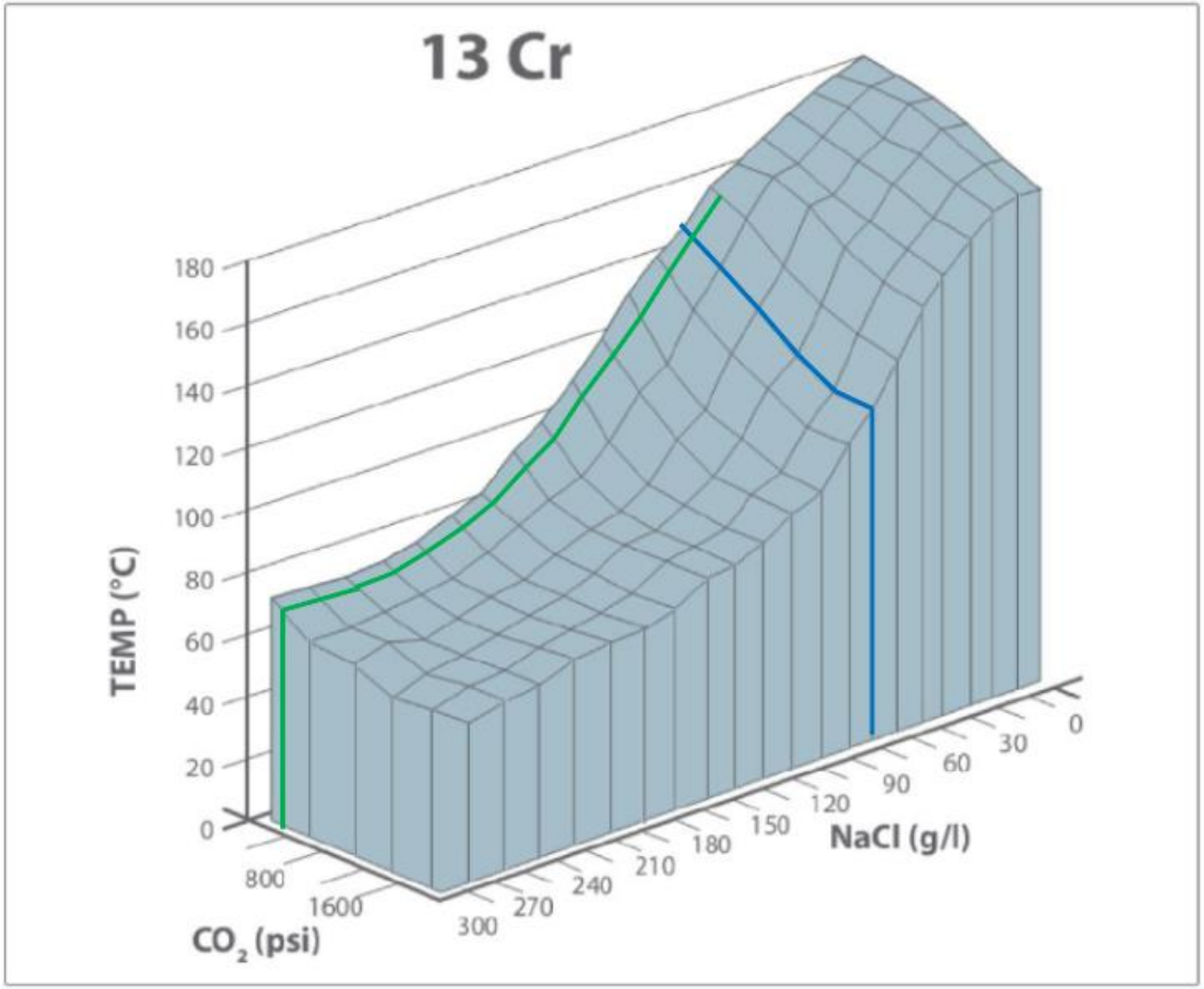
Or Full $CO_2$ level

Corrosion life time 50+ years

Be careful, low oxygen levels allowed!

