



**Schlumberger**

# HIGH RESOLUTION WELL TESTING IN HUNGARY

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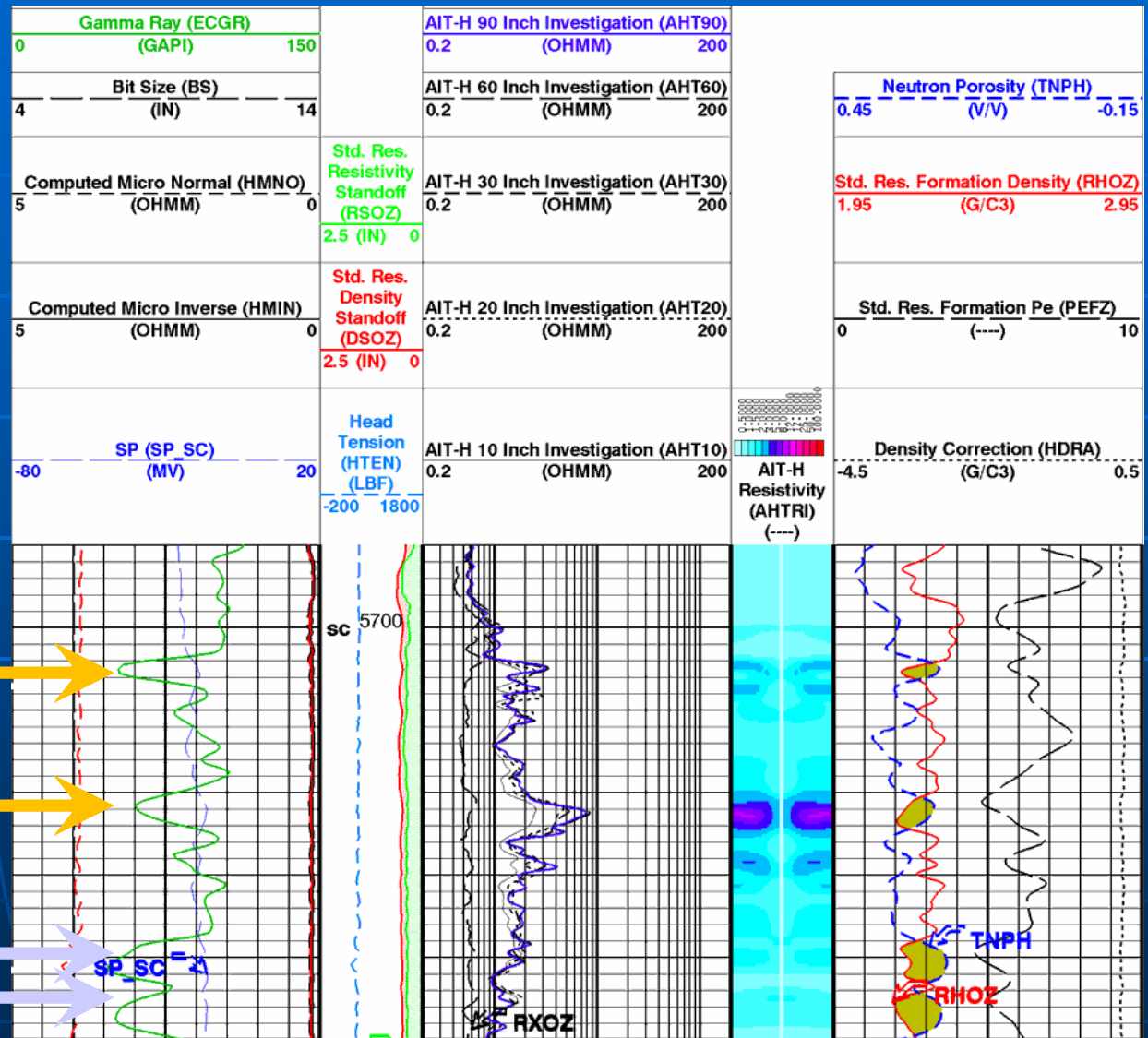
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*Jason Gendur Schlumberger Data and Consulting Services*

# AGENDA

- HIGH RESOLUTION WELL TESTING
- HRWT TOOLS
  - PRESSUREXPRESS
  - MODULAR RESERVOIR DYNAMIC TESTER
- APPLICATIONS OF HRWT
- CASE STUDIES
  - MOL-L2 -> XPT
  - MOL-K -> XPT
  - MOL-L1 -> MDT

# HIGH RESOLUTION WELL TEST



Potential Hydrocarbon Zones

Potential Water Zones

# LOW vs HIGH RESOLUTION

## LOW RESOLUTION, LARGE INVESTIGATION VOLUME

- WELL PERFORMANCE
- REPRESENTATIVE SAMPLE
- RESERVOIR PROPERTIES
  - LARGE SCALE (PRESSURE, PERMEABILITY, BOUNDARY)

### ■ ISSUES

- MULTIPLE ZONES
- MULTIPLE PHASES
- CEMENT QUALITY



## HIGH RESOLUTION, SMALL INVESTIGATION VOLUME

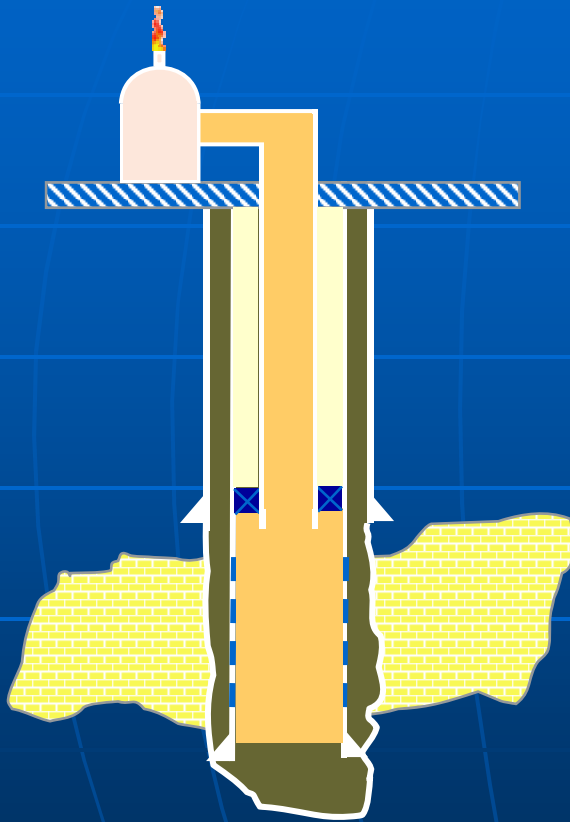
- BEFORE COMPLETION
- SHORT DURATION
- ENVIRONMENT FRIENDLY
- ZONE BY ZONE TESTING

### ■ ISSUES

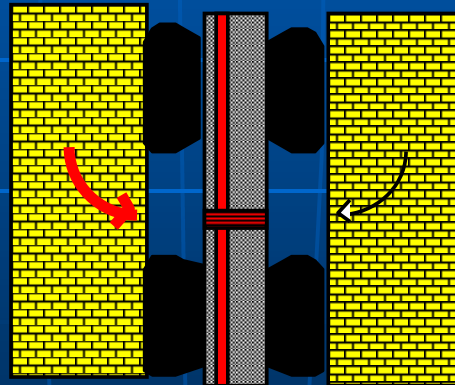
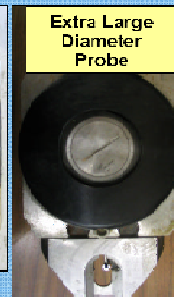
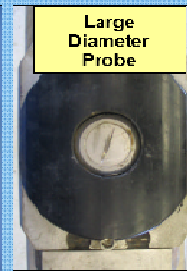
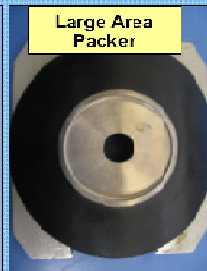
- STICKING (WIRELINER TOOL)
- TOOL PLUGGING

