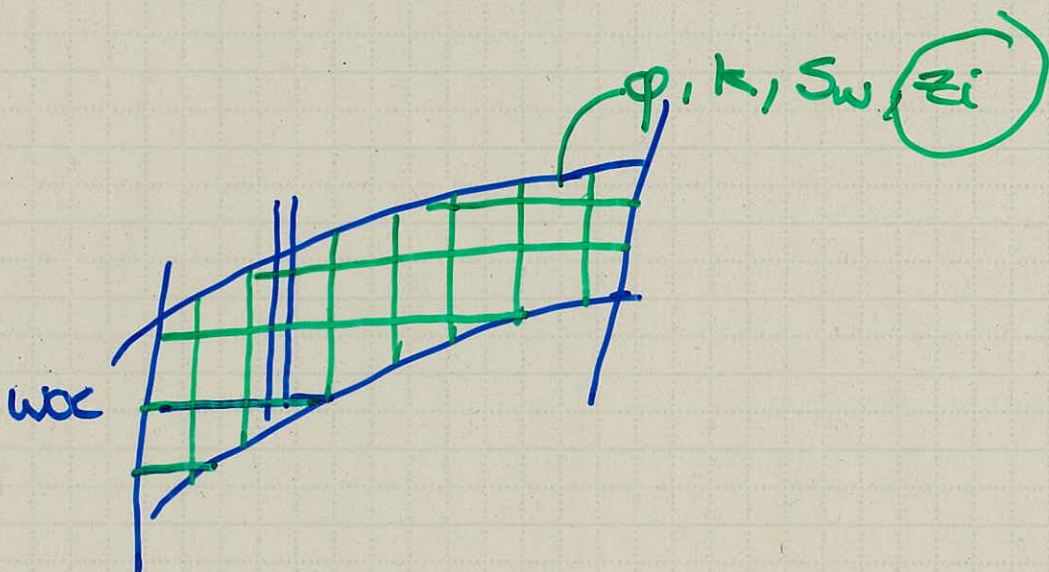# FLUID SAMPLING

a PVT properties
b Fluid Initialization

a P_{sat} , g , μ , z_i

    - accurate measurements of z_i and PVT
       more important than sampling
       an insitu representative sample
       of reservoir fluid.

b

ϕ , k , S_w , z_i

WOC

reservoir simulator

ideally we want point (depth) specific
samples

Representative samples

- Insitu representative sample
    - Sample that reflects the z_i at depth tested
- Representative sample
    - clean sample, ie no OBM
    - GOR may differ from GOR_i
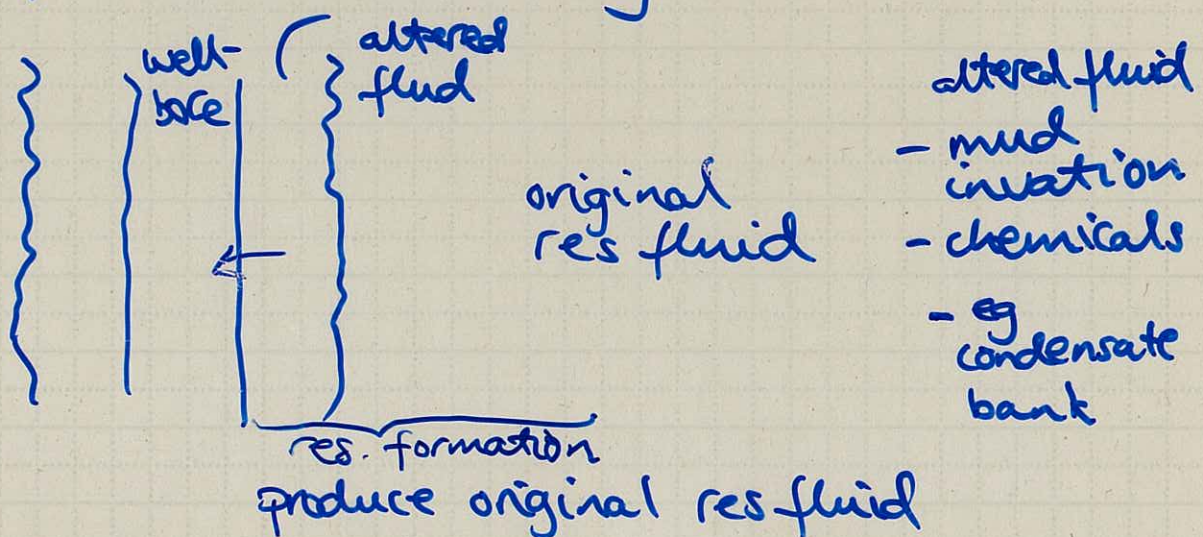
General
- early in the history of the reservoir
    - $P_R > P_{sat}$
    - $P_{wf} > P_{sat}$

