PET500 19 December 2014

February 3, 2019

Contents

Part 1a

1

<u>Processes:</u> HC generation, Migration, Accumulation and Preservation

<u>Elements:</u> Source rock, Migration path, Reservoir rock, Trap and Seal rock

2

Basin modellin is the reconstruction of the evolution of a sedimentary basin in order to make a quantitative prediction of hydrocarbon accumulations.

3

1. Trench
2. Fore-arc
3. Foreland
4. Intracratonic
5. Passive margin
6. Rift basin

1. Subduction
2. Thrust loading
3. Thinning, cooling and loading

4

$\rho_s g h = \rho_w g H \Rightarrow H = \frac{\rho_s}{\rho_w} \cdot h \Rightarrow$

$$H = \frac{1.65}{3.3} \cdot 2.5 = 1.25 \text{ km}$$

5

The lateral shifting of sedimentary environments, due to changes on environment conditions during their deposition, generates vertical sequences of sediments.

6

North Sea Chalk reservoirs have higher porosity and lower permeability than typical carbonate reservoirs. They also show less presence of stylolites.

7

T = 120°C gives high risk for reservoir overpressure according to the GZ.

8

Geothermal gradient = 30°/km, GZ = 60 - 120° ⇒

$H_1 = \frac{60°C}{30°C/km} =$ 2 km, $H_2 = \frac{120°C}{30°C/km} =$ 4 km

Depth interval for the GZ: 2-4 km

9

Exponential to the temperature, and linear to geological time (age).

10

Normal fault, Reverse fault and Strike-slip fault.

11

The one on top is a conventional 3D seismic dataset based on the reflection of P-waves (compressional waves).

The set on the bottom is a OBS (Ocean Bottom Survey) seismic dataset, which include geophones to measure S-waves (Shear waves).

P-waves travel faster than S-waves, and will therefore reach the recording instruments first. The lower part is when the S-waves have arrived, giving different time scale values.

P-waves travel through rock matrix and pore fluid, and they are drastically affected by the presence of gas, which lead to scattering of the waves, anmd hence poor seismic resolution.

S-waves are not affected by the gas as they just travel through the rock matrix. Based on this, the section in the middle is a gas accumulation, and this is why we see a different quality in the resolution.

12

This is a 4D seismic survey.

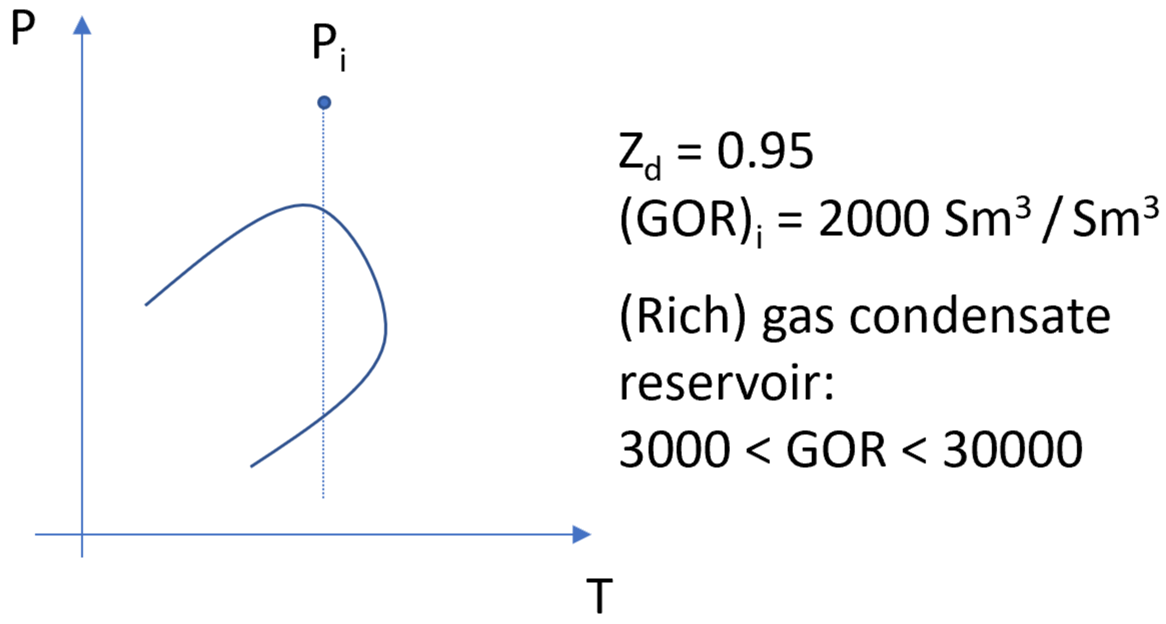
After 11 years of production, we can see that the oil-water contact (OWC) has shifted upwards to a shallower position (green is oil, blue is water).

Part 1b:

This part is not included. If you do the field exercises well, this part should not be to difficult!

13 Part 2: PVT of fluids

13.1 a).



13.2 b).

See lecture 11.

13.3 c).

See lecture notes for this question.

