

# SAMPLING DURING THE LIFE OF A FIELD

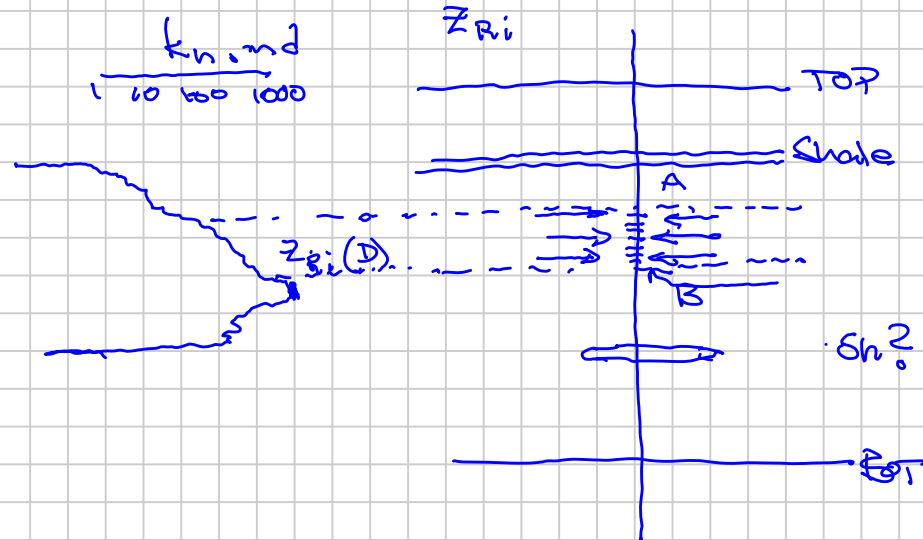
- Exploration
- Discovery
- Delineation
- Development
- Production Phase
  - Early
  - Mature

Oils: BHS  
 SEP: (\*)  
 MDT-Type common  
 $Z_{Ri}(D)$   
 SEP

## Reminder:

Three types of samples used in establishing reservoir-related fluid data and information:

1. Bottomhole Samples
  - (a) - Cased hole wireline sampling in interval of Reservoir (2, 20, 50 m) where connection between R and W.

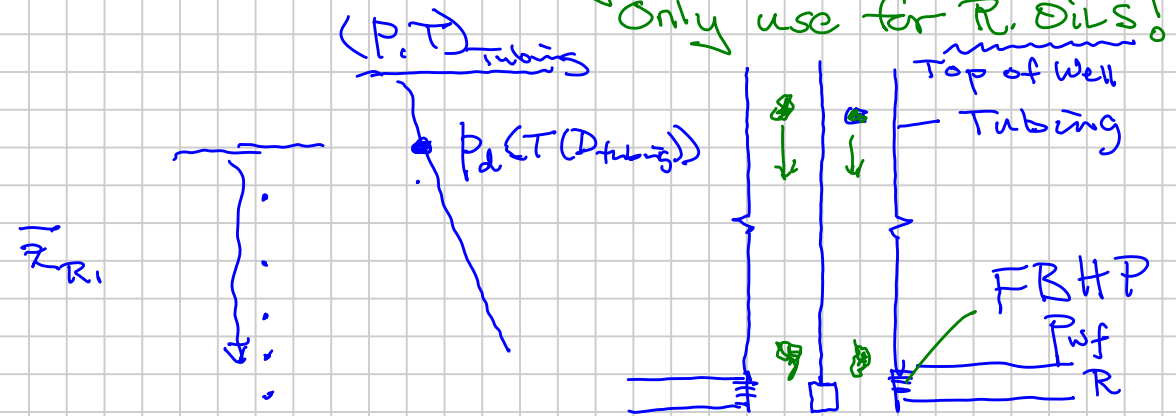


- (a) Well Shut-in (after flowing)
- (b) During low flow rate

$$\bar{z}_{Ri} = \frac{\sum \lambda(D) z_{Ri}(D)}{\sum \lambda(D)}$$

$$\lambda = \frac{k}{m}$$

Only use for R. Oils!



