Excercise

OLGA

THE PRACTICAL USE OF "ARCHIE", CONVERSIONS AND ACCURACY.

Introduction:

This example shows logging results used for the determination of hydro-carbon presence and quantities in a reservoir. This method is also used for the definition of:

- coal seam-thickness and the amount of sterile zones in and between coal layers.
- clay type and its purity (for ceramic industrial purposes).
- ore exploration and exploitation (interpretation of the shape of an ore body).
- etc.

In the near future, many Russian oil provinces promise to be the main supplier of hydro-carbons for Western-Europe. Many of these giant oil fields are producing, but are very poorly developed. As a try out, a Dutch/American consortium consisting of oil companies, banks and insurance companies, intend to put a high risk investments in the UTOPIA-field. Many well data have been evaluated. These pre-perestroika figures are produced in a Marxist-Leninist climate and difficult to interpret for "profit-based" exploitation purposes. For this reason a new appraisal well is drilled by DEDRI (Delft Drilling BV i.o.) and evaluated by DUPE (Dutch-Petrophysics V.O.F.). Relevant data, known after drilling, logging and core-evaluation of this well **OLGA - XIII** are:

Well OLGA - XIII

Core and plug results:

- The section 7050 - 7120 ft. was continuously cored.
- The reservoir is a friable sandstone, non-calcareous and shale free.
- The results of the routine core analysis are shown on the log.
- Sidewall samples were taken in the zone 7000 - 7020 ft. This is a hard clean sandstone.
- No oil or gas shows were observed in the samples nor in the mud while drilling through this section.
- Maximum depth logged; 7140 ft.

Drilling information:

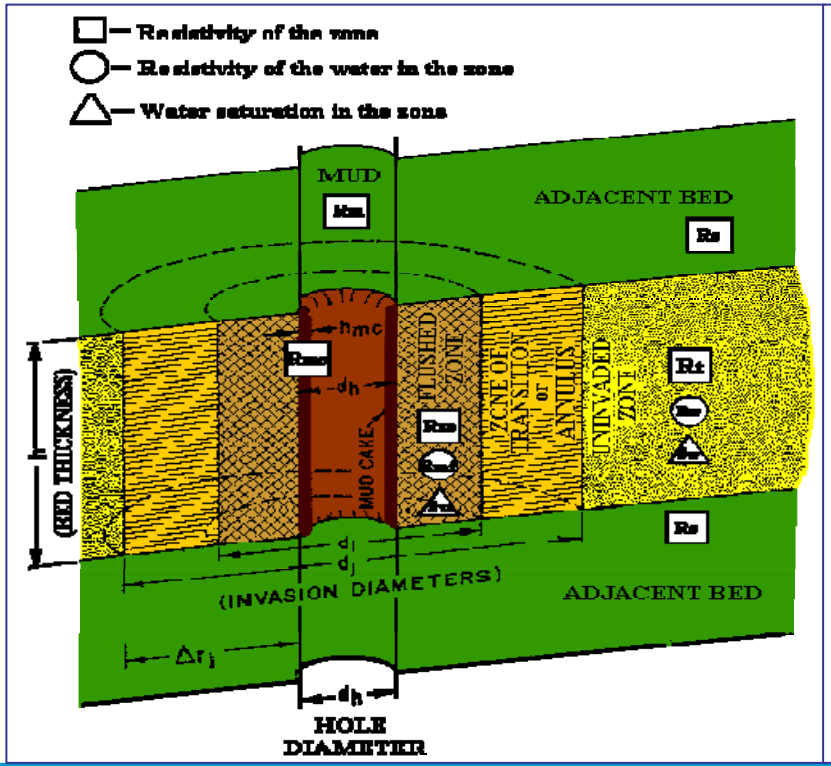
- Bottom hole temperature; 174ºF.
- Bit size; 8".
- Mud type; Caustic Quelracho, mud density-10.2 lbs/gal.

