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E-Field real time well temperature monitoring – Kharyaga field case

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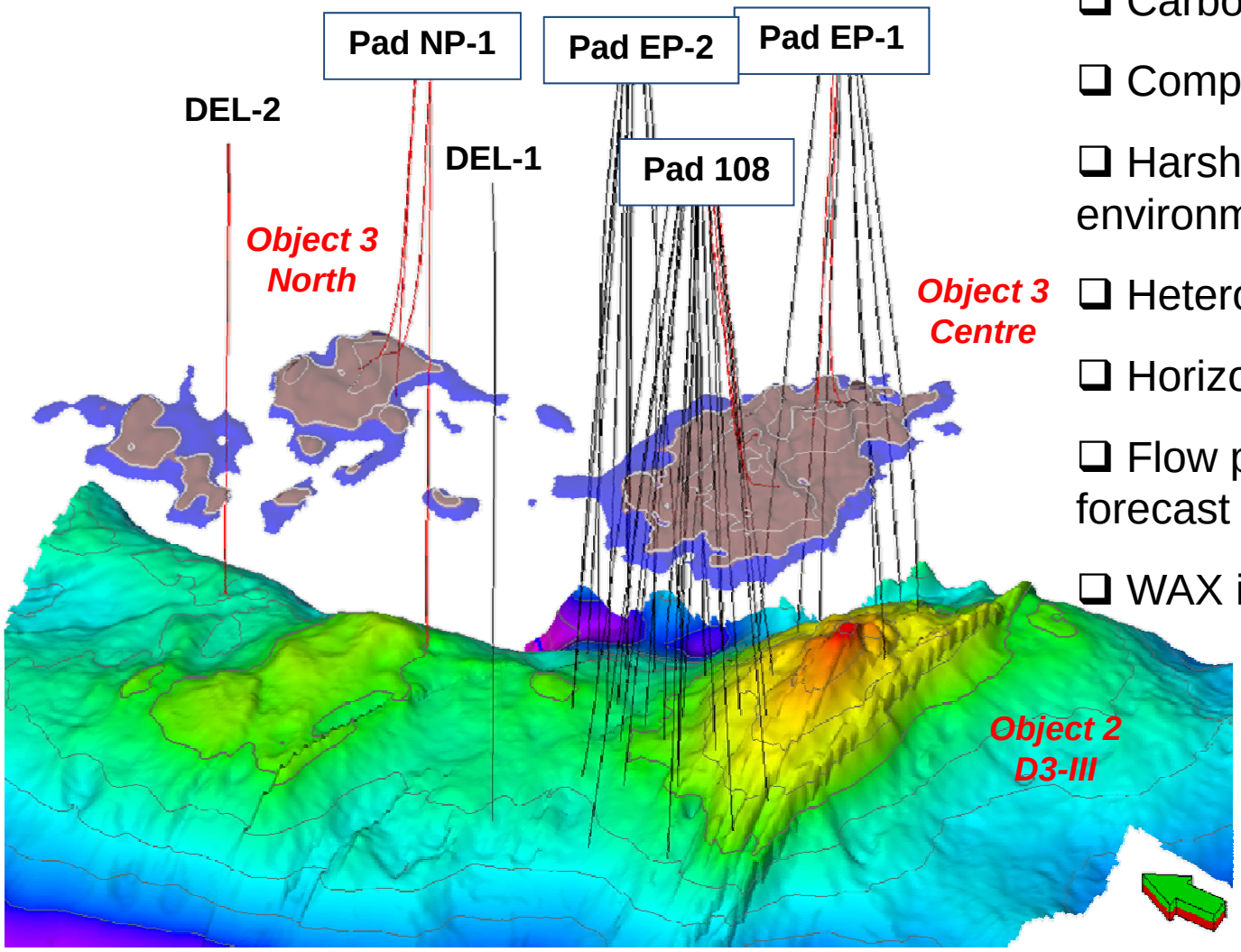
Society of Petroleum Engineers

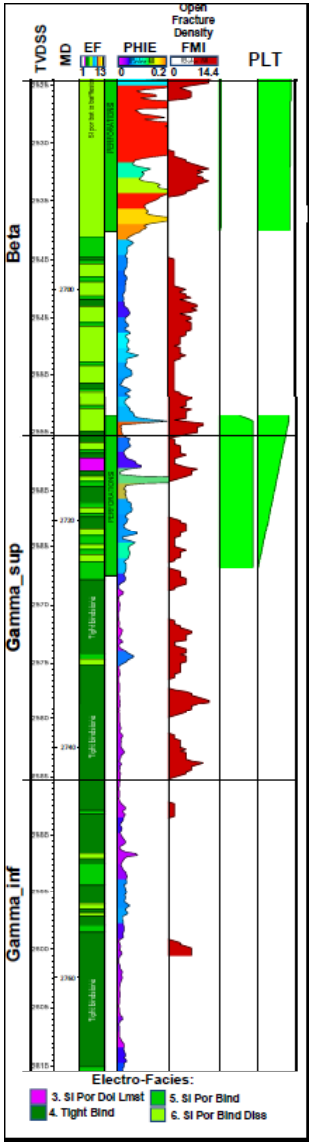
AGENDA

- **Kharyaga field**
- **DTS (Distributed Temperature Sensing) project:**
  - completion systems
  - data transfer infrastructure
  - interpretation
- **Field applications**
  - flow profile evaluation
  - scrapping optimization
  - water shut-off
  - cross flow identification
- **Conclusions**