But Injector temperature is as low as 30 °C temp

Mechanical load cases are simple, corrosion is not

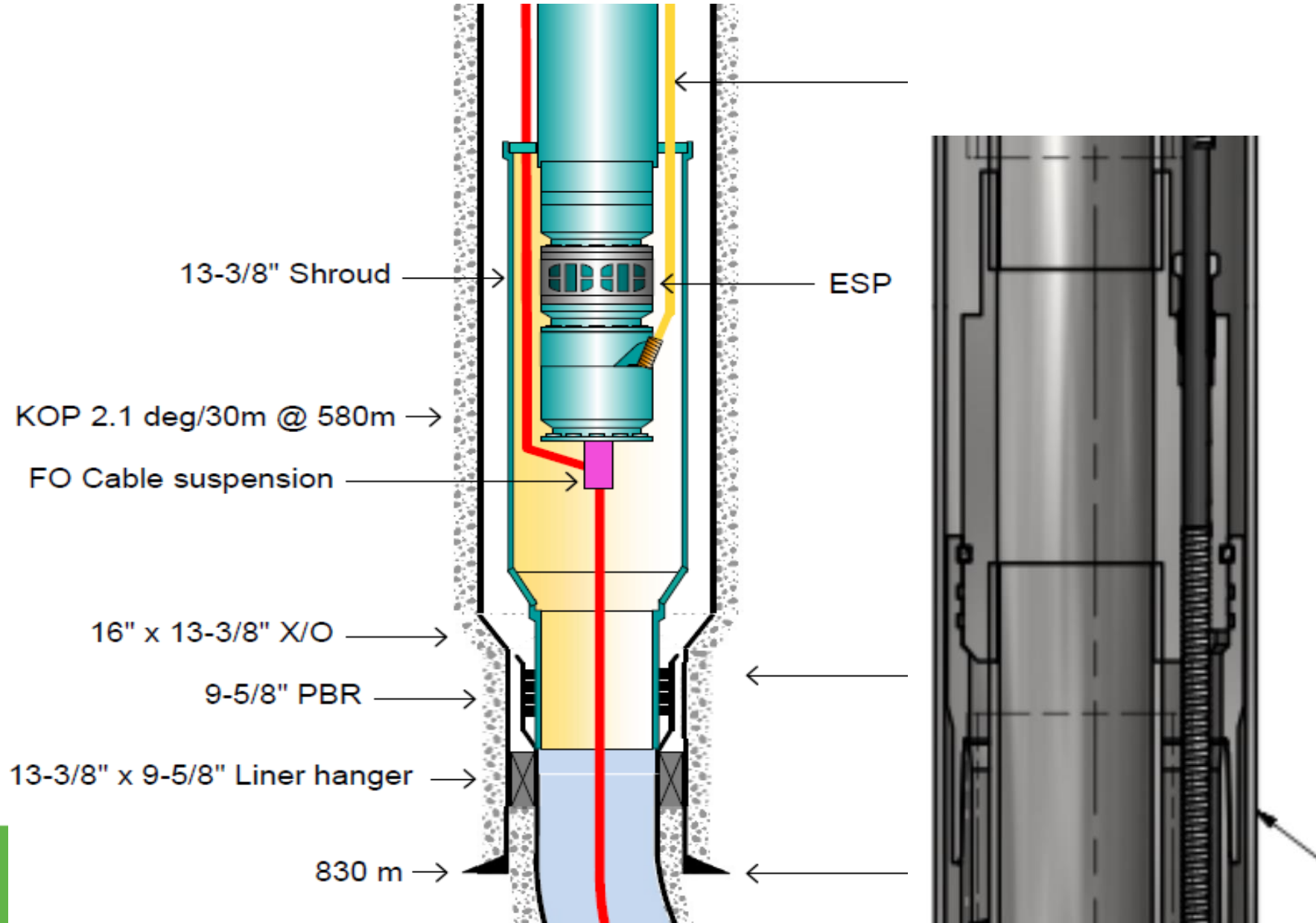


# The Sealed Shroud

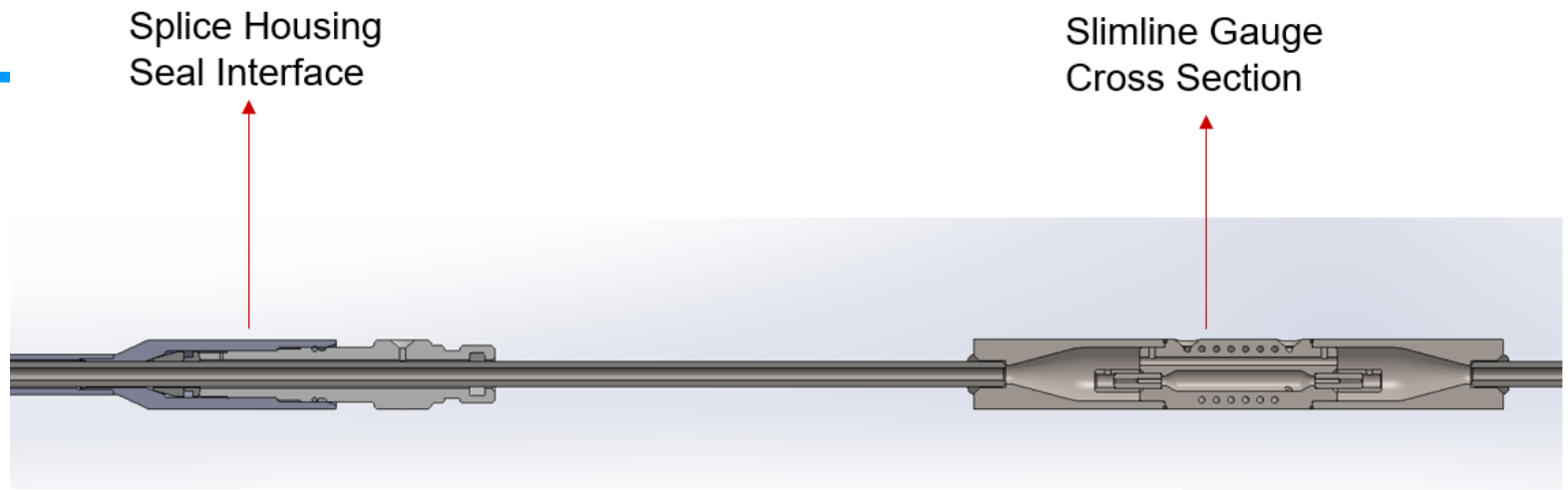
## No active annulus

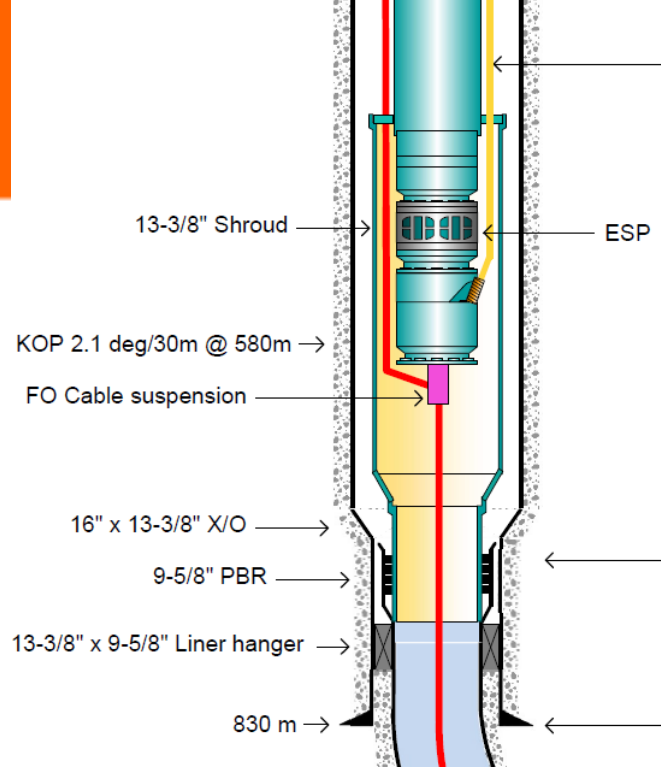
- Large size tubing 9 $^{5}/_{8}$”
  Or 10 ¾” to surface, less friction

- Cable feed-through without making splices
- Seal stem to stab in 9 $^{5}/_{8}$”liner top
- Fully sealed annulus
- Full annulus monitoring
- Needs a Large wellhead!