MDT-XPT CAN BE USED TO OPTIMIZE DST, RESULTING IN TOTAL COST REDUCTION FOR THE OPERATORS

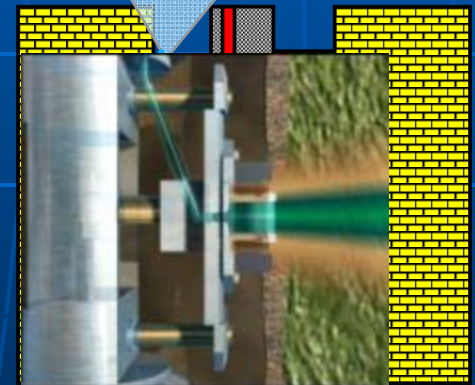
# RESOLUTIONS OF WELL TESTING



**LOW RESOLUTION  
CONVENTIONAL TEST**



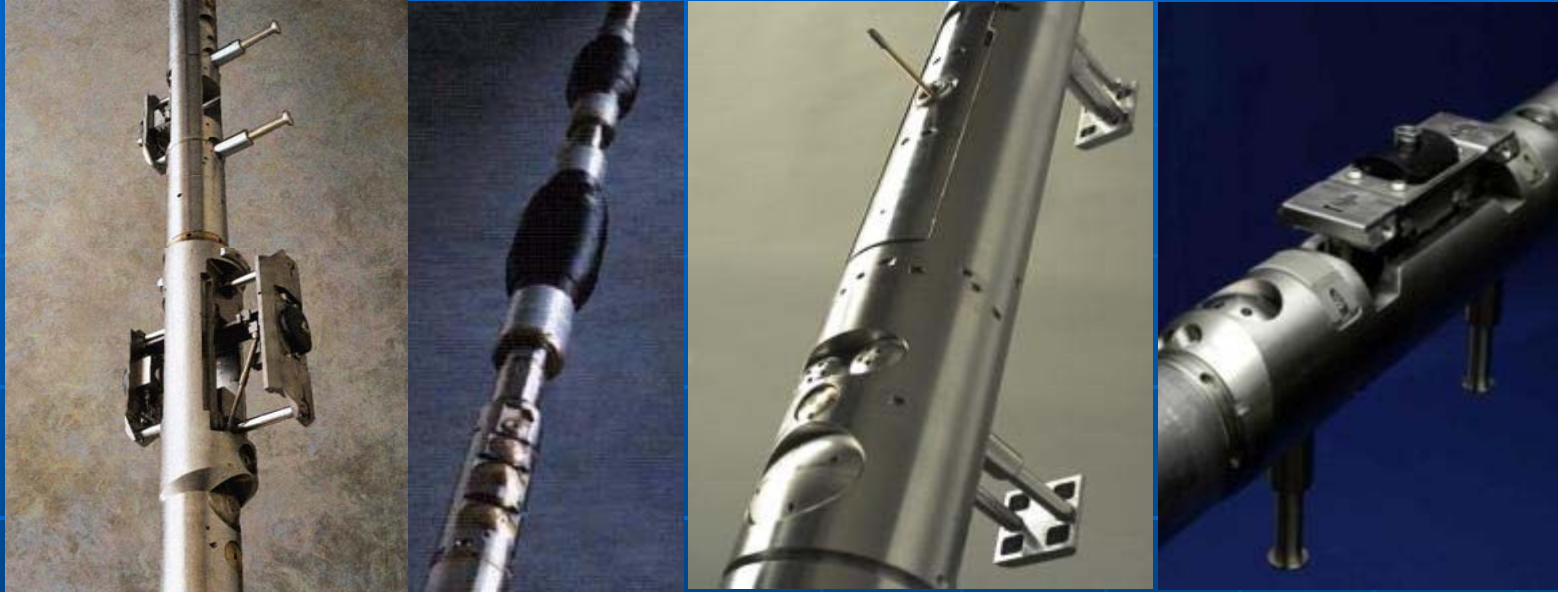
**MEDIUM RESOLUTION  
DUAL PACKER MDT**



**HIGH RESOLUTION  
SINGLE PROBES**



# HRWT TOOLS



## MDT (Open hole)

- Pressure
- Fluid analysis
- Sampling

## CHDT (Cased hole)

- Pressure
- Fluid analysis
- Sampling

## XPT (Open hole)

- Pressure

# PRESSUREXPRESS

- SPECIFICALLY DESIGNED FOR PRESSURE MEASUREMENT
- COMBINES WITH MOST OF OPEN HOLE TOOLS
  - PEX, DSI, FMI, ECS, ...
- MINIMIZES RISK OF TOOL STICKING
- SMALL DIAMETER 3 7/8"
  - SHORTER TEST MEASUREMENT TIME
- HIGH PRECISION DRAWDOWN MECHANISM
  - PRETEST VOLUME OPTIMIZED TO FORMATION MOBILITY