- wells chosen for sampling reflect range of GOR and tank-oil gravity

- proper well conditioning

well-bore   altered fluid

original res fluid

altered fluid
- mud invasion
- chemicals
- eg condensate bank

res. formation

produce original res fluid

goal:
produce original res fluid by displacing altered fluids

Sampling methods

a Subsurface sampling
   - BHS (bottom hole samplers)
   - Samples from Formation Testers

b Surface sampling
   - separator
   - well head

BHS

- undersaturated oil
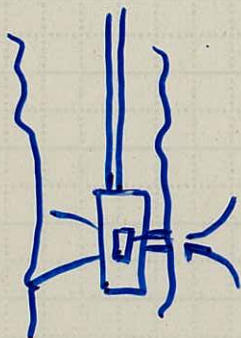- lowrate or SI (shut-in)
- $P_{wf} > P_{sat}$

- lower sample device to pre-selected depth

- sample in pressure tight container

- NOT recommended for GC
   two phases may exist in well bore
   GRAVITY collects liquid in the tubing/well
      at the bottom
      - might be to rich in liquids

Formation Testers
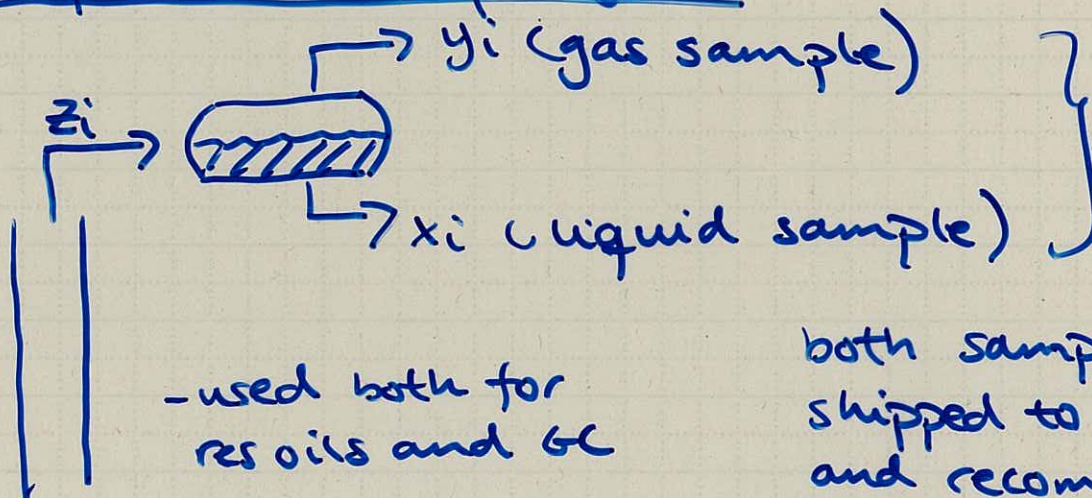
openhole wireline samplers

collect fluids
directly from the formation

5-10 sample units :

    can sample at several depths
    study compositional variation
    within reservoir

Separator Sampling

$\rightarrow y_i$ (gas sample)

$z_i \rightarrow$

$\rightarrow x_i$ (liquid sample)