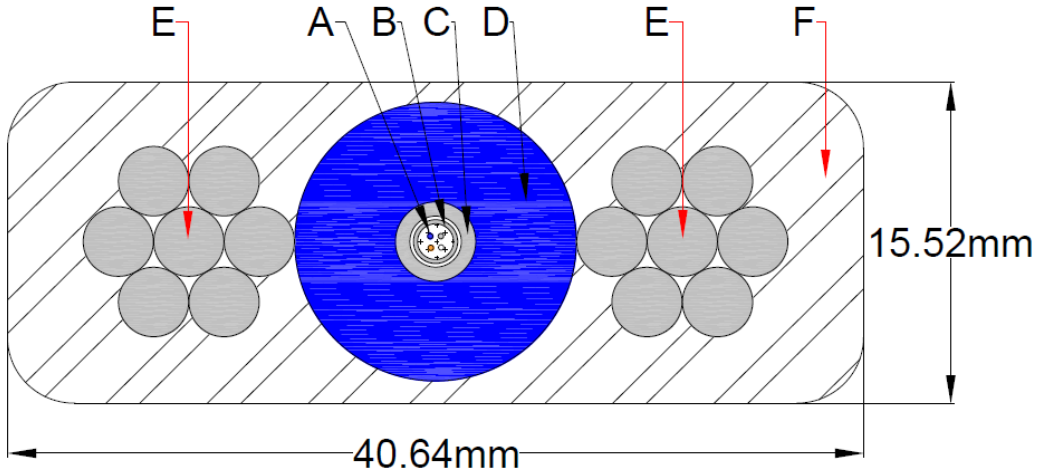
# Spoolable Fibre Optic Cable

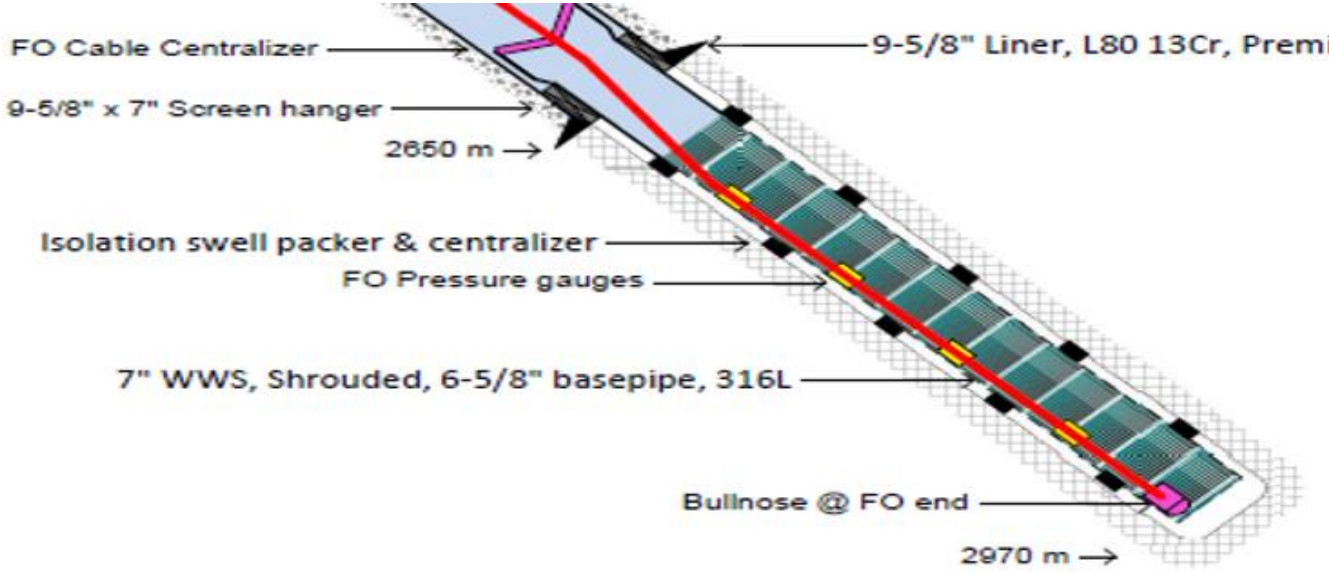



Cable Engineered by PDT

**FLATPACK: 4mm TEF w/ 4 OPTICAL FIBERS and TWO 7/16" BUMPERS**



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