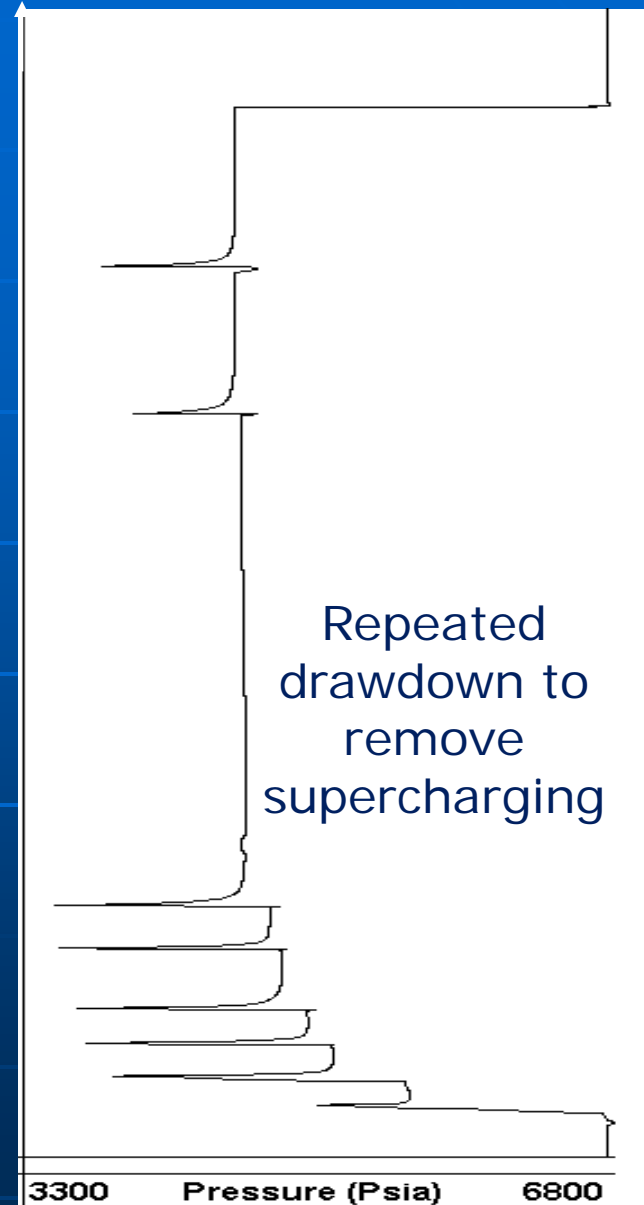
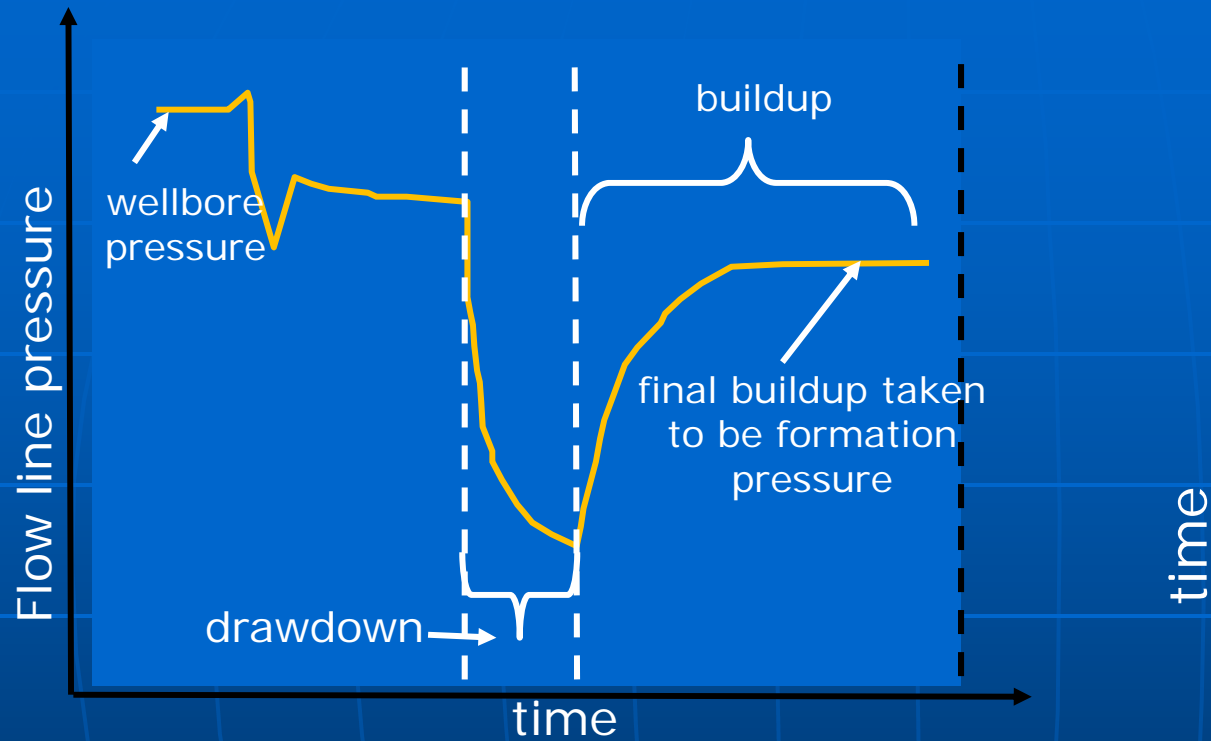