Kharyaga field



- ❑ Carbonate
- ❑ Complex
- ❑ Harsh tundra environment
- ❑ Heterogeneous
- ❑ Horizontal wells
- ❑ Flow profile forecast issue
- ❑ WAX issue



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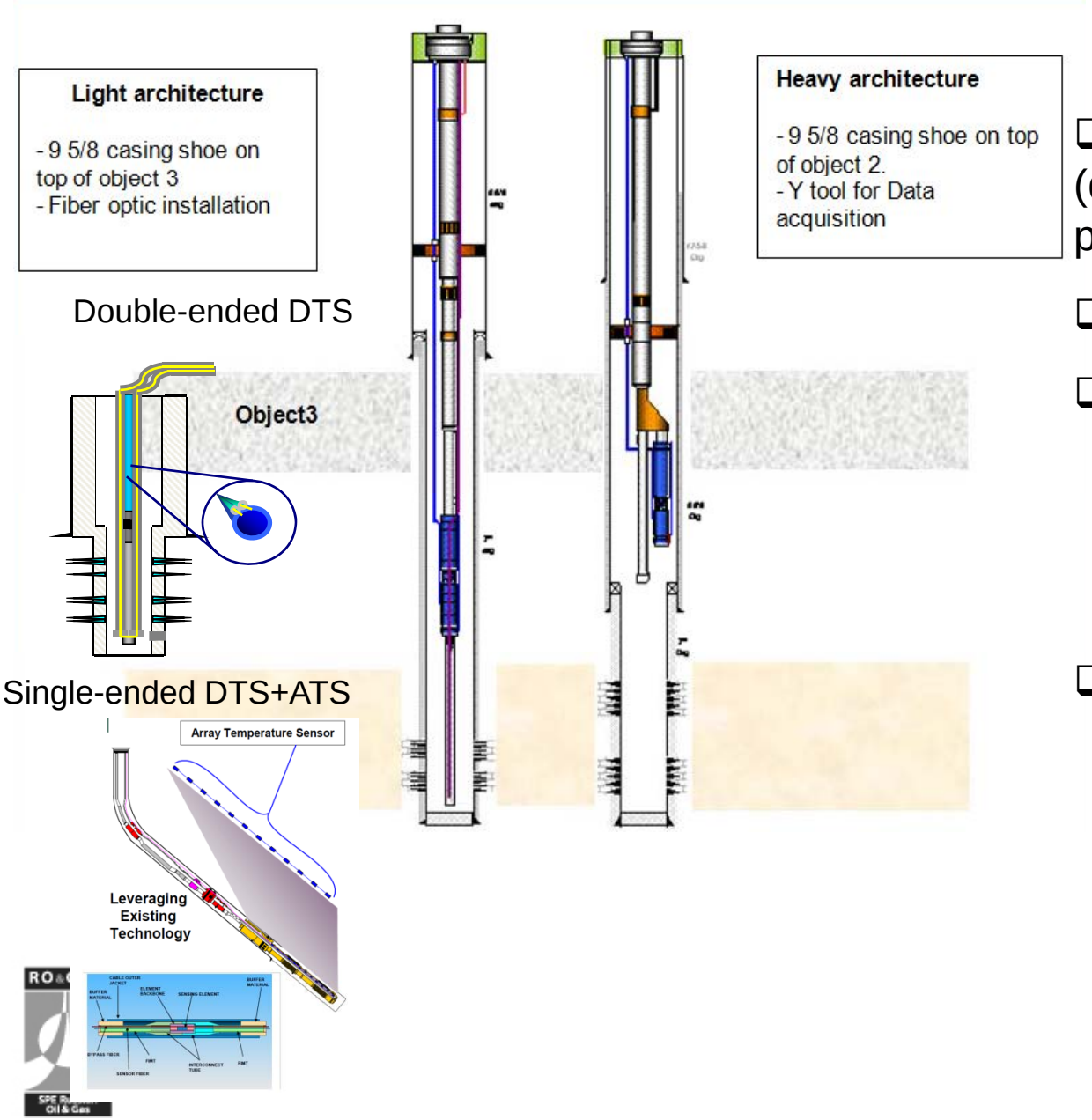
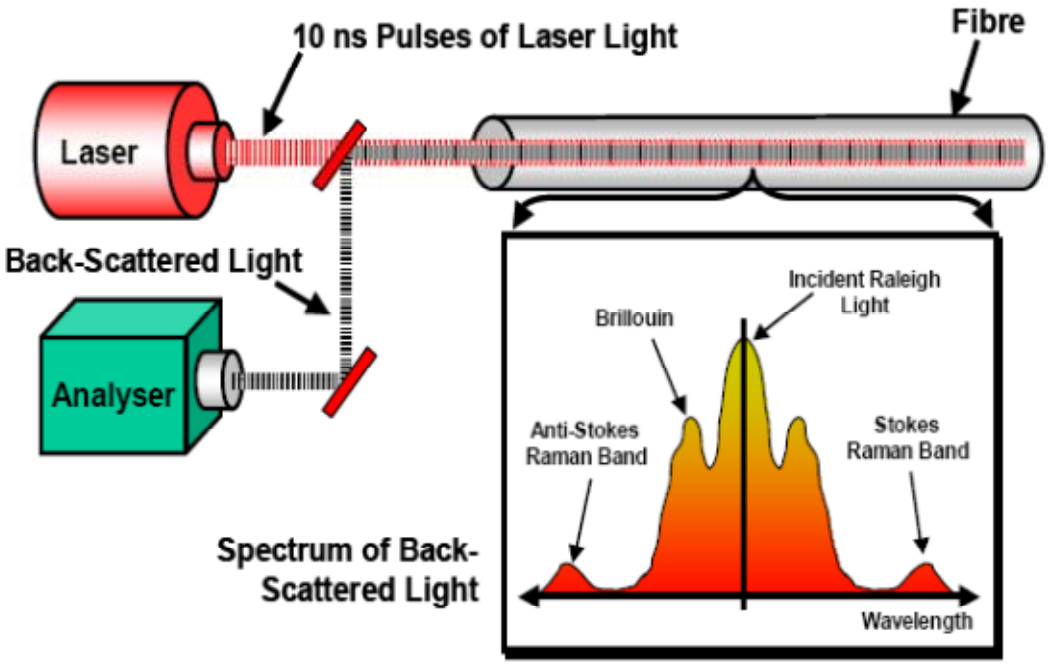
Completion systems