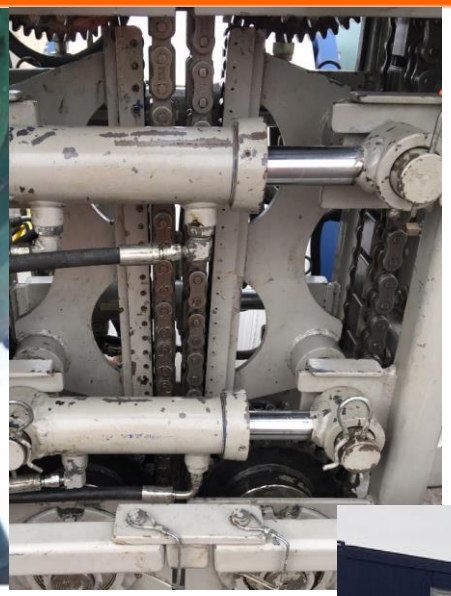
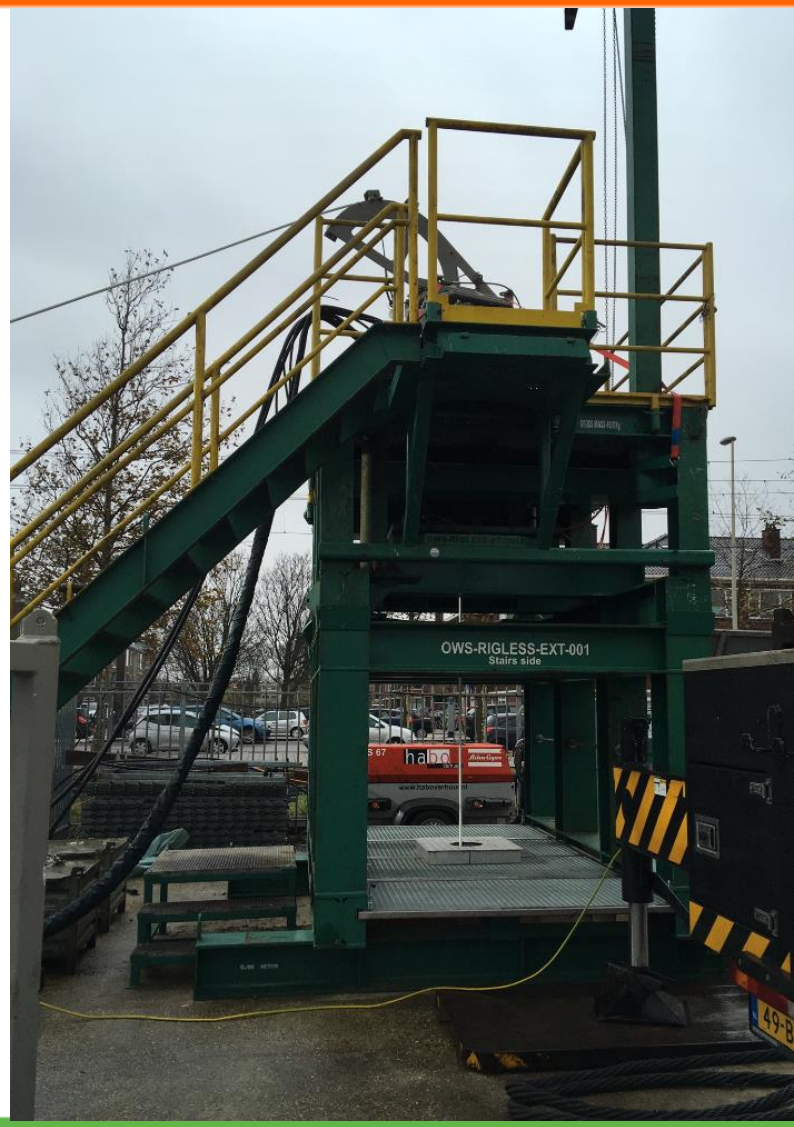


Real time Distributed Temperature

Real time PLT

Real time acoustic

(Differente Gauge solutions possible)



# Clean-Up & Well Testing

Deep Geothermal wells