# HRWT OPERATION

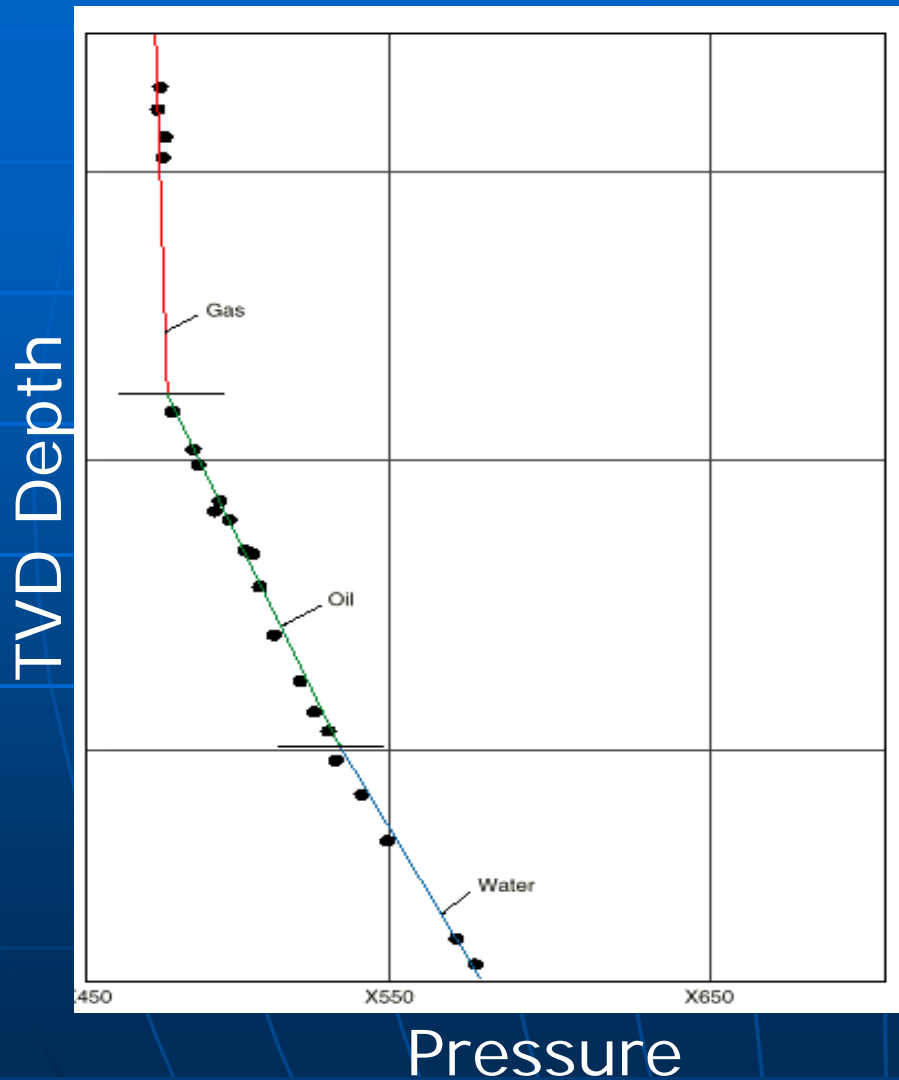
- VIDEO



# PRESSURE



# PRESSURE PROFILE



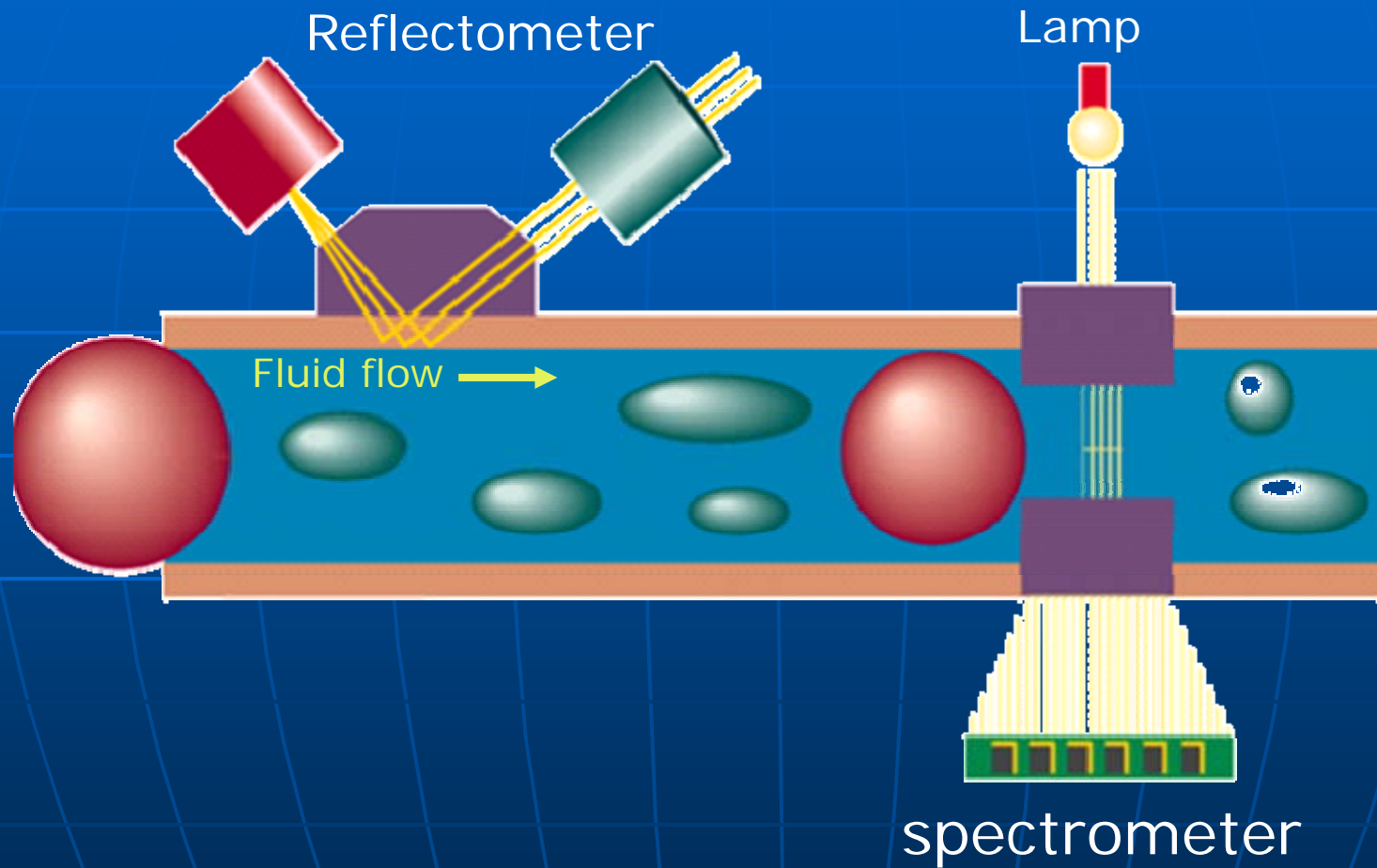
- DEPLETION
- HETEROGENEITY
- FLUID IDENTIFICATION

# FLUID ANALYSIS

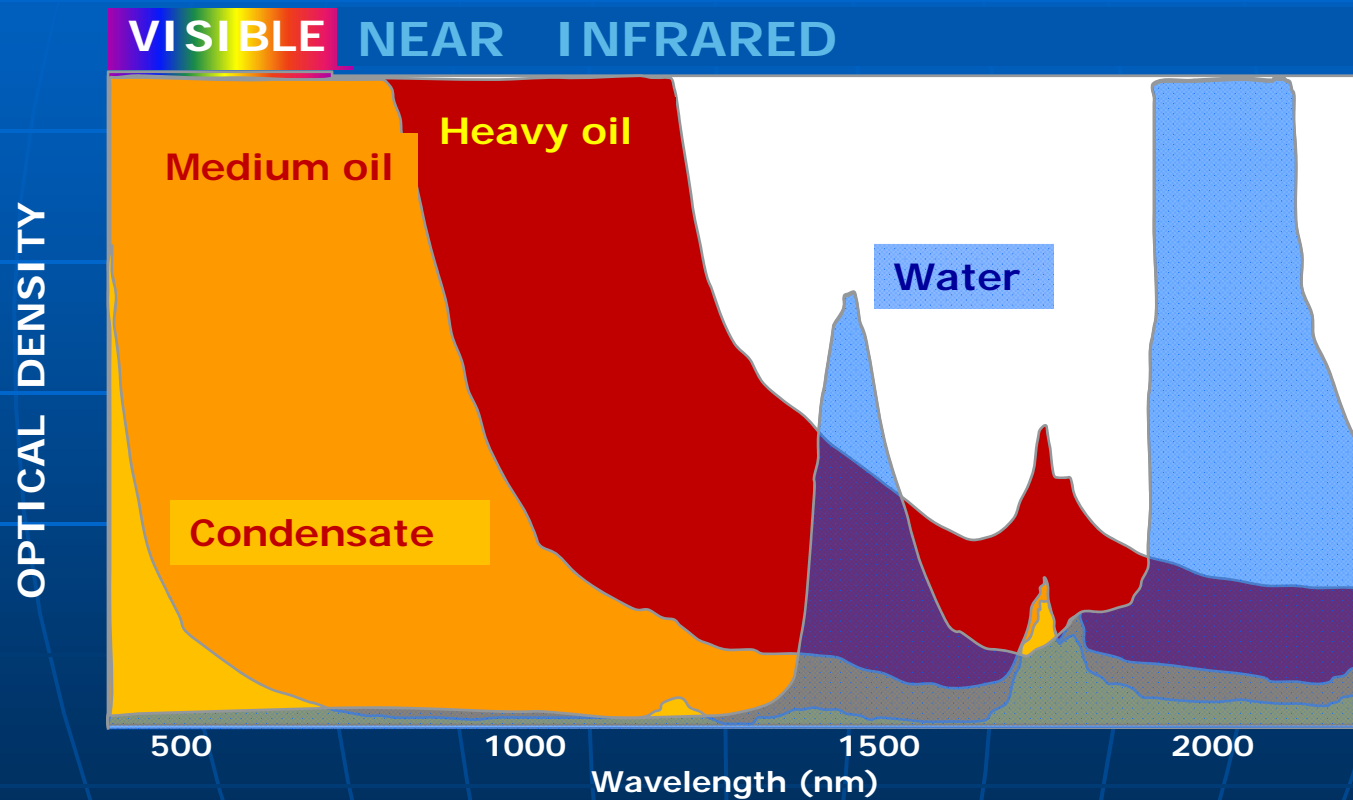
- PRESSURE GRADIENT (DENSITY)
- DOWNHOLE FLUID ANALYSIS
  - MECHANICAL (DENSITY, VISCOSITY, ...)
  - CHEMICAL ( $H_2S$ , ...)
  - ELECTRICAL (RESISTIVITY)
  - OPTICAL (PHASE IDENTIFICATION, GOR, HYDROCARBON COLORATION / COMPOSITION, FLUORESCENCE, WATER pH,  $CO_2$ , ...)