- ❑ Several production layers (different reservoir properties / pressure)
- ❑ Acid stimulations
- ❑ Light architecture:
  - ❑ ESP lower
  - ❑ Limited interventions possibility
- ❑ Heavy architecture:
  - ❑ ESP upper
  - ❑ Y-tool installation

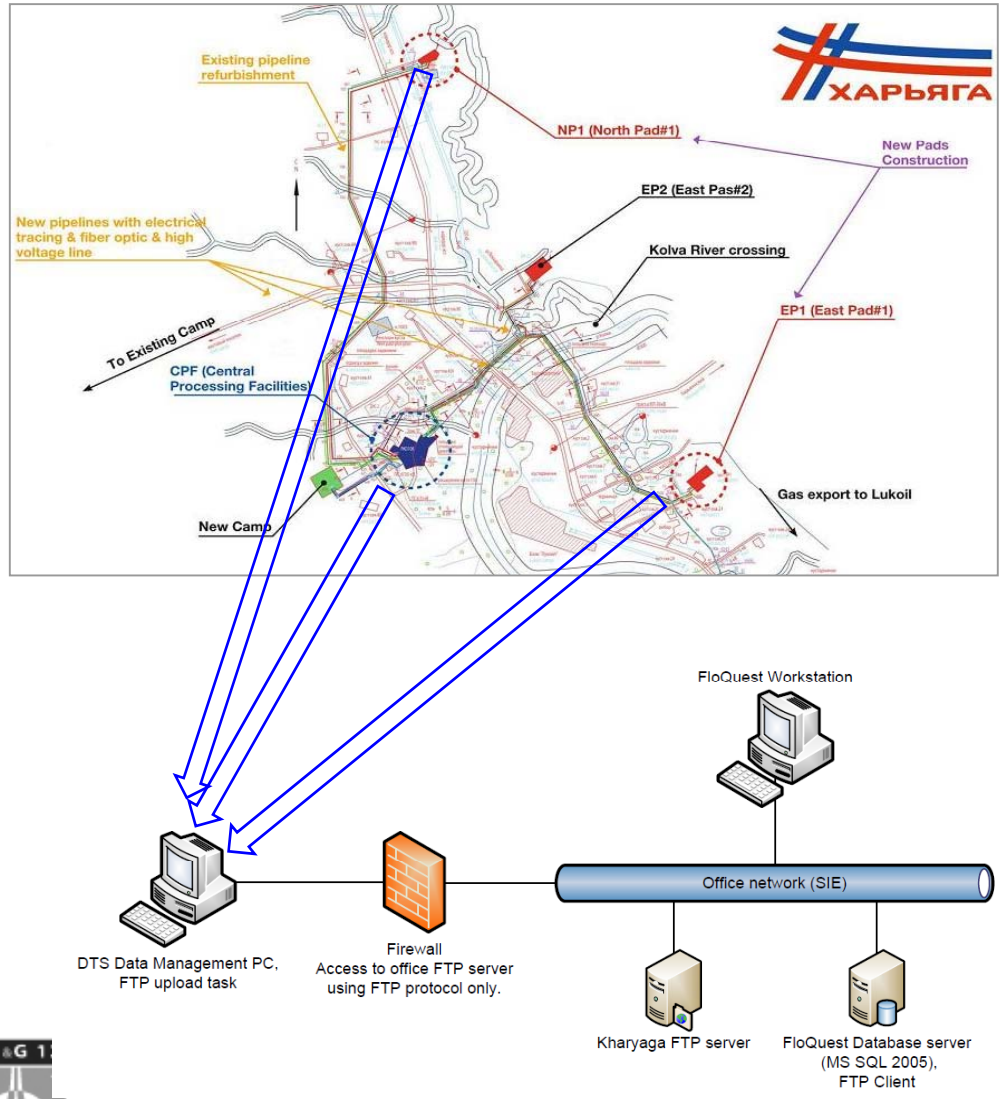
Distributed Temperature Sensing

Technique to measure temperature along a fiber optic line at any time



- Industrial laser launches 10ns bursts of light down to fiber optic
- Light is back-scattered from molecules in the fiber
- Back-scattered light analyzed to measure temperature along the fiber
- Ratio of the Stokes Raman to the Anti Stokes Raman Bands is directly proportional to temperature
- Two way light travel time determines position of recorded temperature along the fiber (due to constant light velocity)