GAS CONDENSATES:

RISK of sampling  
Excess "Condensate"

$$Z_{Si} \neq \bar{Z}_{Ri}$$

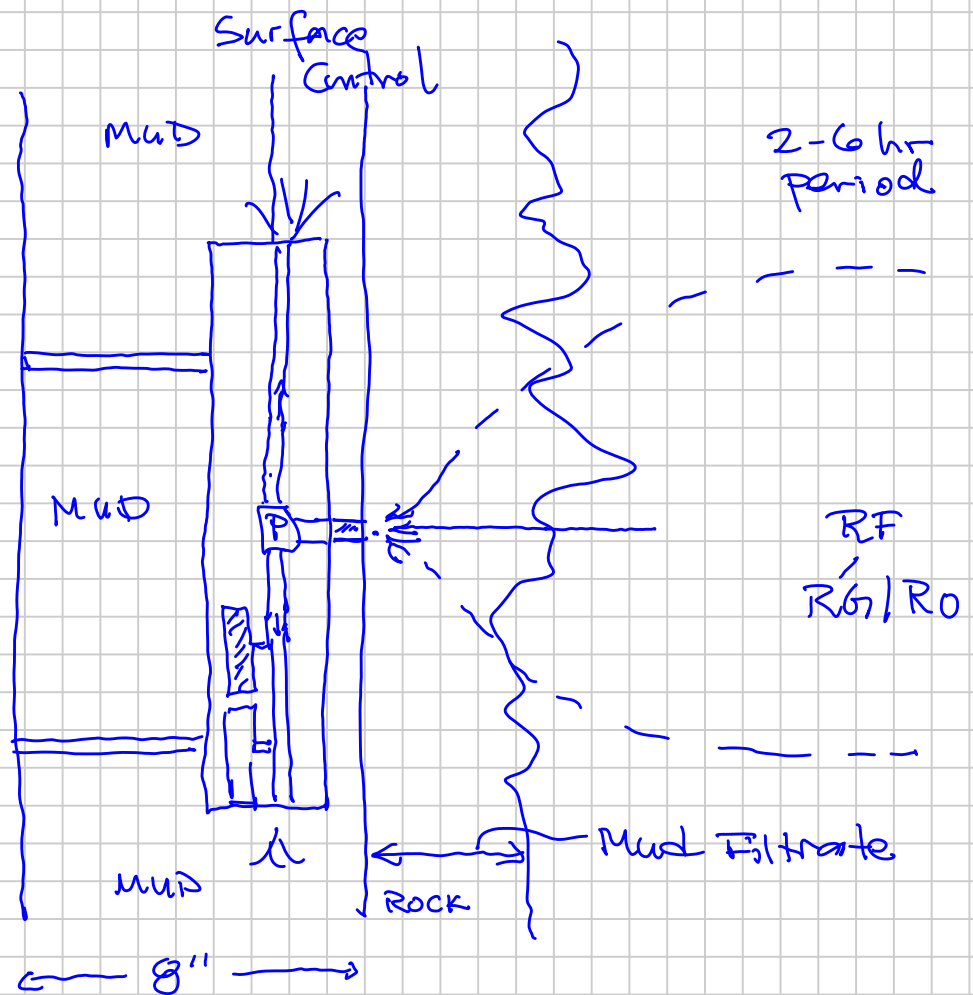
↑  
BHS

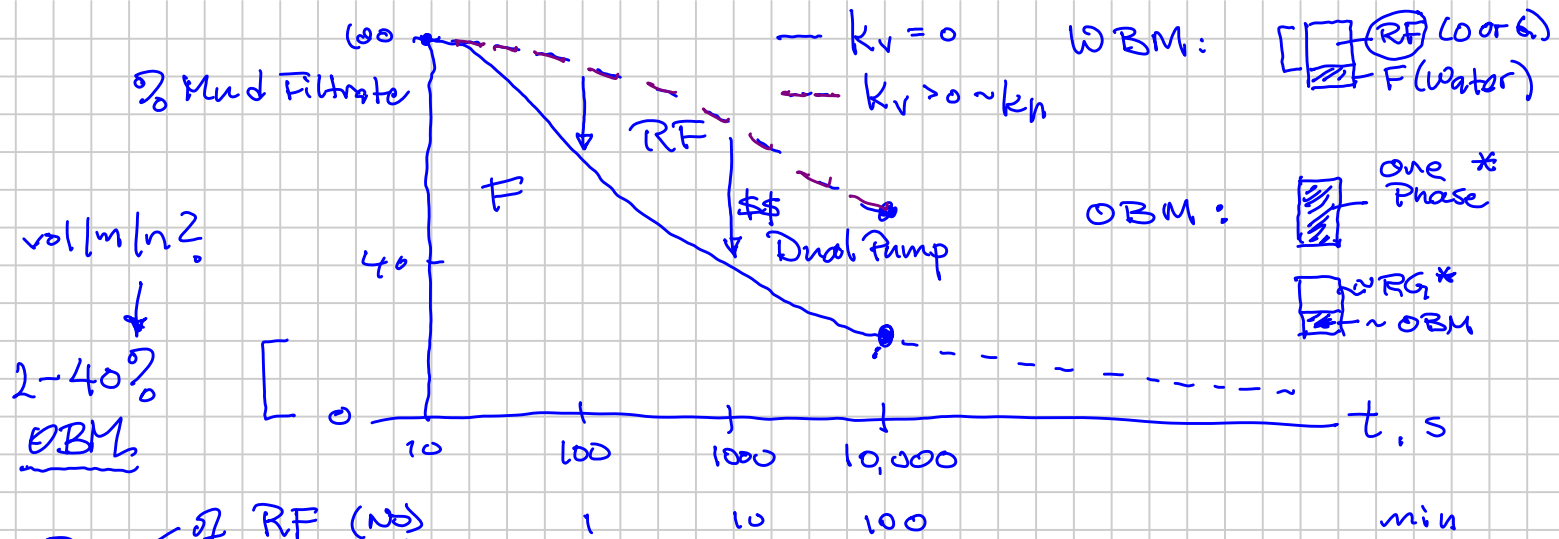
(1) (b) Openhole Formation Tester  
MDT | RCI | RDT

- \$ (u) • Point-Depth Specific Sample (Probe) 95%
- \$\$\$ • Short-Interval, Dual Packer Sample