# OPTICAL FLUID ANALYSIS

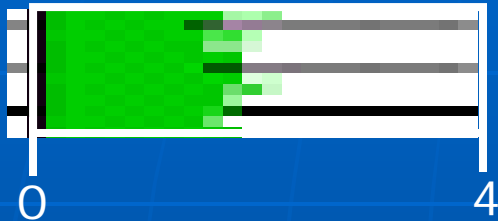


# OPTICAL FLUID ANALYSIS



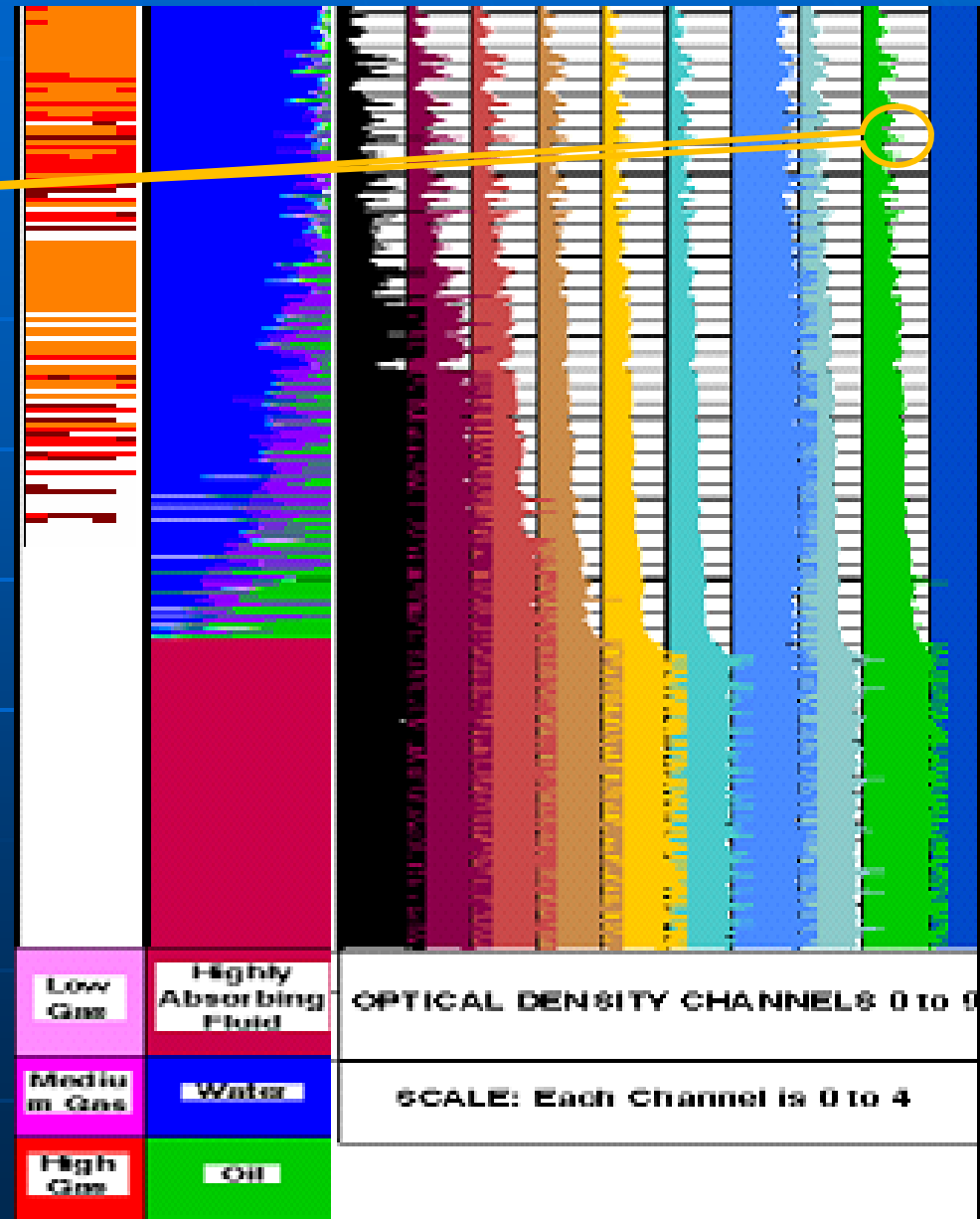
# OPTICAL FLUID ANALYSIS

OIL PEAK CHANNEL 8



OD = 2  $\Leftrightarrow$  1% light transmission

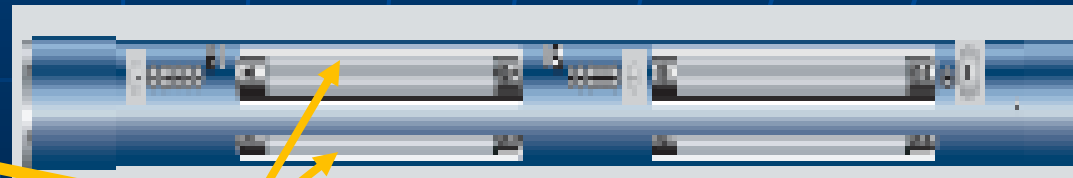
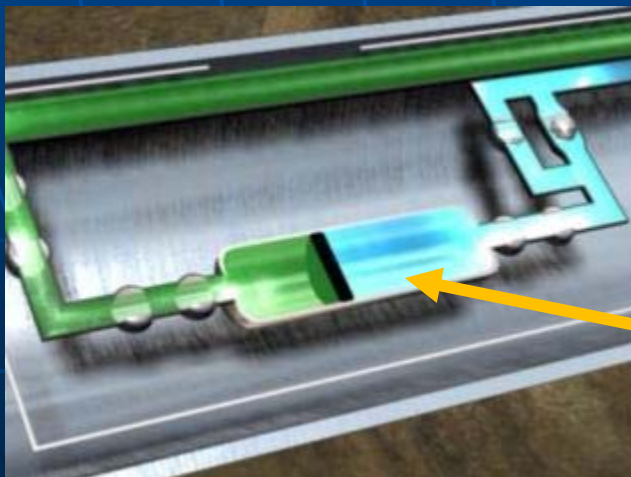
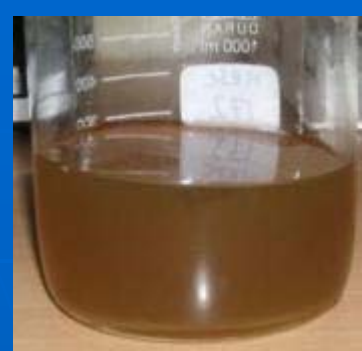
TIME