- used both for
res oils and GC

both samples
shipped to lab
and recombined
at T_{sep}, P_{sep}

  - measure gas and liquid rates

       ↳ must be stable

STB
stock tank bbl

- GOR at sep. cond. scf/sep. bbl

= @ standard cond - if $\overset{GOR}{\text{reported}}$ in scf/STB,

  60 F, 14.7 psia   must know shrinkage factor

$$GOR \, [scf/sep. \, bbl] = GOR \, [scf/STB] \cdot \underset{<1}{SF}$$

well head sampling

  -if oil is single phase at well head

Relative Advantages of Subsurface and
Surface Sampling

a BHS
  - collects samples directly
  - avoid using surface separators
        - no need to measure rates
        - less inf needs to be transmidded
          to lab
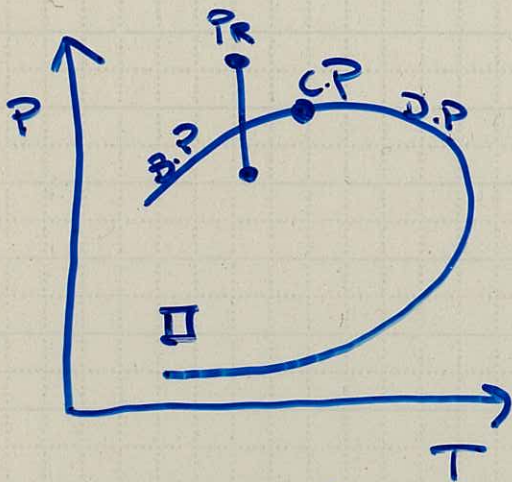   - eliminates recombination errors

b Formation Testers

  - same as for BHS
  - directly from formation
  - depth specific
  - sampling not affected by fluids in
          well bore

c Surface Sampling
  - easy, less expensive (no rig or wireline
                          unit on location)
  - avoid loss of production during SI
  - avoids tool getting stuck
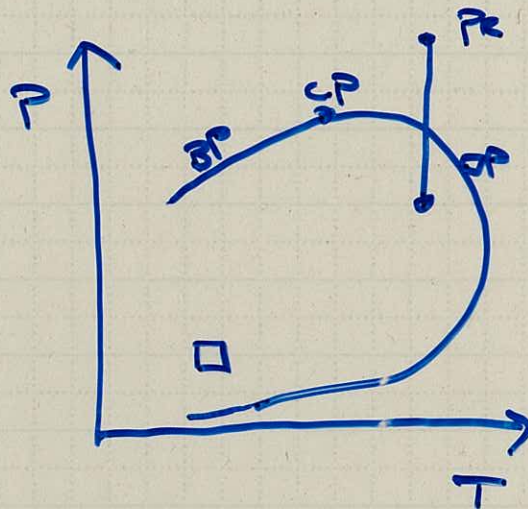 - large volumes
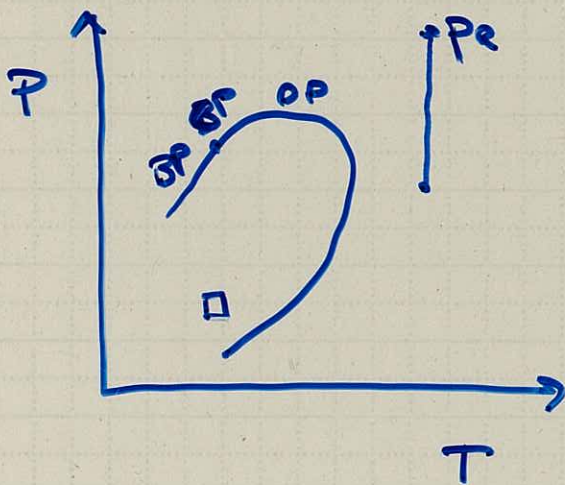 - preffered method for saturated GC
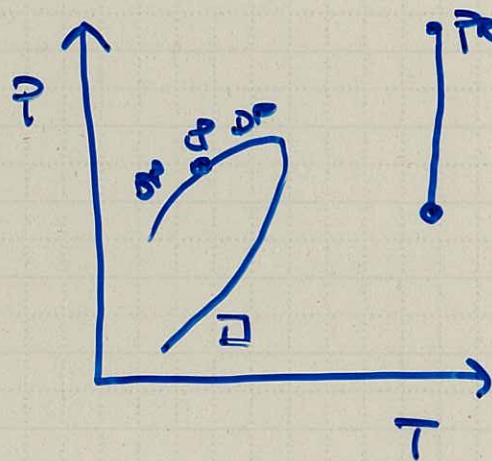
Fluid Types