Kharyaga DTS installations and data transfer

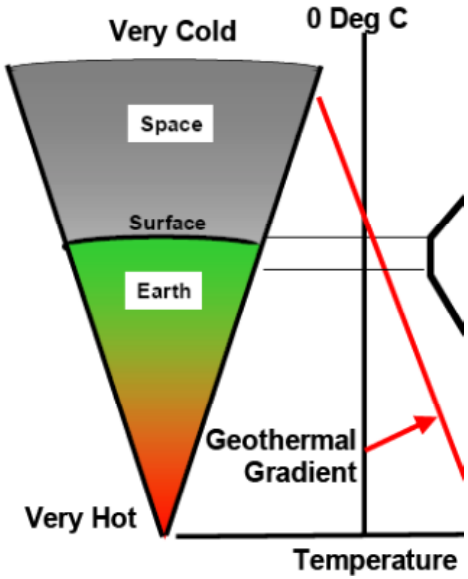


- Installed as part of completion on
  - PAD108: 4 wells
  - Pad NP-1: 2 horizontal wells
  - Pad EP-1: 4 wells DTS+ATS
- Data transfer solution:
  - Automated data transfer
  - Traces DB from any contractor
  - Huge amount of data (1 trace every 30 min) stored and available for analysis
  - Dedicated DTS visualization/interpretation software
  - Comply with Total IT security

Temperature traces interpretation

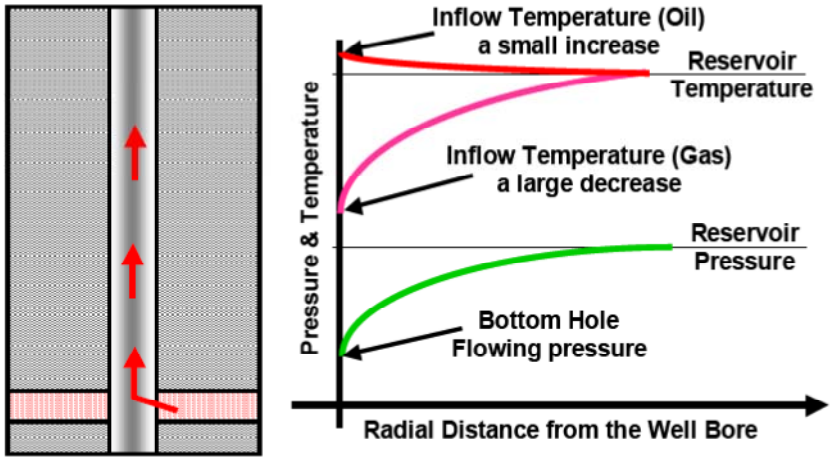
Geothermal gradient

(typical values between 1.0 – 3.0 Deg C/100 m)

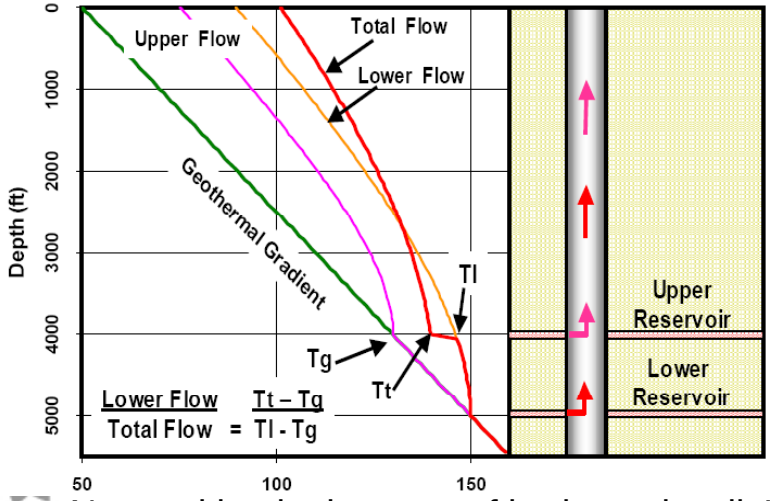


Joule-Thomson effect

(fluid changes temperature due to pressure drop at well bore)