13.4 d).

$$GE_{STO} = n_{STO} \cdot V_m = \frac{m_{STO}}{M_{STO}} \cdot V_m = \frac{\rho_{STO} \cdot \overbrace{V_{STO}}^{=1}}{M_{STO}} \cdot V_m \Rightarrow$$

$$GE_{STO} = \frac{\rho_{STO}}{M_{STO}} \cdot 23.6447 \left[\frac{Sm^3 gas}{Sm^3 oil}\right]$$

13.5 e).

$$\text{HCPV} = V_b \cdot \phi \cdot (1 - S_{wi}) = 1000 \cdot 0.23 \cdot (1 - 0.18) = 188.6m^3$$

$$(HCPV)_{SC} = (N_g)_i \cdot V_m = \frac{P_i \cdot HCPV}{Z_i R \cdot T_{res}} \cdot V_m$$

$$\frac{45000 \cdot 188.6}{1.15 \cdot 8.3145 \cdot (120 + 273.15)} \cdot 23.6447 = 53382m^3$$

$$(GOR)_i = \frac{IGIP}{IOIP} = 2000 \Rightarrow IOIP = \frac{IGIP}{2000}$$

$$(HCPV)_{SC} = IGIP + GE_{STO} = IGIP + \frac{\rho_{STO}}{M_{STO}} \cdot V_m \cdot IOIP$$

$$= IGIP + \frac{\rho_{STO}}{M_{STO}} \cdot V_m \cdot \frac{IGIP}{2000} = IGIP \left[1 + \frac{\rho_{STO} \cdot V_m}{2000 M_{STO}}\right] \Rightarrow$$

$$\text{IGIP} = \frac{(HCPV_{SC})}{1 + \frac{\rho_{STO} \cdot V_m}{2000 M_{STO}}} = \frac{53382}{1 + \frac{800 \cdot 23.6447}{2000 \cdot 110}} = 49155.6Sm^3$$

$$\text{IOIP} = \frac{IGIP}{2000} = \frac{49155.6}{2000} = 24.58Sm^3$$

14 f).

$$\rho_g = \frac{m_g}{(V_g)_i} = \frac{n_g M_g}{\frac{Z_i n_g R T_{res}}{P_i}} = \frac{P_i M_g}{Z_i R T_{res}} \Rightarrow$$

$$\rho_g = \frac{P_i \sum z_i M_i}{Z_i R T_{res}}$$

$$\sum z_i M_i = (0.752 \cdot 16.04) + (0.077 \cdot 30.07) + \cdots + (0.052 \cdot 114) = 27.53 \Rightarrow$$

$$\rho_g = \frac{45000 \cdot 27.53}{1.15 \cdot 8.3145 \cdot (120 + 273.15)} = 329.55kg/m^3$$

$$(B_g)_i = \frac{HCPV}{IGIP} = \frac{188.6}{49155.6} = 3.84 \cdot 10^{-3}$$

15 g).

HCPV $= 188.6$ m^3

$P_i = 45000$ kPa, $P_d = 30500$ kPa

$Z_i = 1.15$, $Z_d = 0.95$

$T_i = T_d = 120° = 393.15K \ (= T_{res})$

$$(\Delta n)_P = (\Delta n)_i - (\Delta n)_d = \frac{P_i HCPV}{Z_i R T_{res}} - \frac{P_d HCPV}{Z_d R T_{res}} = \frac{HCPV}{RT_{res}} \left[\frac{P_i}{Z_i} - \frac{P_d}{Z_d} \right]$$

$$= \frac{188.6}{8.3145 \cdot 373.15} \left[\frac{45000}{1.15} - \frac{30500}{0.95} \right] = 405.33$$

$$V_{well} = (\Delta n)_P \cdot V_m = 405.33 \cdot 23.6447 = 9584 Sm^3$$

$V_{well} = V_g + GE_{STO} = V_g + V_m \cdot \frac{\rho_{STO}}{M_{STO}} \cdot V_{STO}$, $GOR = \frac{V_g}{V_{STO}} = 2000 \Rightarrow V_{STO} = \frac{V_g}{2000}$

$$V_{well} = V_g \left[1 + \frac{V_m \rho_{STO}}{2000 M_{STO}} \right] \Rightarrow$$

$$V_g = \frac{V_{well}}{1 + \frac{V_m \rho_{STO}}{2000 M_{STO}}} = \frac{9584}{1 + \frac{23.6447 \cdot 800}{2000 \cdot 110}} = 8825.2 Sm^3$$

$$V_{STO} = \frac{8825.2}{2000} = 4.41 Sm^3$$

15.1 h).

$$(V_g)_{C_1+C_2+C_3} = (n_g)_i \cdot (y_{C_1} + y_{C_2} + y_{C_3}) \cdot V_m$$

$$= \frac{P_i HCPV}{Z_i R T_{res}} (y_{C_1} + y_{C_2} + y_{C_3}) \cdot V_m$$

$$= \frac{45000 \cdot 188.6}{1.15 \cdot 8.3145 \cdot 393.15} \cdot (0.752 + 0.77 + 0.044) \cdot 23.6447 = 46602.6 Sm^3$$