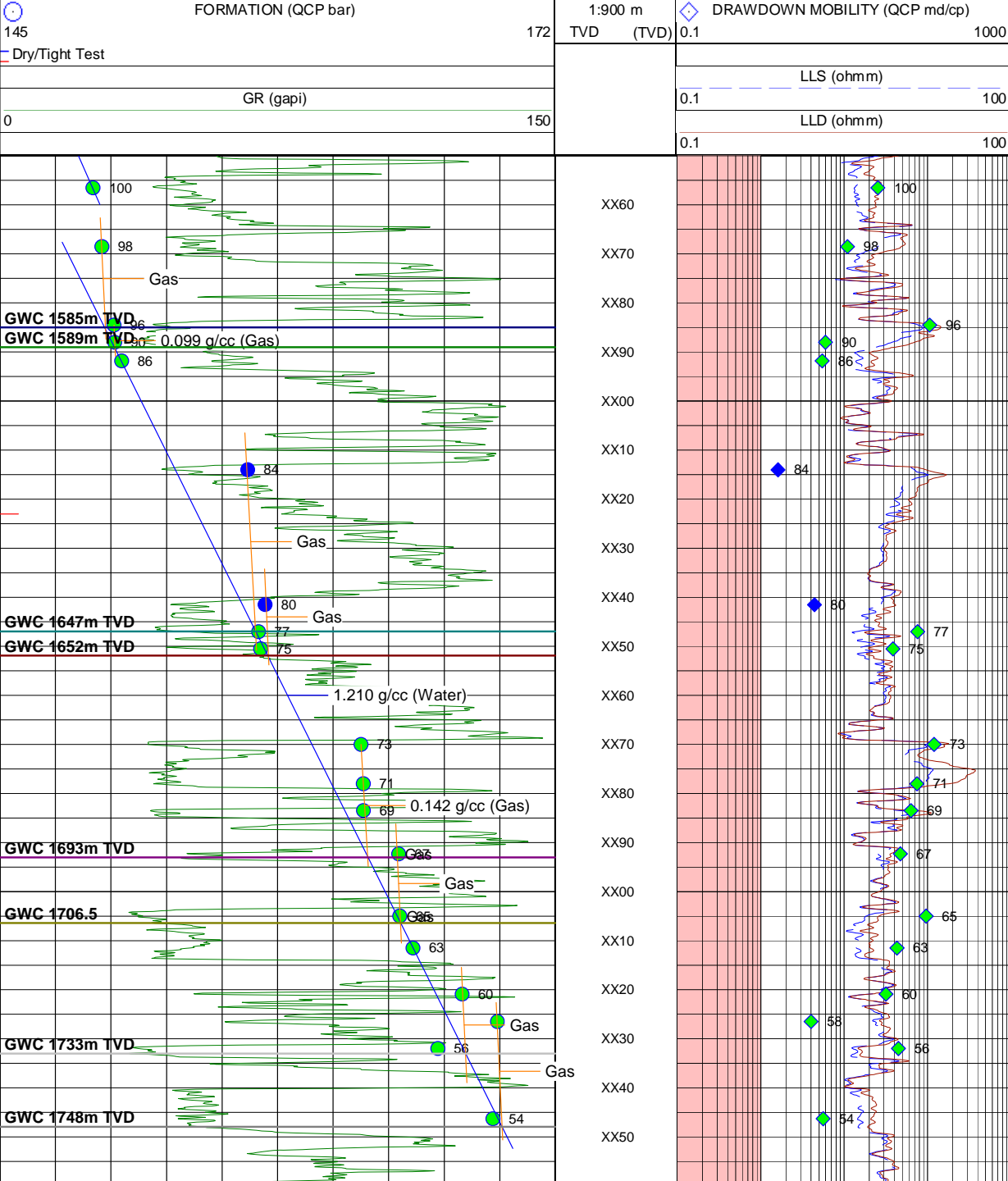


# SAMPLING

- CONFIRM THE PRESENCE OF HYDROCARBONS
- DETERMINE FLUID PROPERTIES IN LABORATORY
- AVAILABLE SAMPLING CHAMBERS
  - MRSC STANDARD 1, 2  $\frac{3}{4}$  AND 6 GALLONS
  - MRMS MULTISAMPLE (6 BOTTLES) MPSR 450 CC. OR SPMC 250 CC.
- UP TO 15 SAMPLES CAN BE COLLECTED IN EACH RUN