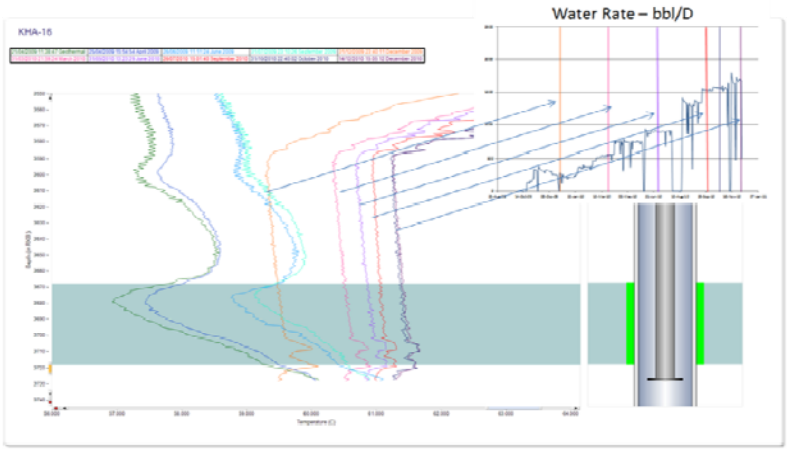


Thermal response of Multy-Zone Flow



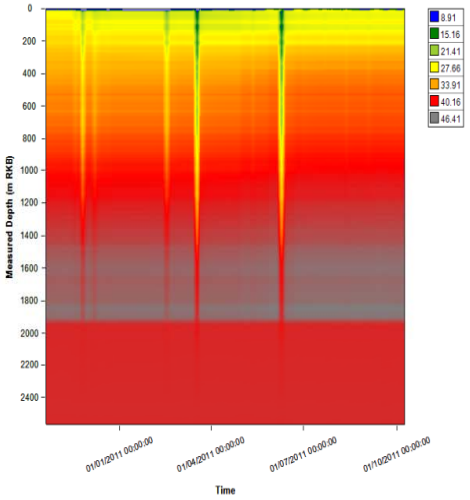
Not working in the case of horizontal wells!