are harder to handle than oil and gas wells!

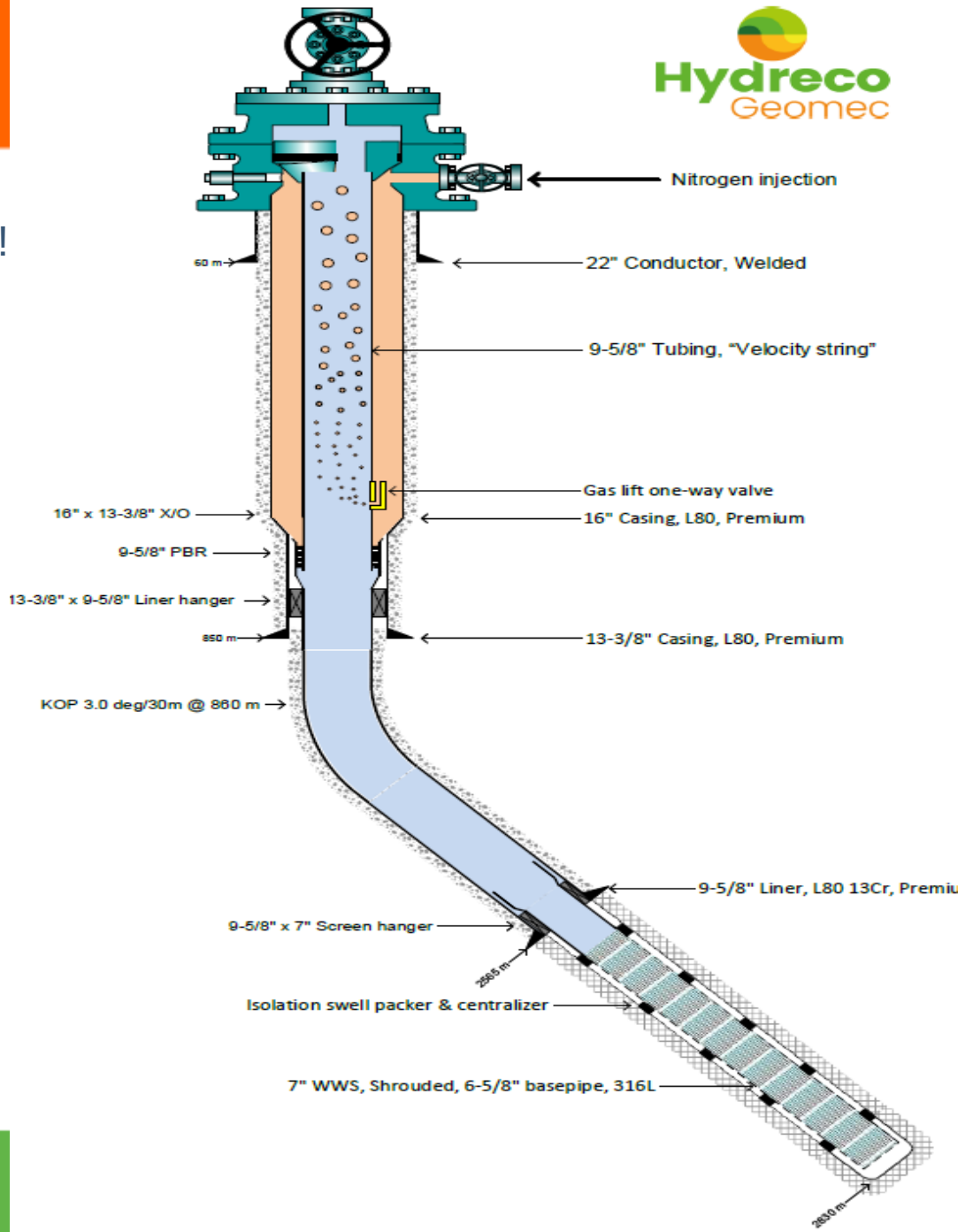
Geothermal wells are non flowing due to salt water (self killing) They need a pump to flow, when the pump is not on, all fluid (and dirt) is pushed into reservoir.