MDT-Type Sample

Always a Mini production test

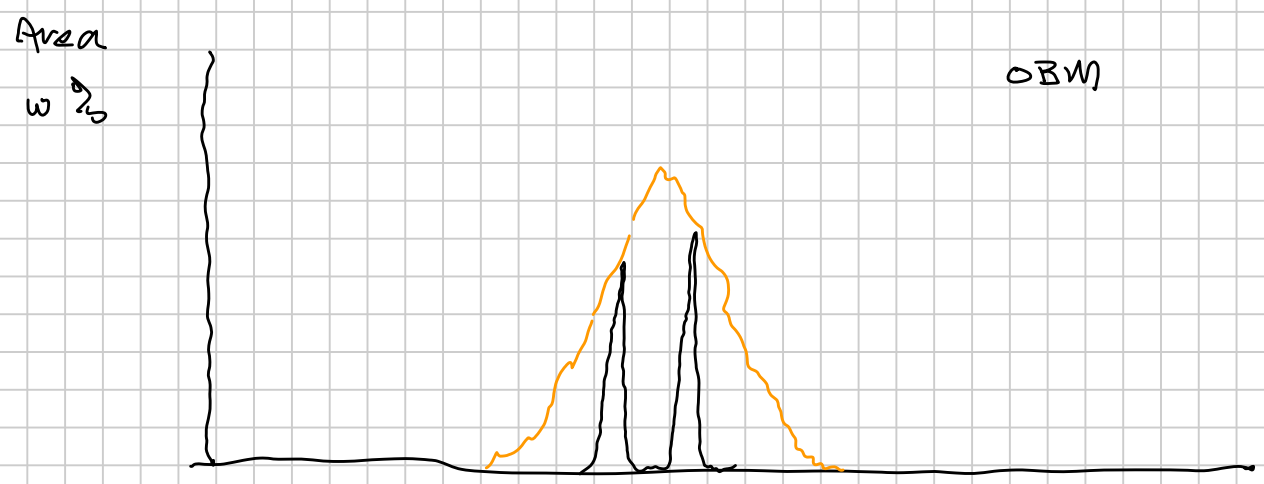
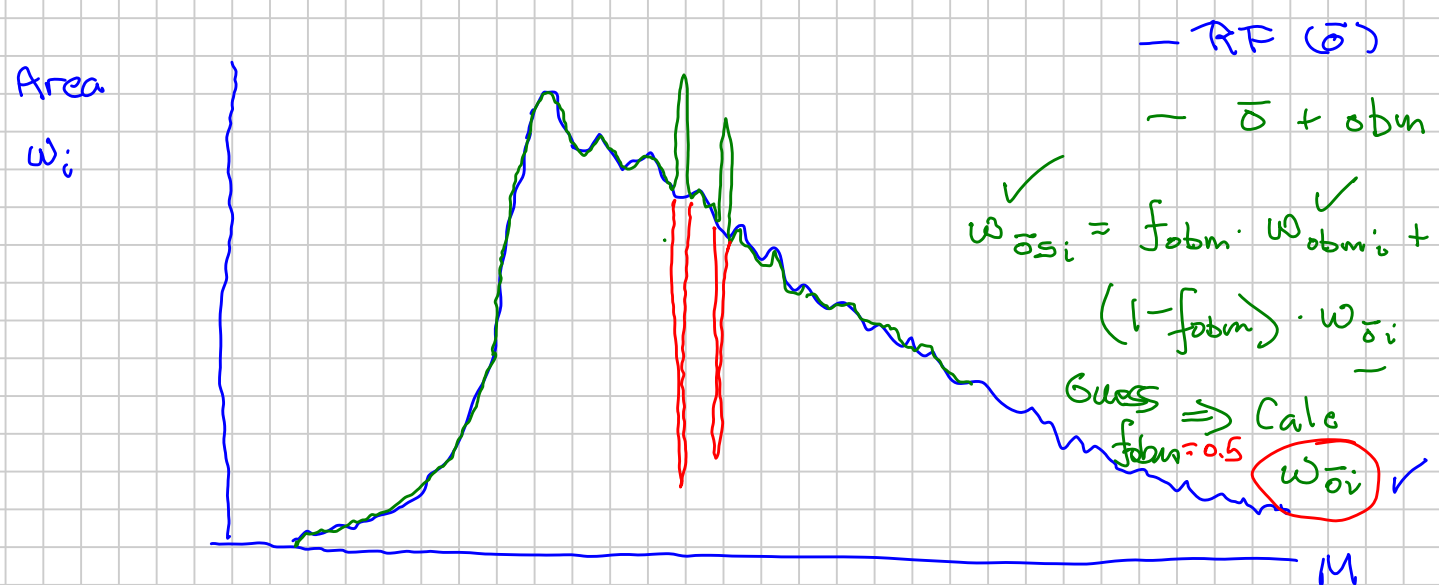




$x_{oi}$   $\left[ \begin{matrix} w_{oi} \\ \uparrow \end{matrix} \right]$

$$OBM \varnothing_o = \frac{m_{obm}}{m_o + m_{obm}}$$

\* OBM - Contaminated Reservoir Sample



# SEPARATOR SAMPLING Potential Problems

## ① Waxy Oils

Wax precipitation =  $f(T)$

$$r - C_{20} \rightarrow r - C_{xx}$$

Sep. Oils may contain an EXCESS of wax components

$$K_w \uparrow^P \quad \underbrace{(K_w z_{+})}^{SEP} > \underbrace{(K_w z_{+})}^{BHS}$$