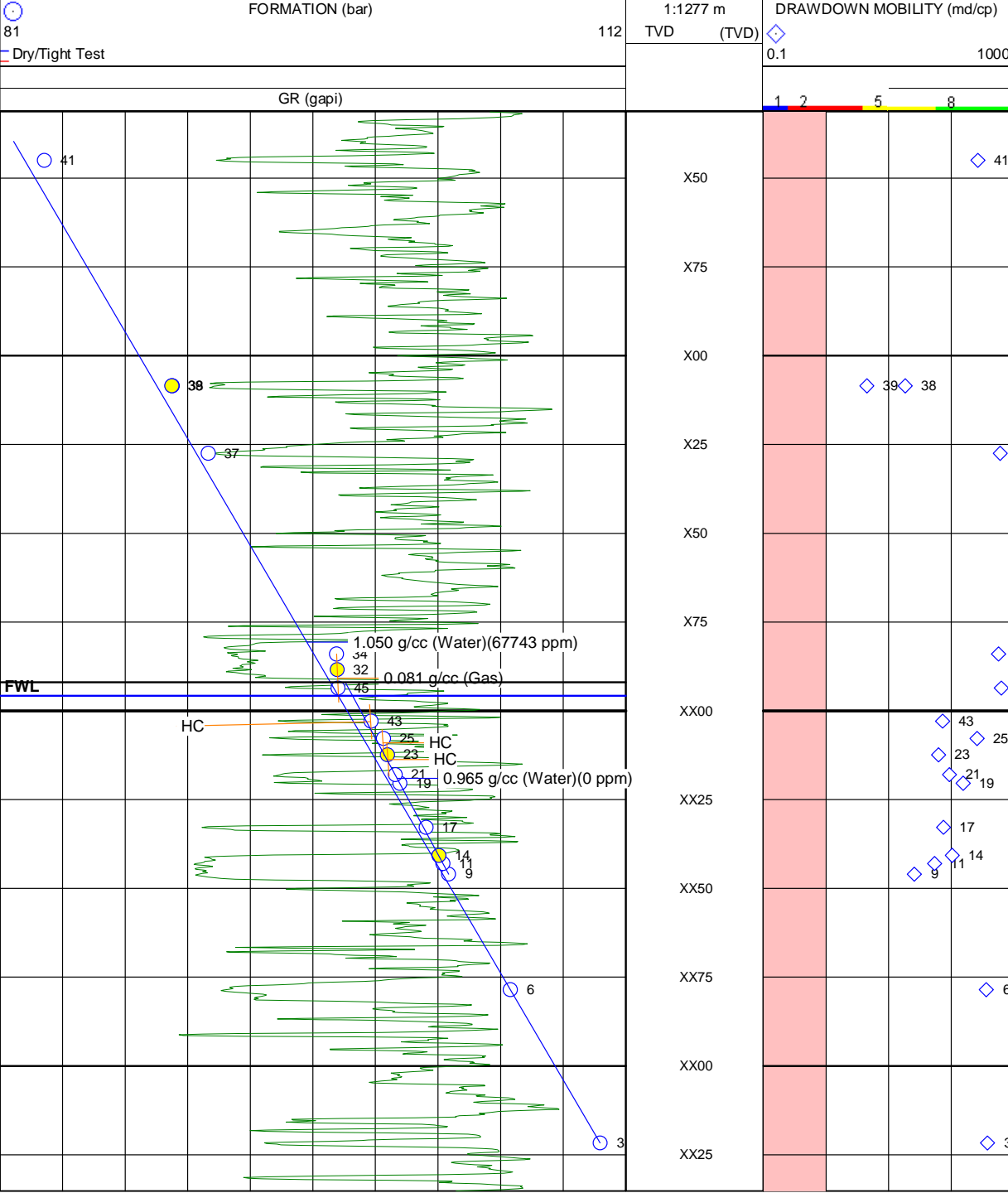


BOTTLE



# MOL-L2

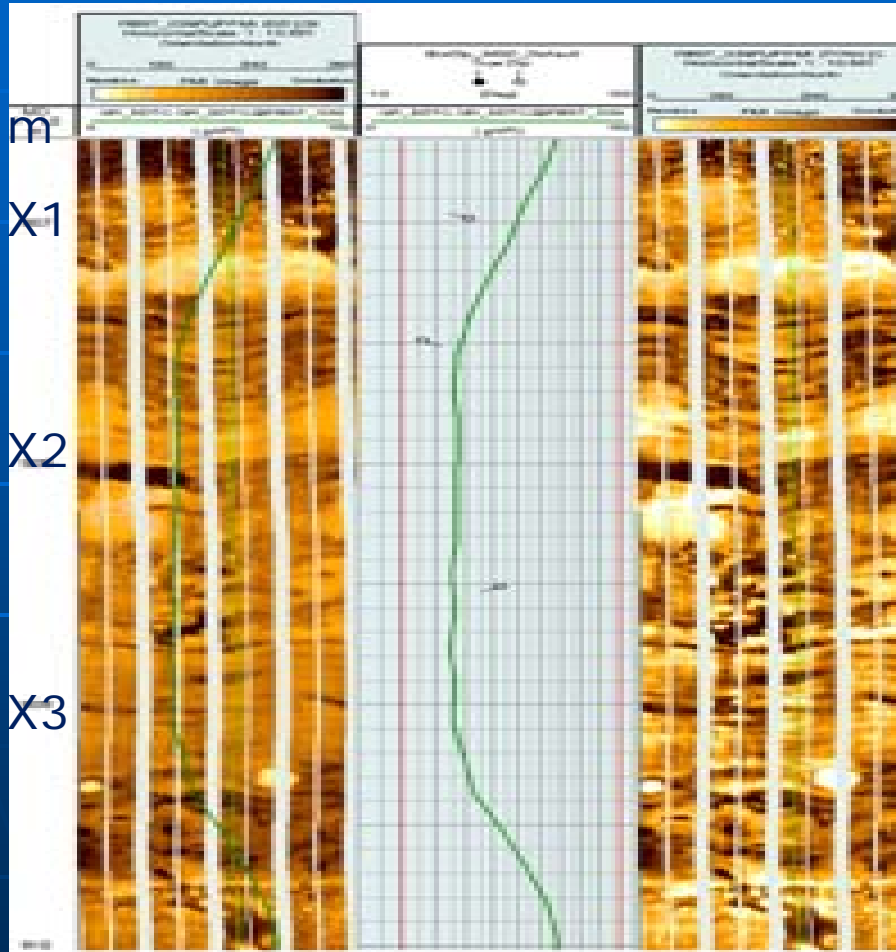
- LAYERS HYDRAULICALLY SEPARATED
- NO PRESSURE GRADIENT IN THIN LAYERS
- GAS AND WATER GRADIENT IDENTIFIED
- DIFFERENT WATER GRADIENTS (SALINITY)
- GAS-WATER CONTACTS EXTRAPOLATED, SHOULD BE CONFIRMED WITH DOWNHOLE FLUID ANALYSIS



# MOL-K

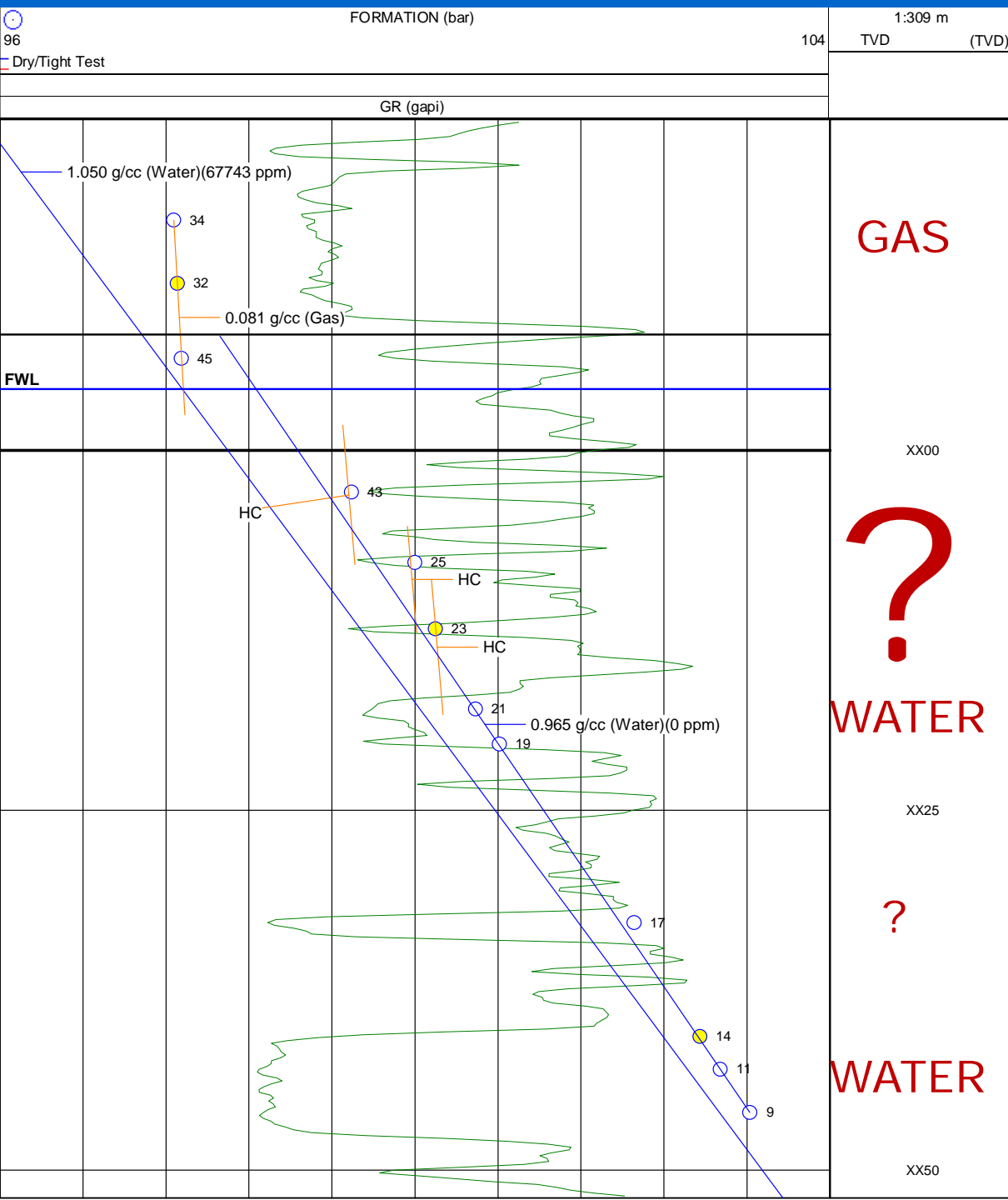
- COMPARTMENTALIZED RESERVOIR
- PRESSURE GRADIENT ACROSS LAYERS IS MEANINGLESS BECAUSE OF THE PERMEABILITY BARRIERS
- FREE WATER LEVEL NOT DEFINABLE WITH PRESSURE ONLY DUE TO COMPARTMENTS
- DOWNHOLE FLUID ANALYSIS IS THE KEY TO UNDERSTAND THE RESERVOIR FLUIDS

