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Development of an Ultra-High Temperature High Pressure Organophilic Clay-Free (OCF) Invert Emulsion Fluid to Reduce Surge and Swab Effects and Pressure Drops Compared to Existing Conventional Clay-Based Invert Emulsion Fluids

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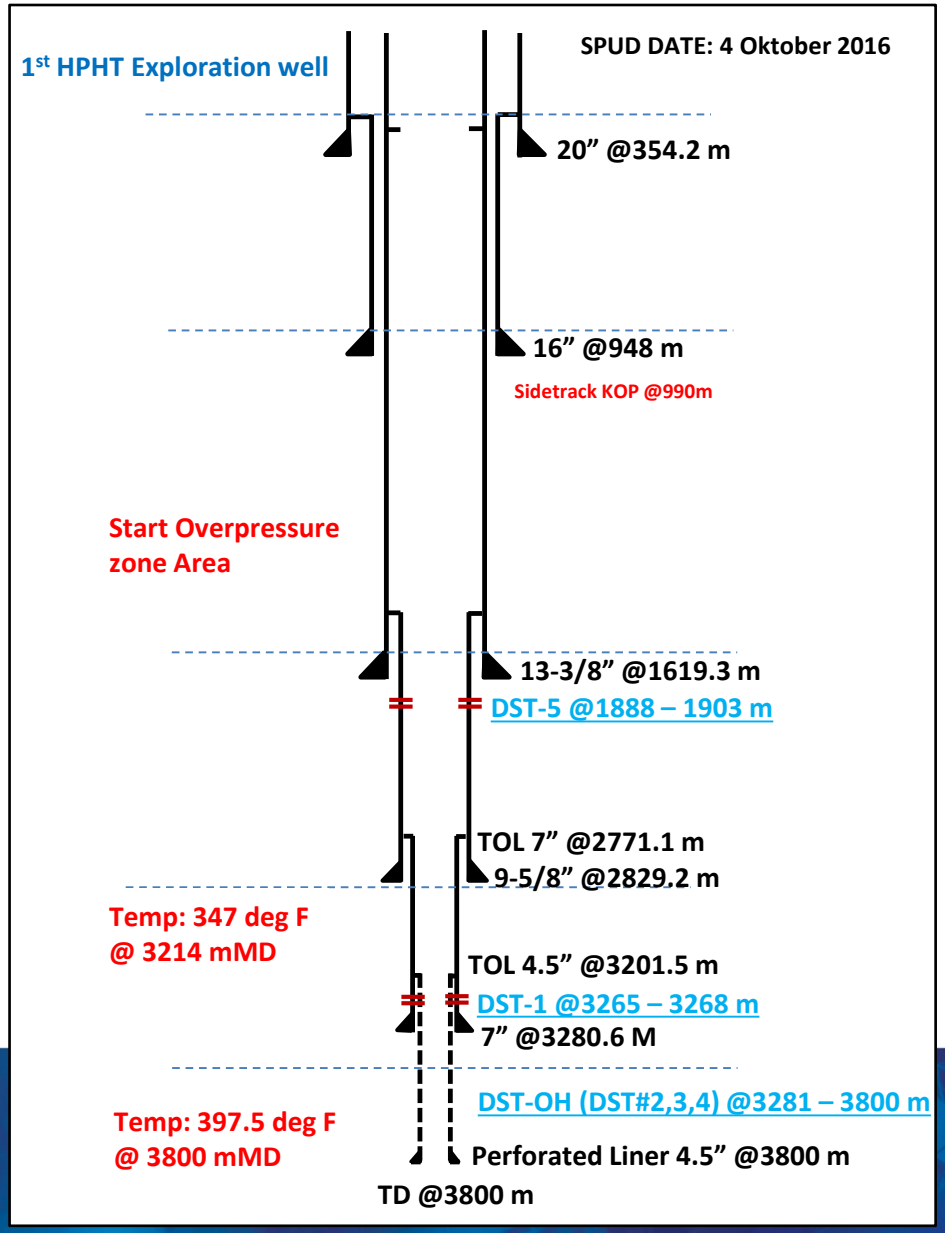
Introduction: Well Melucut-001 at Northern Sumatera