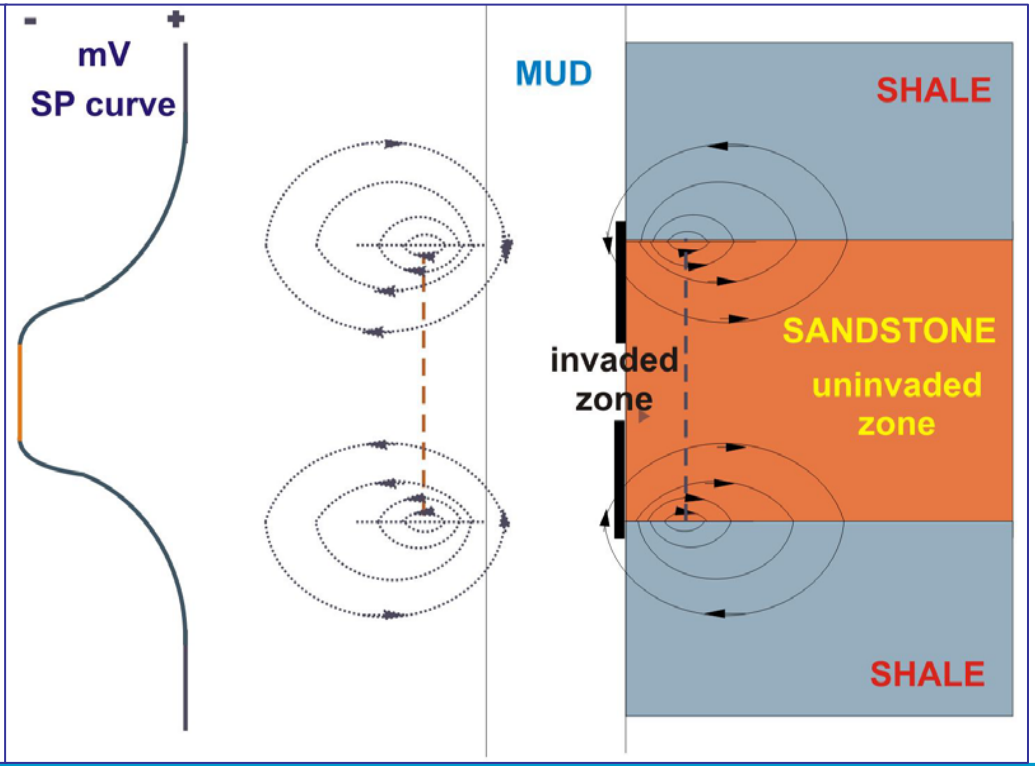
Additional information:

- Saturation exponent; n = 1.6
- 1 acreft = 1233 m3
- No borehole or bed thickness corrections are required

Define the following in-situ resistivities:

Resistivity mud	0 .7 ohm m at 77ºF		ohm m at 174ºF
Filtrate resistivity	0.5 ohm m at 77ºF,		ohm m at 174ºF
Rw in the bottom sand	0.14 ohm m at 77ºF		ohm m at 174ºF
Rw in top sand	0.058 ohm at 77ºF		ohm m at 174ºF





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Questions

1) What "m" would you consider for the bottom sand?

2) What "m" would you consider for the top sand?

3) Calculate the amount of Oil In Place in barrels per acre in the lower sandstone,
taking into account the information provided by the core data. (Determine R_O bottom sand in two ways).

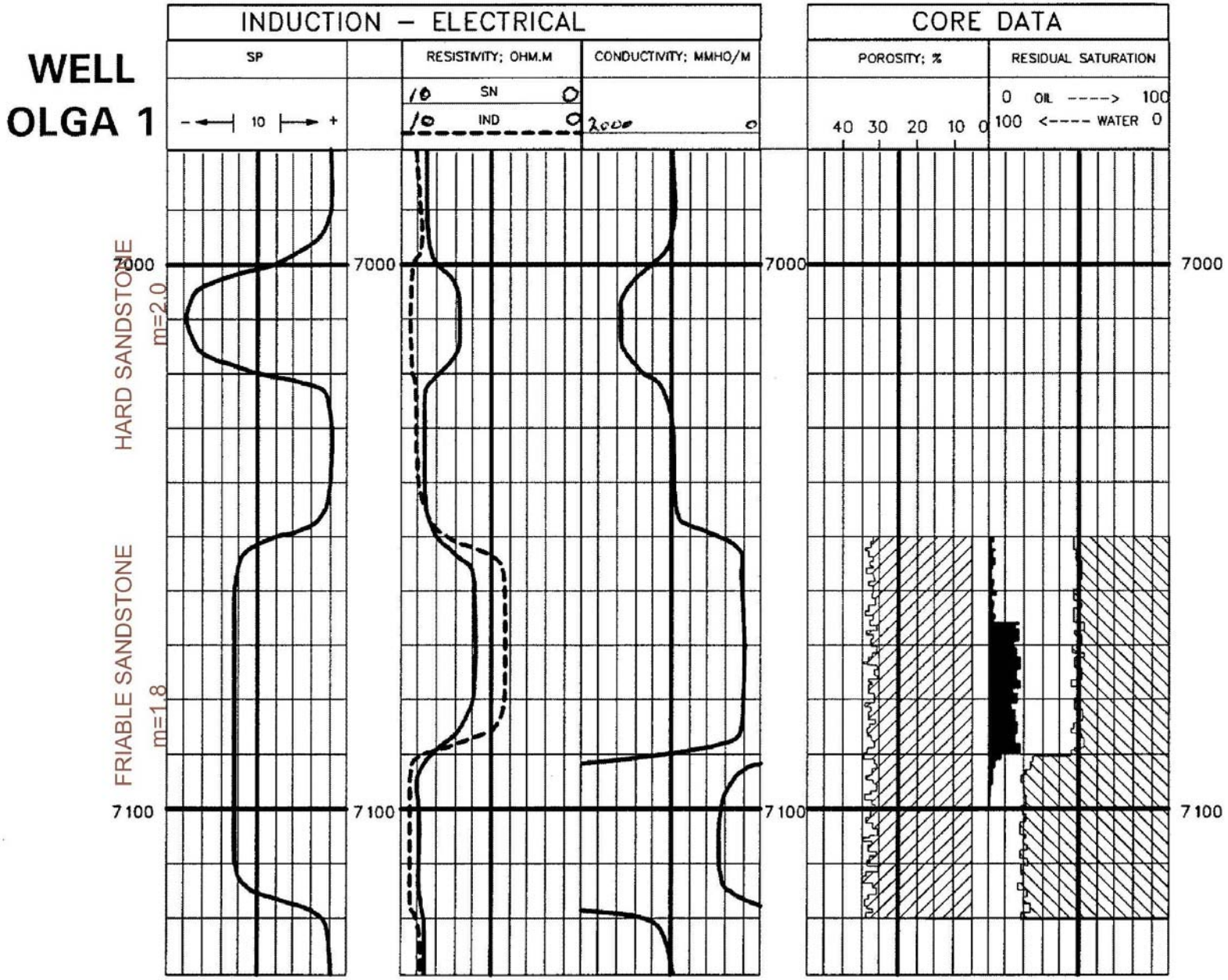
4) What is the water saturation Sw at 7010 ft.?