First in Geothermal; Direct Vertical Access (DVA) in producer.

In situ samples for R&D project TU Delft

- Corrosion testing
- Scale testing
- Gas / $C0_2$analysis
- Production water analysis per section (instead of mixture)

Ability to use a PLT to determine contribution (Skin) of each layer

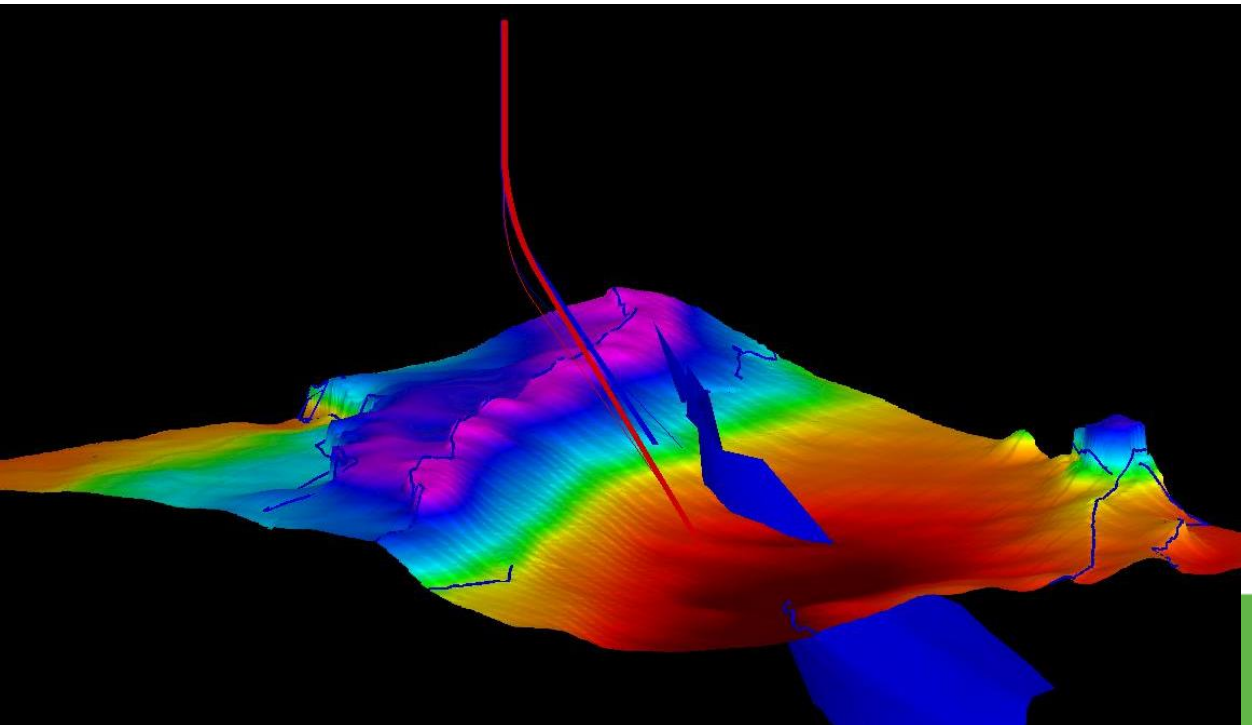


# Well Planning

**Iterative process with all partners (EBN thumbs up!)**

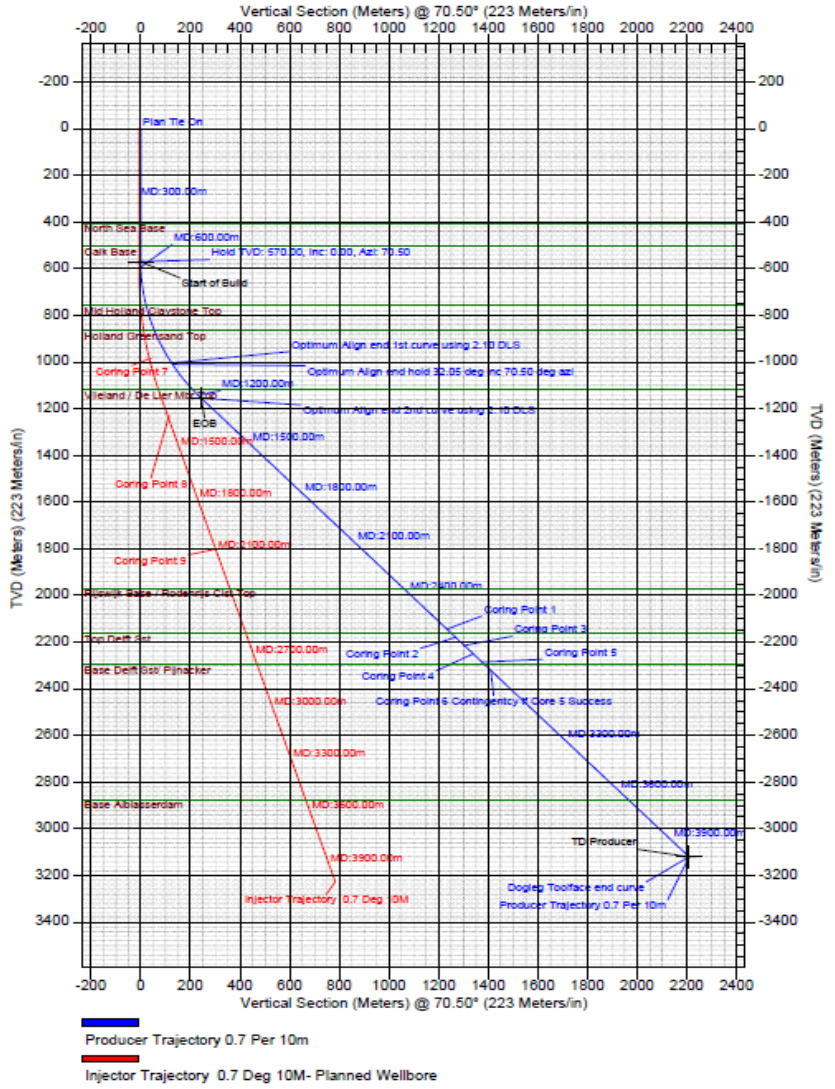
- Producer 45 Degrees, 190M intersection, 135m TVD Layer
- Injector 42 Degrees, 118m Intersection, 93m TVD Layer
- Full Cores: 5x Producer (full reservoir incl interfaces)