Res Oil

P

P.R

B.P

C.P

D.P

□

T

□ sep. cond

Gas Cond

P

BP

C.P

Pe

DP

□

T

Wet Gas

P

BP
BP

OP

Pe

□

T

Dry Gas

P

BP

B
DP

PR

□

T

Sampling Res Oil.

if producing well
well conditioning

- measure GOR - prod until stable GOR
- reduce prod rate in steps
- $GOR_i = GOR_{i+1}$
  - → original res oil
  - → samples taken

if not met
sample at low rate and stable GOR
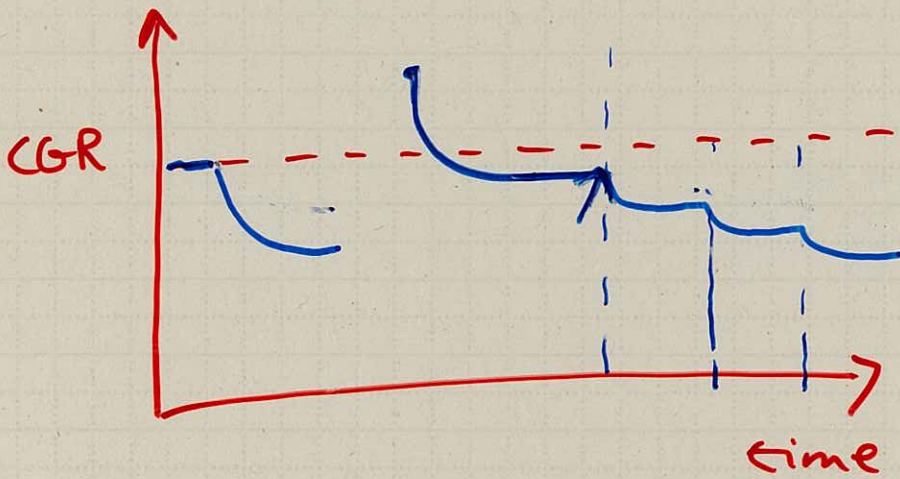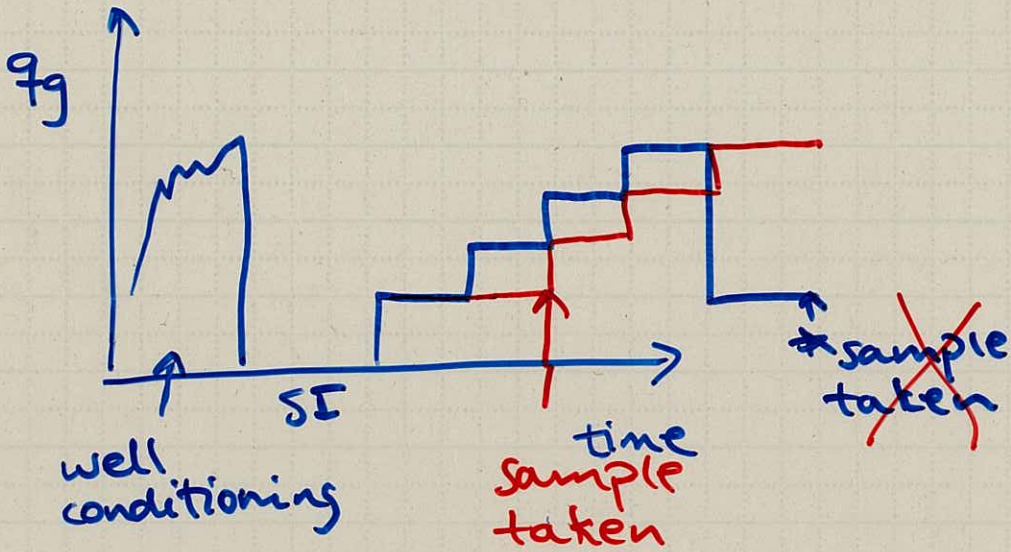
Sampling GC