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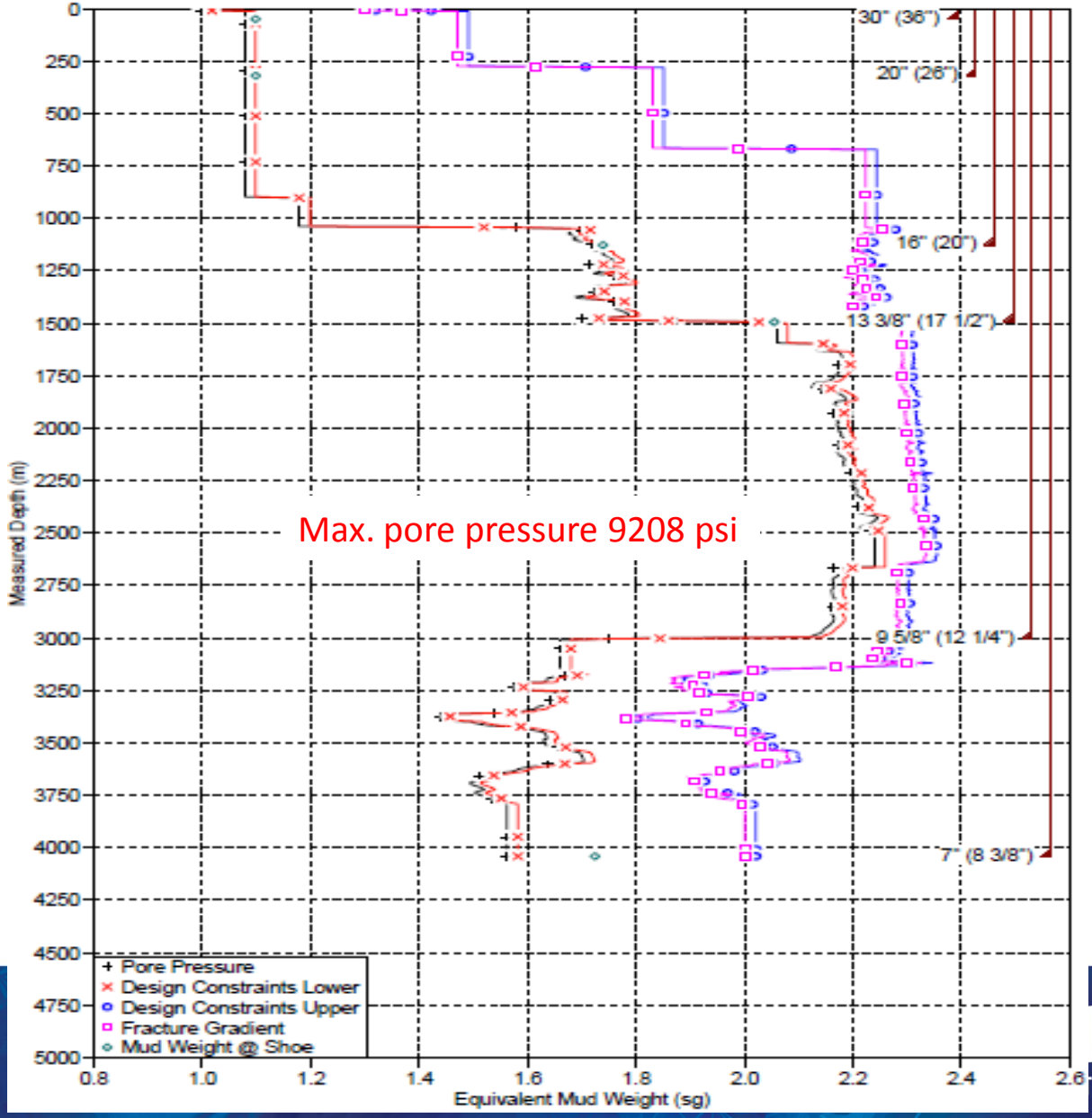