# MOL-K



## ELECTRICAL IMAGE HELPS

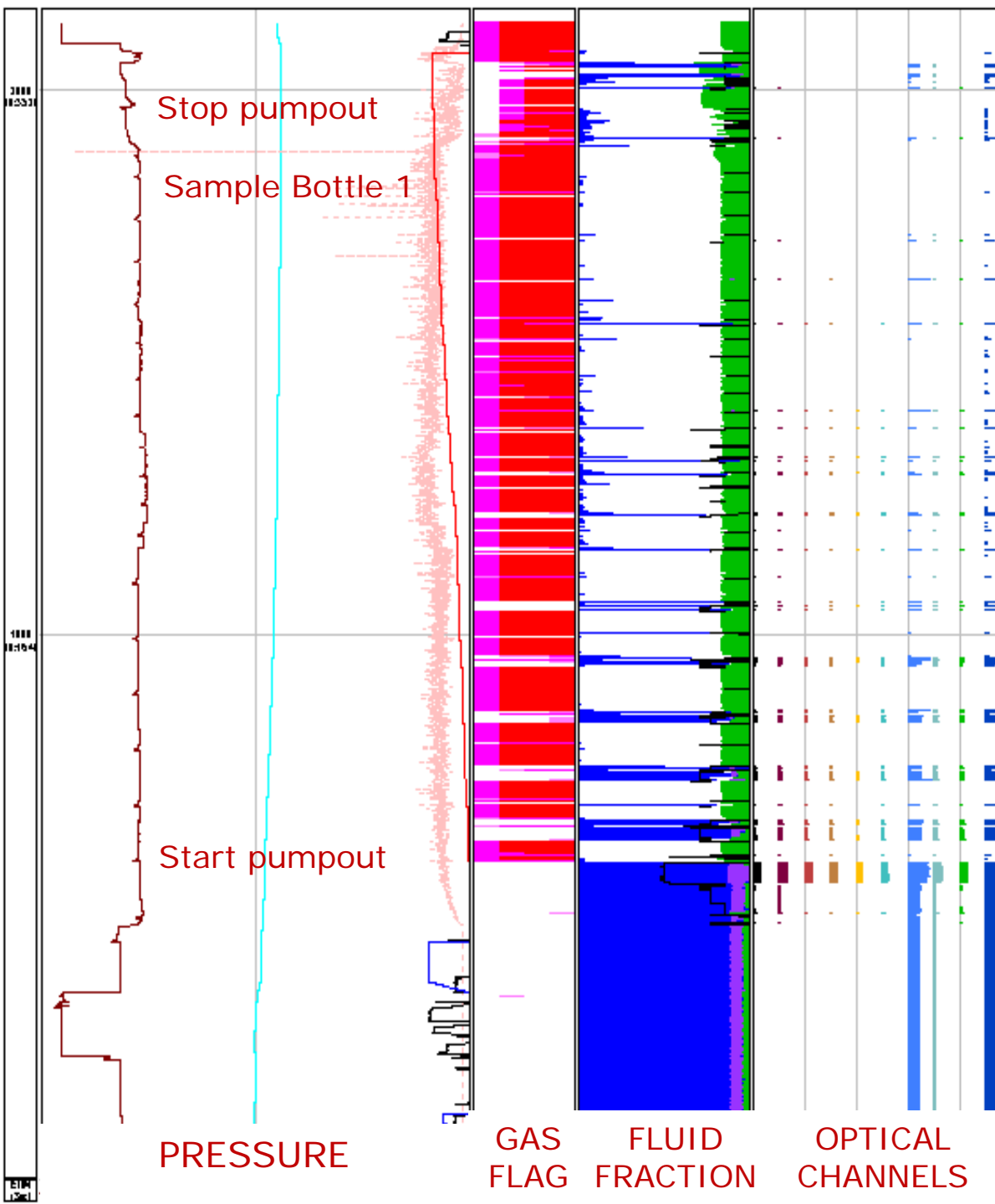
- CHARACTERIZE PERMEABILITY BARRIERS
  - LAMINATIONS, FAULTS, FRACTURES...
- VERY HIGH RESOLUTION SELECTION OF TEST POINTS
- TESTS INTERPRETATION
- DEFINE GEOLOGICAL MODEL



# MOL-K

- LOW PRESSURE IN GAS
  - COMPARED TO WATER PRESSURE BELOW
  - DEPLETION IS NOT CONSIDERED IN THIS EXPLORATION WELL
  - RESERVOIR WAS PROBABLY SUBSIDED AFTER CHARGING DUE TO TECTONIC EVENTS AND PERMEABILITY BARRIERS PREVENTED PRESSURE EQUALIZATION
- TRANSITION ZONE CAN BE FULLY CHARACTERIZED WITH **FLUID SCANNING** USING DOWNHOLE FLUID ANALYSIS

# MOL-L1



- RESERVOIR FLUID IS IDENTIFIED AS GAS.
- 1 GAS SAMPLE IS TAKEN
- ALTERNANCE OF BLUE AND RED IS DUE TO FLUID SEGREGATION IN THE TOOL
- RESERVOIR GAS + FILTRATE WATER PUMPED AT START



# CASE STUDY RESULTS

## APPLICATIONS OF HWRT IN HUNGARY

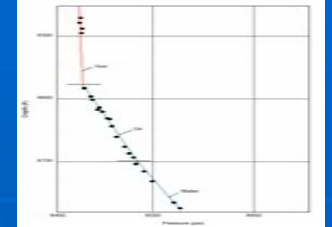
- INPUT FOR RESERVOIR MODELING
  - COMPARTMENTALIZATION
  - GEOLOGICAL MODEL, LAYER / ACQUIFER CONNECTIVITY
  - POSITIVE IDENTIFICATION OF RESERVOIR FLUIDS
- OPTIMIZE CONVENTIONAL WELL TESTING
  - DETERMINATION OF FREE WATER LEVEL, INITIAL PRESSURE, PERMEABILITY
  - SELECTION OF PERFORATION INTERVALS
  - WELL TEST INTERPRETATION
- OPTIMIZE DRILLING
  - SELECTION OF MUD WEIGHT

## LESSONS LEARNED

- DOWNHOLE FLUID ANALYSIS IS THE KEY TO EVALUATE COMPLEX RESERVOIRS
  - COMPARTMENTALIZED
  - THICK TRANSITION ZONES

# APPLICATIONS OF HRWT

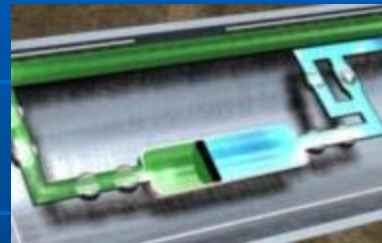
- PRESSURE / PERMEABILITY



- DOWNHOLE FLUID ANALYSIS



- SAMPLING

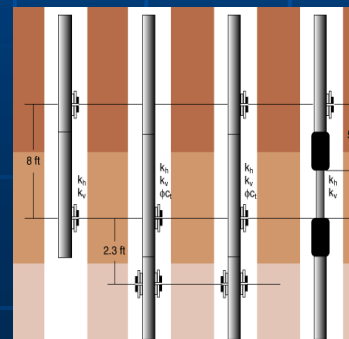


- FRACTURED RESERVOIR



- MINI DST TEST

- INTERFERENCE TEST





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# HIGH RESOLUTION WELL TESTING IN HUNGARY

**QUESTIONS**