5) Estimate the porosity of the upper sandstone using;

a) the resistivity indicated by the induction log?

b) the resistivity indicated by the short normal?

6) Are the values found in 5a) and 5b) minimum or maximum values?


WELL
OLGA 1
INDUCTION – ELECTRICAL
CORE DATA
SP
RESISTIVITY; OHM.M
CONDUCTIVITY; MMHO/M
POROSITY; %
RESIDUAL SATURATION
10
SN
IND
2000
40 30 20 10 0
0 OIL ----> 100
100 <---- WATER 0
7000
7100
HARD SANDSTONE
m=2.0
FRIABLE SANDSTONE
m=1.8

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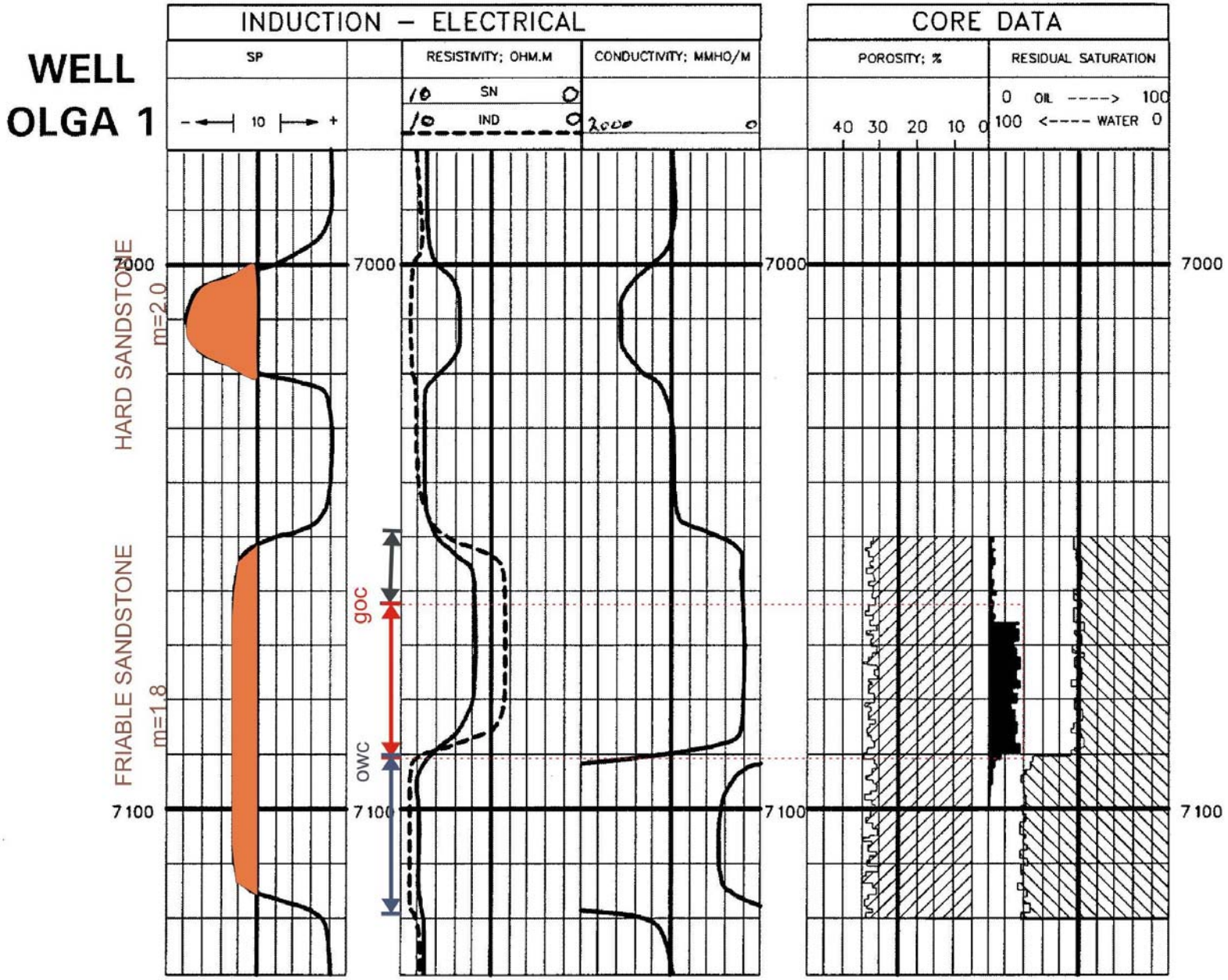
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OLGA 1
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FRIABLE SANDSTONE
m=1.8
goc
owc