Excess  
 $r - C_{20}$

## ② Asphaltenes

Semi-solid (nasty stuff) precipitates =  $f(p - p_b)$

$$p_{Ri} = 5000 \text{ psia}$$

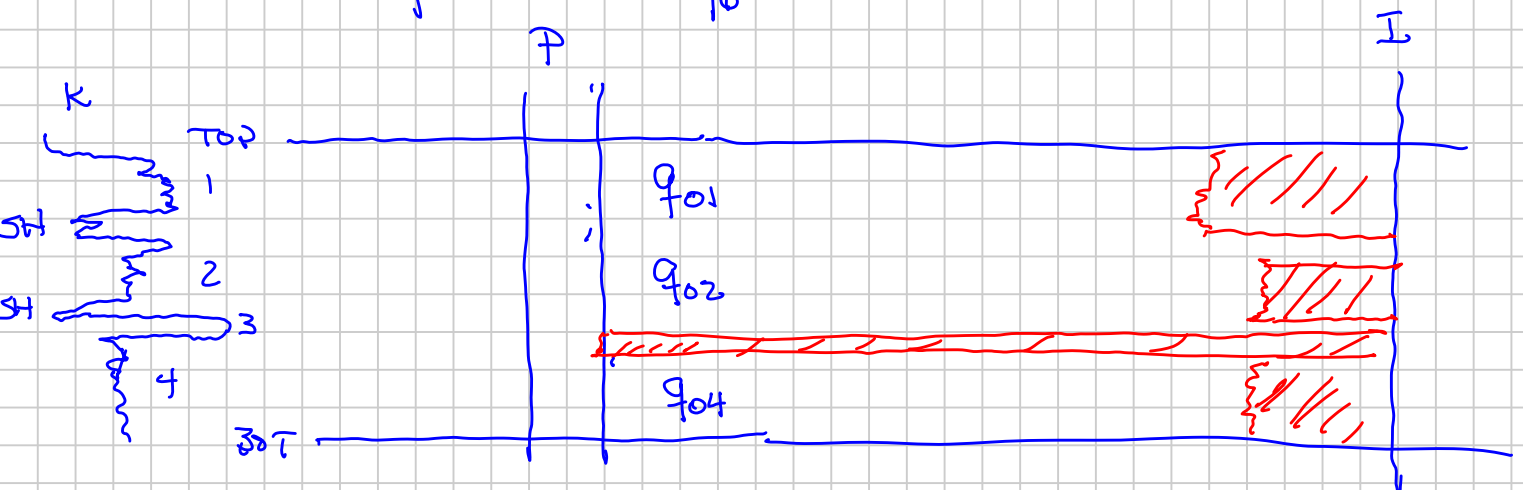
$$p_b = 2000 \text{ psia} \quad \checkmark$$