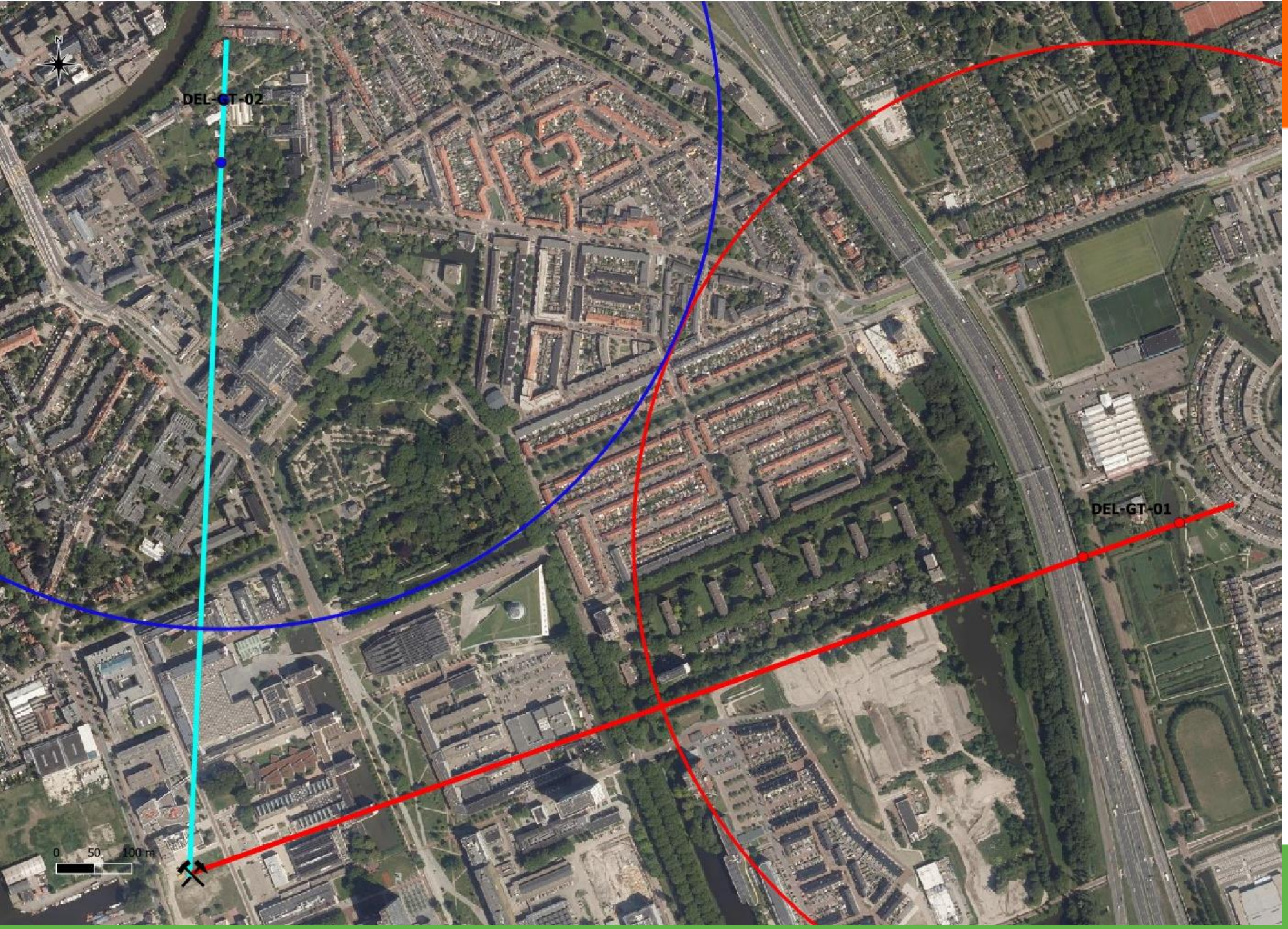
  3x Injector (overburden)



Inco-Drilling

| Project Details | |
|---|---|
| Operator | Hydreco Geomec B.V. |
| Field | Delft |
| Facility | Delft |
| Well | Producer Trajectory |
| Wellbore | Producer Trajectory 0.7 Per 10m |






Producing

up to 450m$^3$/hr

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Crossing right under Mijnbouwstraat 120

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# Acceleration…

## It all has to be right at the same time

- Business case (gas price was low @ 7 ct… now 1 Euro)
- Subsidy (Too early or too late or in the wrong direction)
- Materialen & long lead items (ready to go or after FID)
- Vergunningen/Permits (All needs to be 100% before submission)
- Cooperation
  - Great cooperation from TUD R&D team
  - Great cooperation from Ammerlaan
  - Great help from the contracting industry

- It always seems impossible, until it’s done  (Nelson Mandela)
  - Next week, ordering casing, August 2022, get ready for spud

# Thanks to the Team and to our GTD Partners

## Team:

Barbara Cox

Bas van Schravendijk

Annelies Bender

Bas van Dun

Marc Pijnenborg

Eric van Bennekom

Anton de Blok

Koos Huismans / Serge Santoo

Peter Odermatt / Saskia Hagedoorn

En vele anderen….

## GTD Partners:

Hydreco Geomec

ebn

TU Delft

# Thank You! Glűck Auf

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## And it all started here on the 28th of Feb 2007


Founding Fathers..

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Andries Wevers

Dick Swart

Hans Hombroek

Duco Drenth

Robert Dijkhuis

G Bahlen, J van Eldert

Chris den Boer

En vele, vele anderen

# Questions? Glűck Auf

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# Well time and well cost

## The GTD wells have a large R&D Component

| | |
|---|---|
| Rig Time Producer: | 54 Days (including short well test, excluding ESP installation) |
| Rig Time Injector: | 40 Days |
| Total time | 72+ 22 = 94 Days |
| R&D Activities | 14+8 = 22 Days (included in 94 days) |
| | |
| R&D Cost | €3,6 M (incl €300,000 Contingency) |
| GTD Cost | €12,5 M (inclusive of ESP and surface platform) |