Multiphase flow issue

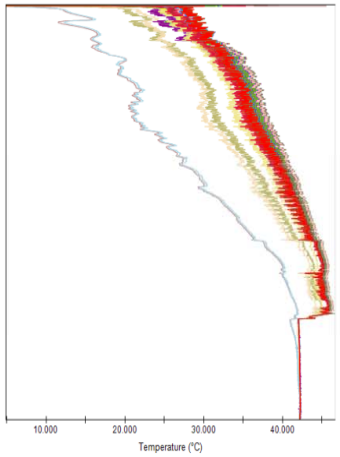


Flow profile evaluation workflow

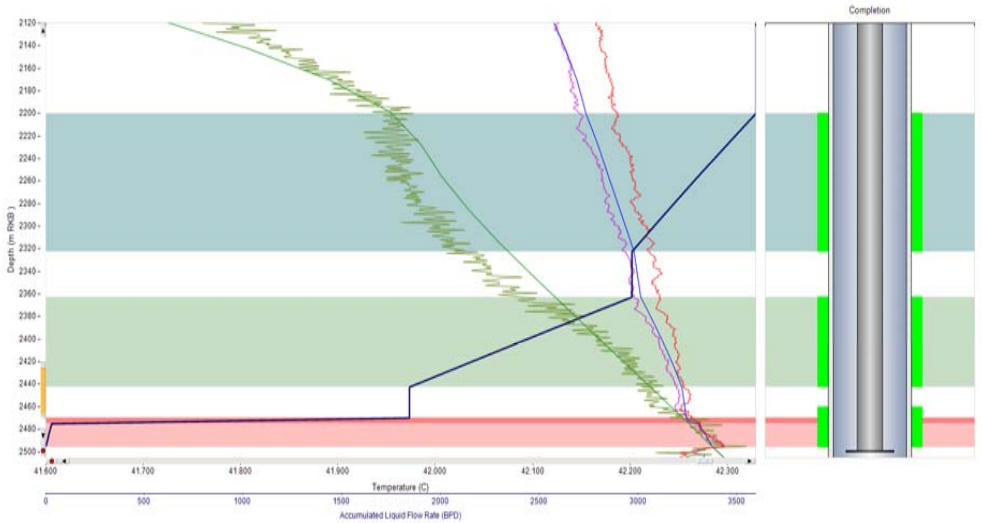
QC all traces
Events identification



Static-dynamic
traces comparison

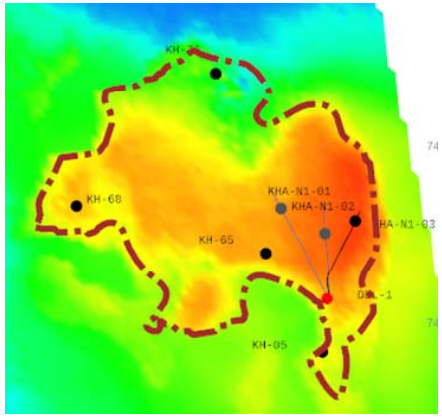


Identification model construction
Inflow profile identification

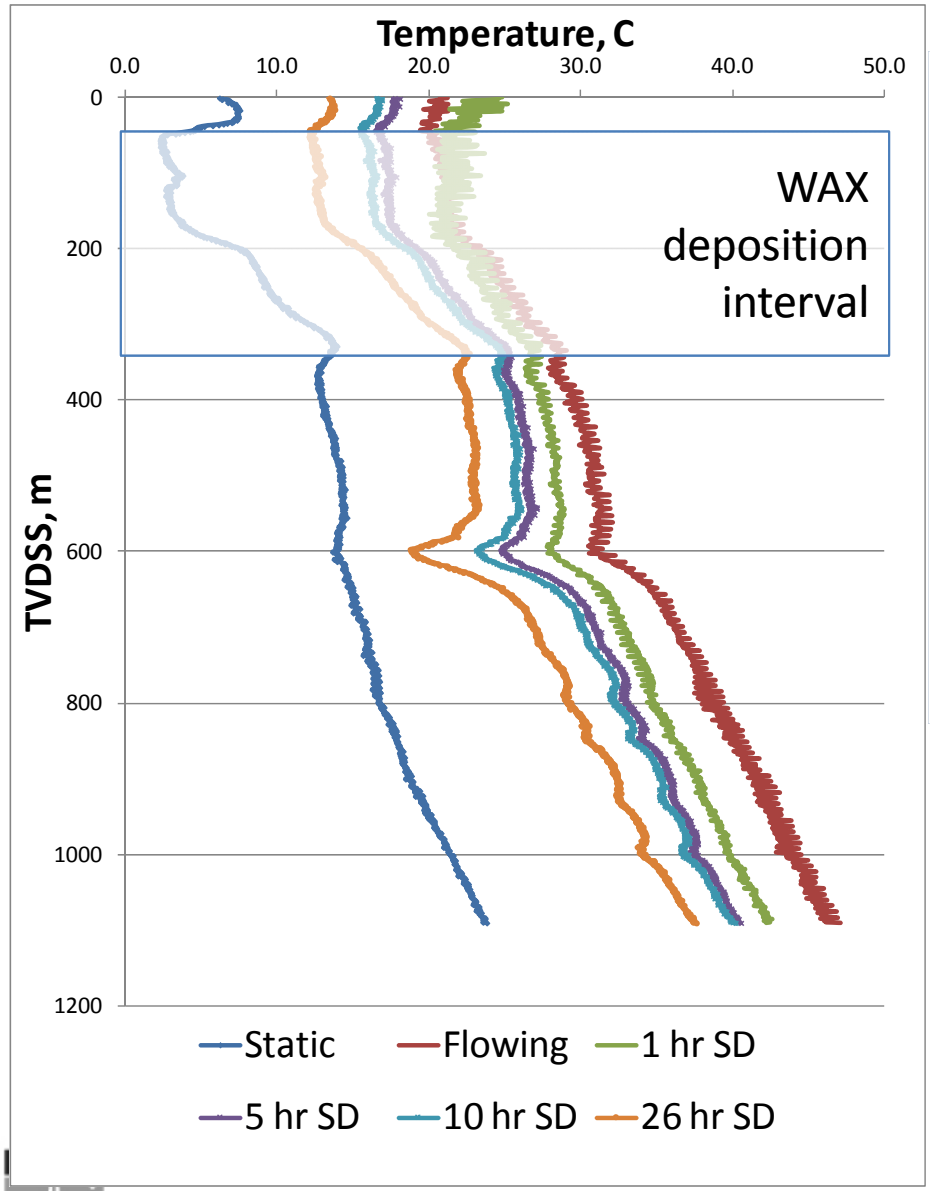


Flow profile distribution		
Top, m MD	Bottom, m MD	Inflow, bpd
2470	2475	3200
2363	2443	120
2200	2323	210