$$p_{wf} = 4500 \text{ psia}$$

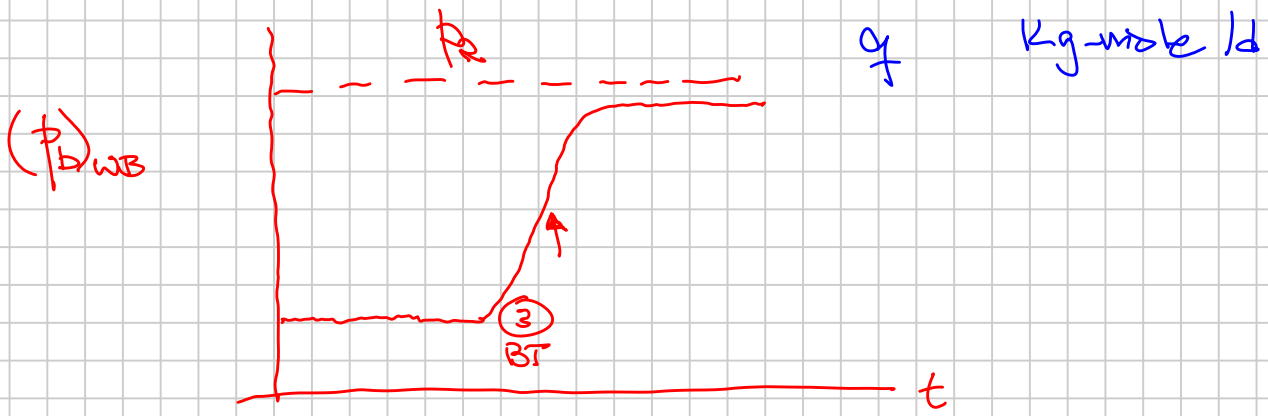
$$p \leq p_b$$

max  
tendency for  
asphaltene  
precipitation

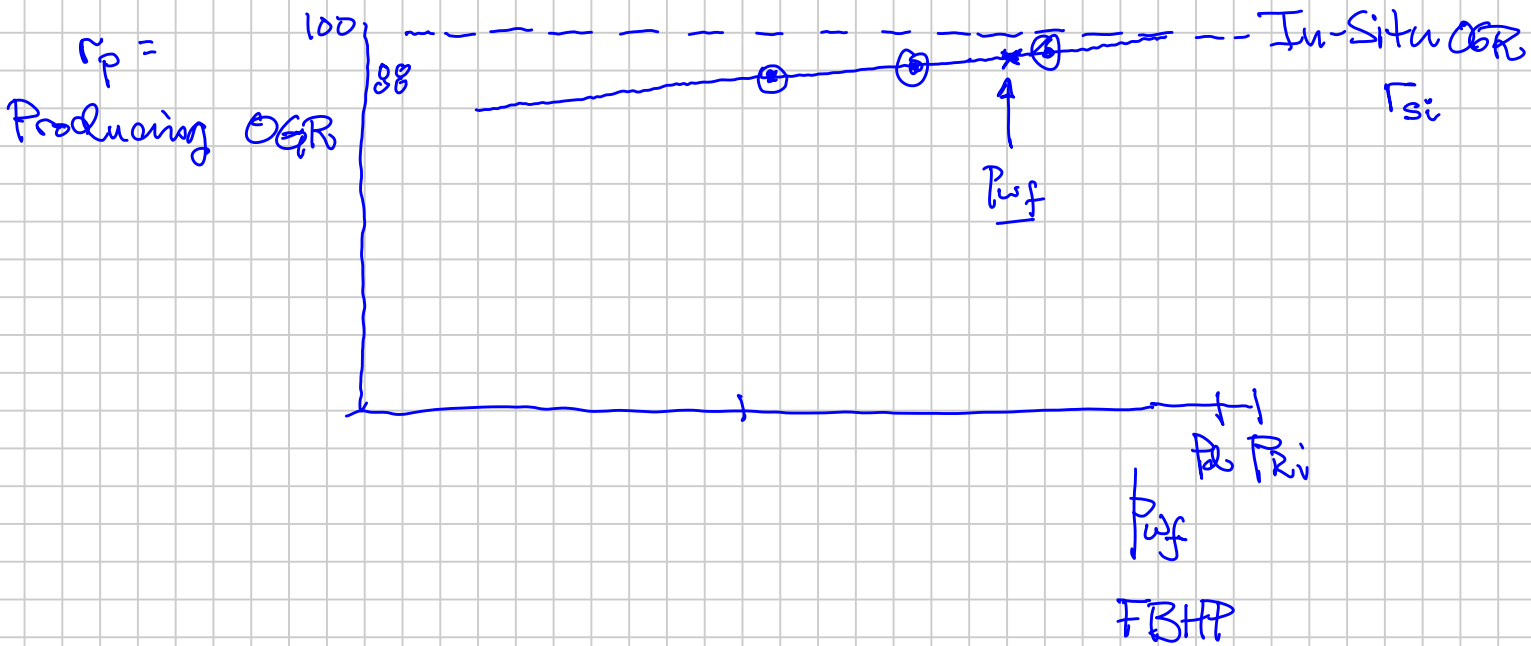
Gas Injection :  $p_b \uparrow$



$$Z_{pi} = Z_{oi} = \frac{(q_{01} + q_{02} + q_{04}) X_{Ri} + q_{g3} z_{gi}}{q_{01} + q_{02} + q_{g3} + q_{04}}$$



③ Gas Condensates  $p_R \sim p_{di}$  (Near)-Saturated G.C.  
 STB/MMscf



$$z_{wi} \neq \gamma_{Ri}$$

Leaner  
 (lower OGR)

$$\bar{p} < \bar{p}_{si}$$

④ (particularly important to Gas Cond.)

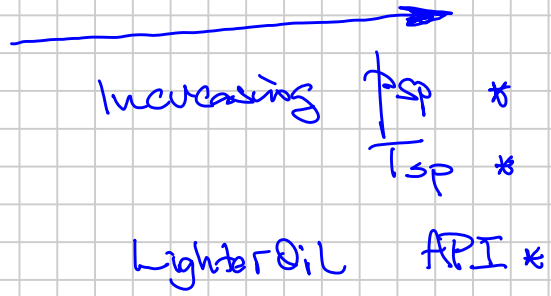
Report Correctly to the Lab

$$(T_{sp}, p_{sp}) \left[ q_{gsp} \left( \frac{\text{Sm}^3}{d} \mid \frac{\text{scf}}{D} \right) \quad q_{gsp} \left( \frac{\text{sep-vol}}{\text{Sm}^3 \mid \text{scf}} \right) \right] @ T_{sp}, p_{sp}$$

$$GOR_{sp} = \frac{q_{gsp}}{q_{asp}}$$

Shrinkage  
Factor

$$\frac{q_{fo}}{q_{fsp}} \sim 0.98 \sim 0.7 (0.6)$$



BEWARE / BE CAREFUL

Field Testing Company

$$z \dots q_{fsp} \quad q_{fo}^{EST} = \overset{\checkmark}{q_{fsp}^{Meter\ Test}} \cdot SF^{EST} \rightsquigarrow \text{Comments}$$