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Define the following in-situ resistivities:

Resistivity mud	0 .7 ohm m at 77ºF	**0.3**	ohm m at 174ºF
Filtrate resistivity	0.5 ohm m at 77ºF,	**0.22**	ohm m at 174ºF
Rw in the bottom sand	0.14 ohm m at 77ºF	**0.06**	ohm m at 174ºF
Rw in top sand	0.058 ohm at 77ºF	**0.024**	ohm m at 174ºF

OLGA

1. Bottom sand: 7,050-7120 ft m=1.8
2. Top sand: 7,000-7020 ft m=2.0
3. OIP 7,050-7,120 ft

1 acre = 4046 m2, 1 acreft=1233 m3, 1 bbl = 0.1589 m3

Total vol. of 1 acreft = 7758 bbl

OIP = 7758 . h . Porosity . (1 - Sw)

Gross thickness: 70 ft

Gas bearing zone: 7,050-7065 = 15 ft

Below 7065 residual oil in cores

Oil bearing zone: 7,065-7,090 = 25 ft

h = 25 ft

Porosity: atm.= 32 % Cores

in-situ = 28 % ?

porosity = 0.28

Oil saturation:

$Ct = Por^{+m} . Sw^{+n} . Cw$

Ct = 1000/5.7 = 175 (neglecting inv.)

m=1.8, n=1.6, Cw =15385 mmho/m

Sw = 0.255

Using in-situ conditions:
OIP=7758 x 25 x 0.28 x 0.745 = 40,186 bbl/acre

Using surface conditions:
OIP=7758 x 25 x 0.32 x 0.78 = 40,186 bbl/acre

4) What is the water saturation Sw at 7010 ft.?
Answer: Sw = 1. Induction high conductivity, lack of shows in SWS (saturated water system)

5) Estimate the porosity of the upper sandstone using;
a) the resistivity indicated by the induction log?
b) the resistivity indicated by the short normal?

Answer 5A: induction log: Deep in the formation Rt and Sw can be used.

$$\frac{Formation Water}{Induction \log} ....or..... \frac{R_O}{R_W} .....or..... \frac{C_W}{C_O} = \varphi^{-m}$$

Or:

$$log\varphi = \frac{\log\left(C_w / C_O\right)}{-m} .....valued.... \log \frac{\left(35714/1667\right)}{-2}$$

$$Then.....\varphi = 0.22$$

Answer 5 B: in the invaded zone the Rmf and Rxo can be used.

$$\frac{Mudfiltrate}{Shortnormal}....or.....\frac{R_{XO}}{R_{MF}}.....or.....\frac{C_{MF}}{C_{XO}}=\varphi^{-m}$$

Or:

$$log\varphi=\frac{\log\left(C_{MF}/C_{XO}\right)}{-m}.....valued....\log\frac{\left(4545/323\right)}{-2}$$

$$Then.....\varphi=0.27$$

6) Are the values found in 5a) and 5b) minimum or maximum values?

Answer:
Cfw > Cmf, 35714 > 4545 mmho/m
Invasion of mudfiltrate ((Cmf) causes:
-Induction conductivity will be too low.
-Correction could result in 2000 mmho/m.
Then:

$$log\varphi = \frac{\log\left(C_{MF} / C_O\right)}{-m} .....valued....\log\frac{\left(35714/2000\right)}{-2}$$

$$Then.....\varphi = 0.237$$

Similar Conductivity of the "short normal" correction would result in a lower porosity than 0.27