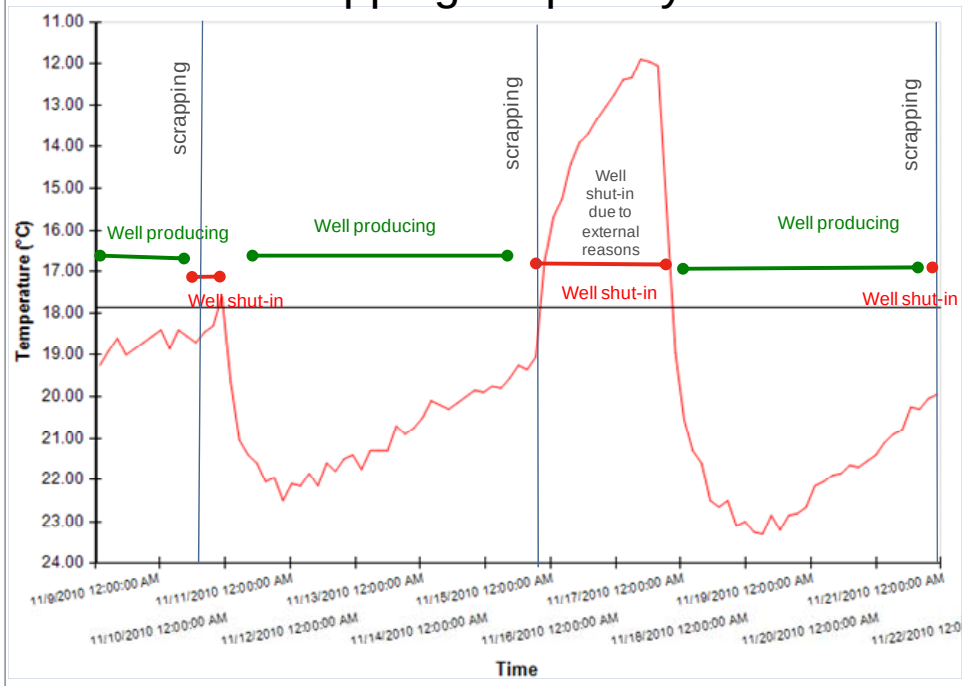
Simulation model



Scrapping frequency optimization



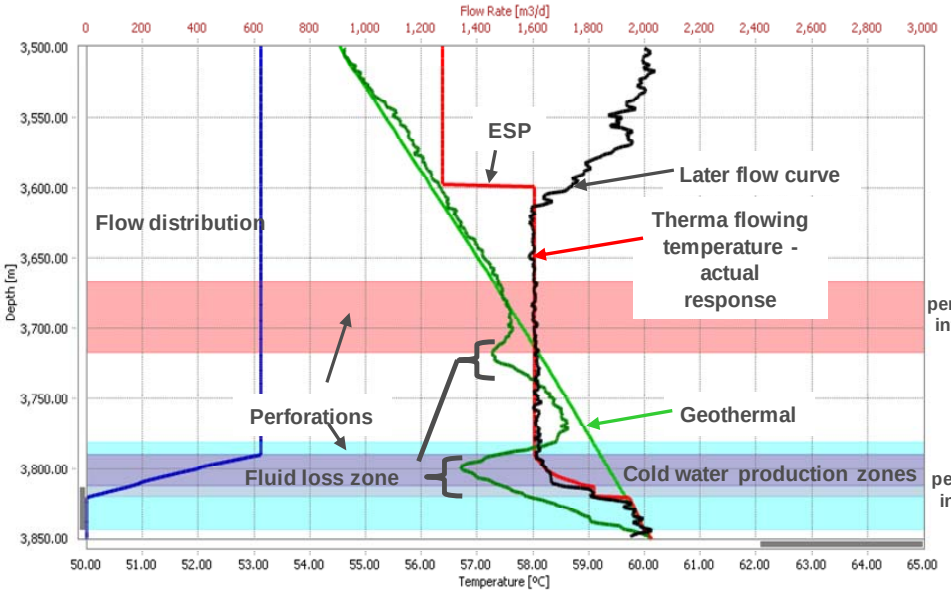
Scrapping frequency

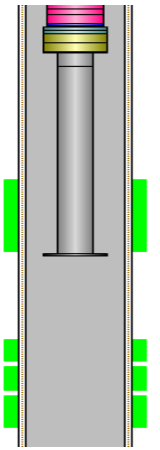


- ❑WAX deposits interval is 50-350 m TVDSS
- ❑Scrapping operations are necessary but lead to production short falls
- ❑Detections of wax deposits inside tubing
- ❑Interventions only if temperature below threshold

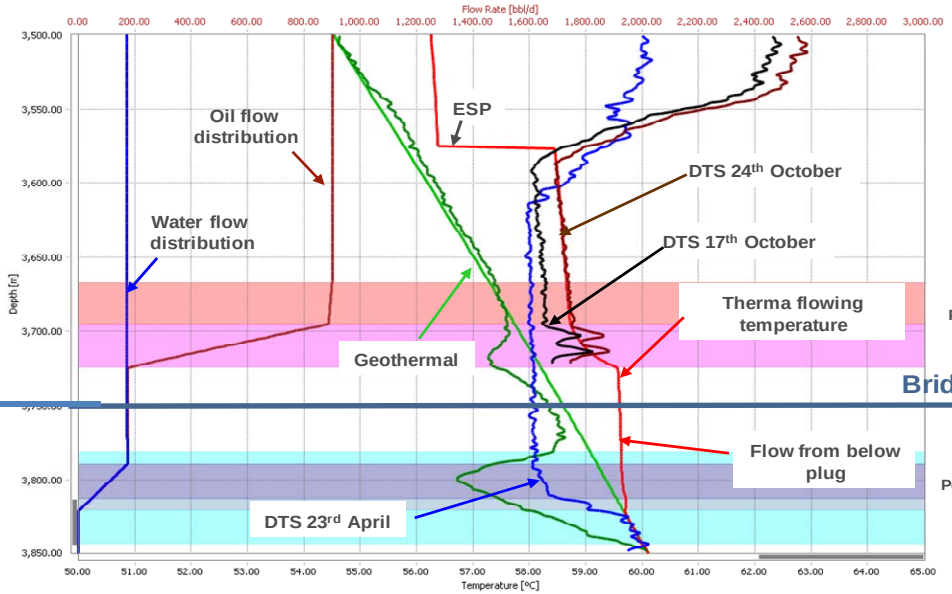
Water inflow identification and shut off