- $SF^{EST}$
- 0.83
  - 0.83
  - 0.83
  - 0.96
  - 0.78

# SAMPLING DURING THE LIFE OF A FIELD (With Wells)

- Exploration (Pre-Discovery) Sample Water  $\leq$  HC traces Salinity

- Discovery - MDT-type samples ( $z_{Ri}(D)$  |  $p(D)$ )  $\xrightarrow{\text{Cores - Geochemical Analysis}}$  GOC/WOC
- Delineation

Low-Mod  $k \Rightarrow$  Production Testing

- (1) Accuracy  $\bar{z}_{Ri}$  Important  $\left\{ \begin{array}{l} \text{BHS (Oils)} \\ \text{SEP (All Fluid Types)} \end{array} \right.$

(2) Measure Valid PVT Data  $p_o, p_d, S, \mu, V_o/V_t$   $\Rightarrow$  BUILD RELIABLE PVT MODEL (EOS)  $\left\{ \begin{array}{l} \text{Equation} \\ \text{of} \\ \text{State} \end{array} \right.$

- Development  $\left\{ \begin{array}{l} \text{Simple (if little complexity in PVT)} \\ \sim \text{Delineation Phase Sampling} \\ \text{(if complexity PVT)} \end{array} \right.$

## • Production Phase

- Early : GOR<sub>well}(t) z<sub>wi}(t) ... <sup>Maybe</sup> Sep. Samples</sub></sub>
- Mature : Late-life Gas EOR  
New set of all types of samples