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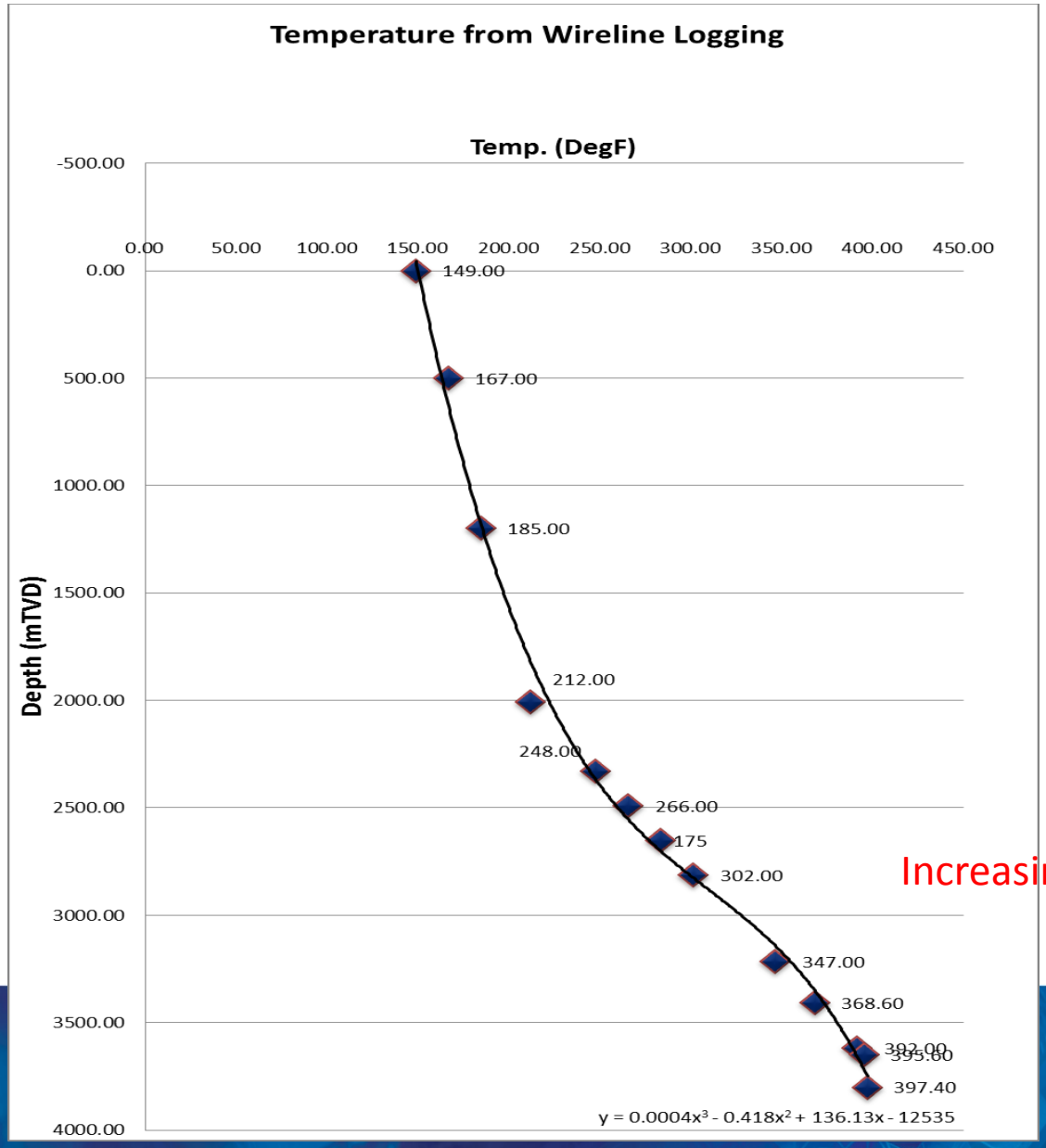

Increasing thermal gradient

Challenges and Objectives of the Drilling Campaign

- Drilling Challenges
  - Ultra high density mud
  - Excessive ECD on narrow margin window
  - Ineffective hole cleaning - related to hole size and pumping speed
  - Mud stability under high temperature

- Drilling Objectives
  - Provide Wellbore stability from mud that is designed for HPHT
  - Drilling with ECD under Fracture Gradient on narrow margin
  - Effective hole cleaning with optimum rheology

Conventional System vs OCF - IEF System

- Conventional
  - System mud that relies Clay for Rheology, Suspension as well as Fluid loss controller.
  - Need significant Shear and Circulating time to yield fully.
  - Temperature sensitive mud system
- Organophilic Clay-Free Invert Emulsion Fluid System
  - Stable Rheological Properties over wide range temperature
  - Excellence Suspension with Fragile Gel structure
  - Low friction, lower ECD, Zero Barite Sag

New Pertamina Base Oil Opportunity

- Non-toxic Base Oil:
  - Low Aromatic content (UV, %) <0.01%
- Low Kinematic Viscosity:
  - Viscosity at 40^{o}C < 2.7 cST
- Aniline point > 80^{o}C
- PVT analysis up to BHST & pressure
- Establish QA/QC controls (e.g. GC analysis fingerprint; flash point measure)

Lab Results and Downhole Simulation

Surface Rheology

	Non OCF-IEF	OCF-IEF
MW, SG	2.15	2.50
Test Temperature °F	120	120
600 rpm	233	137
300 rpm	129	81
200 rpm	91	62
100 rpm	52	40
6 rpm	11	13
3 rpm	9	11
PV, cP	104	56
YP,lb/100ft^2	25	25
10 sec gel,lb/100ft^2	18	14
10 min gel, lb/100ft^2	33	18
30 min gel, lb/100ft^2	43	20

Downhole ECD and Annular Pressure Drop

Result	PV, cP	Annular Pressure drop, psi	Density, ppg	ECD, ppg	ECD - Density, ppg
Conventional Mud	104	751	18.0	19.167	1.167
OCF-IEF	56	468	21.0	21.642	0.642

Conclusions and Recommendations

- Solution for upcoming HTHP wells
- Reduce/Remove risk of loss circulation from excessive ECD
- OCF – IEF provide stable mud, optimum cutting carrying capacity on high temperature
- Recommended to continuing study on higher temperature 425 F
- Local Pertamina base oil has opportunity to be formulated with this combination.