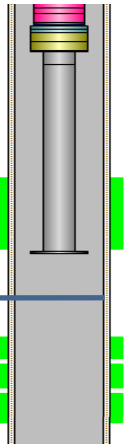
Bridge plug set up





100% water right after start up





18% water production below plug

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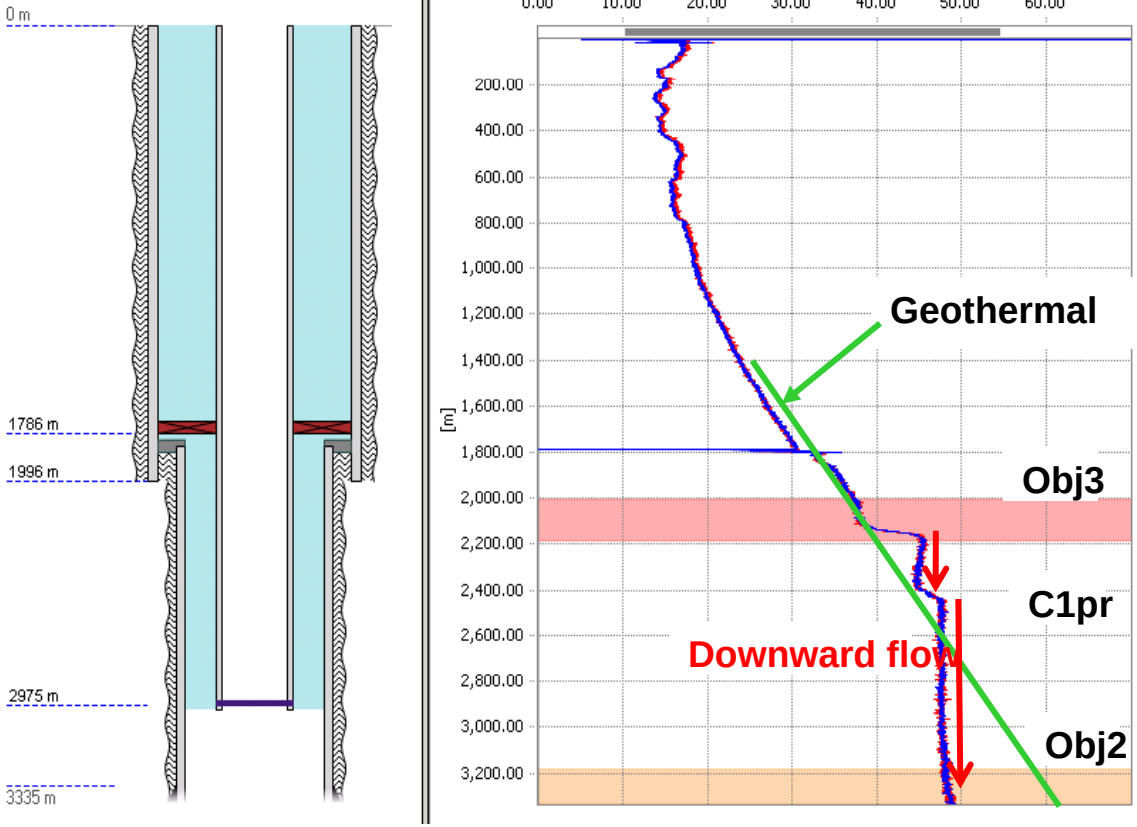
Cross-flow identification and remedial work



- ❑ Water cross-flow (tubing-casing) from upper layer was identified
- ❑ Cross-flow was confirmed by other acquisitions (nearby wells pressure, RST)
- ❑ Successful remedial work was done
- ❑ Well was started with 0% BSW

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Conclusions

1st full field DTS integrated project in Russia/Total

- Permanent DTS on Kharyaga field became a valuable part of overall field monitoring strategy. DTS solutions were installed on 3 Kharyaga pads (10 wells)
- Automatic data acquisition/transfer allows quick data visualization and qualitative interpretation in the Moscow office
- On-site (Moscow) quantitative DTS data interpretation become possible to get flow profile distribution
- The number of operational optimization could be done based on DTS data analysis: scrapping frequency, water shut off, cross flow elimination

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