recommended practice

- produce at sufficient rate - guarantees
  liquid lift through tubing

- maximize p_{wf}
  - avoid two phase in res if possible

- try to get a stabilized GOR before sampling
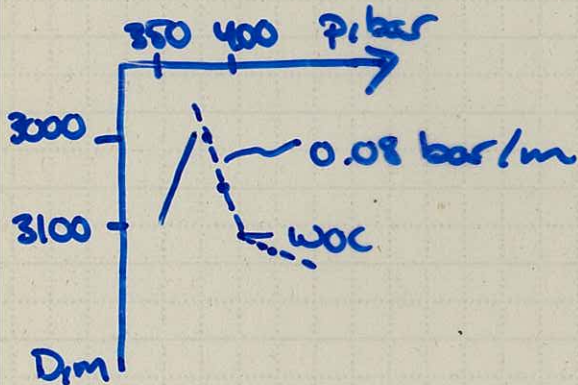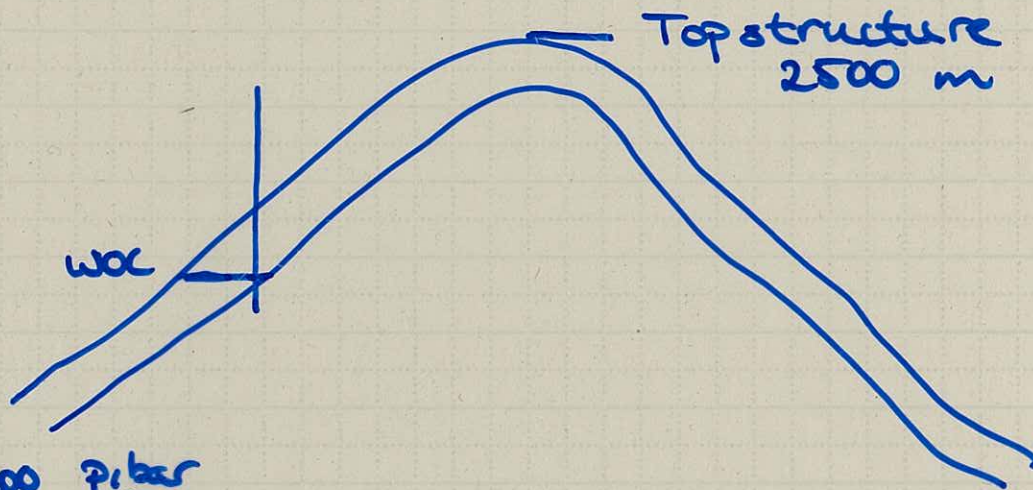- avoid sampling after SI or rate
  reduction

qg

well
conditioning

SI

time
sample
taken

sample
taken

CGR

time

CGR - condensate gas ratio = 1/GOR

P_b vs % OBM (STO) graph

~ 2-4 bar / % OBM

Class Problem

Top structure 2500 m

WOC

P, bar axis: 350 400

3000

~0.08 bar/m

3100

WOC

D, m

MDT Sample : 3050 m
(Formation Tester) $P_R = 390$ bara

12 % OBM

$P_b = 350$ bara

Fluid Model $\nabla P_b \approx 0.02$ bar/m
(decreasing with depth)

340   350   360   370   380   390

2500
2600
2700
2800
2900
3000
3100
3200

SOC — 2650 m

SOC ?