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Permeability Evaluation in Pilaspi (M. Eocene - U. Eocene) Formation

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ABSTRACT
Studying the permeability in a particular formation will be our address in this paper, through collection of a set of data in relates to the past real core analyses by the oil operators and correlating them to our lab works on the samples of the same formation from Pilaspi formation (M.EOCENE - U.EOCENE) outcrop on Haibat Sultan Mountain near Taq Taq oil Field.

Lab works were done in Koya University using most of reservoir lab equipments for getting and determining the most important properties like porosity and permeability on plug samples of that formation. The key study in this paper is oil well TT-02 in Taq Taq oil field.

In this paper we will try to nominate and recognize the more active porosity type through measuring air and liquid permeability in our reservoir lab and show the effects of increasing flowing pressure on the permeability using saturated and dry core plug. Water and air were used as flowing fluids and two methods were used to measure the permeability; steady-state method, measures the permeability of a saturated Core plug under constant flow rate conditions and air permeability with (N2) for dry core plug.

***Keywords* –** Air, Lab, Permeability, Pilaspi, Taq Taq.

I. INTRODUCTION

Relative permeability is a critical parameter for evaluation of reservoir Performances. Relative permeability is a direct measure of the ability of the porous Medium to conduct one fluid when two or more fluids are present. This flow property is the composite effect of pore geometry, wettability, fluid saturation, saturation history, Reservoir temperature, reservoir pressure, overburden pressure, rock types, porosity and Permeability types. The relative permeability curves are very important in reservoir Studies. They are used in predicting production rate and recovery from the reservoirs during all recovery stages (primary, secondary, and tertiary).

All our measurements were studied at room conditions only. This study is concerned to measure and calculate of permeability and porosity of Pilaspi formation from its outcrops on surface.

II- LITERATURE REVIEW

2.1 Factors affecting the relative permeability Curves

Wettability affects relative permeability because it is a major factor in the control of the location, flow, and spatial distributions of the fluids in the core. Wettability determines the relative locations of oil and water with in the reservoir porous medium. Because of its effect on the oil/water distribution, wettability influences the relative permeability of the flowing fluids [2-6].

Temperature: early studies of temperature on relative Permeability was presented by Edmondson [7], Weinbrandt et al.[8], Casse and Ramey [9], Ref. [10], Miller M.A. and Ramey H.J. [11] Measured dynamic-displacement relative. The study proves that temperature has no effects. Also the references [12-16] had shown consolidated sands water/oil relative permeability at temperature ranging from 22 C^0 to 175 C^0. They found that water/oil relative permeability curves are affected by temperature especially at low interfacial tensions (IFT).

The change in wettability of the rock and reduction of the interfacial tension with increasing temperature were important factors in causing the observed changes in the relative permeability curves. The above results from experimental were conducted on fired Berea sandstone cores using n-dodecane and 1% NaCl. Aqueous low concentration surfactant solutions were used to change interfacial tension levels. For the experiments reported, the fluid pressure was kept constant at 300 psig and the overburden pressure at 650 psig.

2.2Taq Taq oil field is one of the most important and first one to produce oil soon after 1997 by our KRG (Kurdistan Regional Governorate) locate to 20 km south west of Koya city and TT-02 was the second exploration oil well drilled to pilaspi formation its location exactly in N = 3984594 and E = 456804, the well was drilled vertically to its find depth 621 m. Its conductor casing is 13 3/8”, 54.5 lb/ft, and K55 to depth of 140m.

The second section is 9 5/8” casing 36 lb/ft and K 55 to 545m, the internal of 545 m to 663m was left as an open hole in pilaspi formation as its Fig. 1

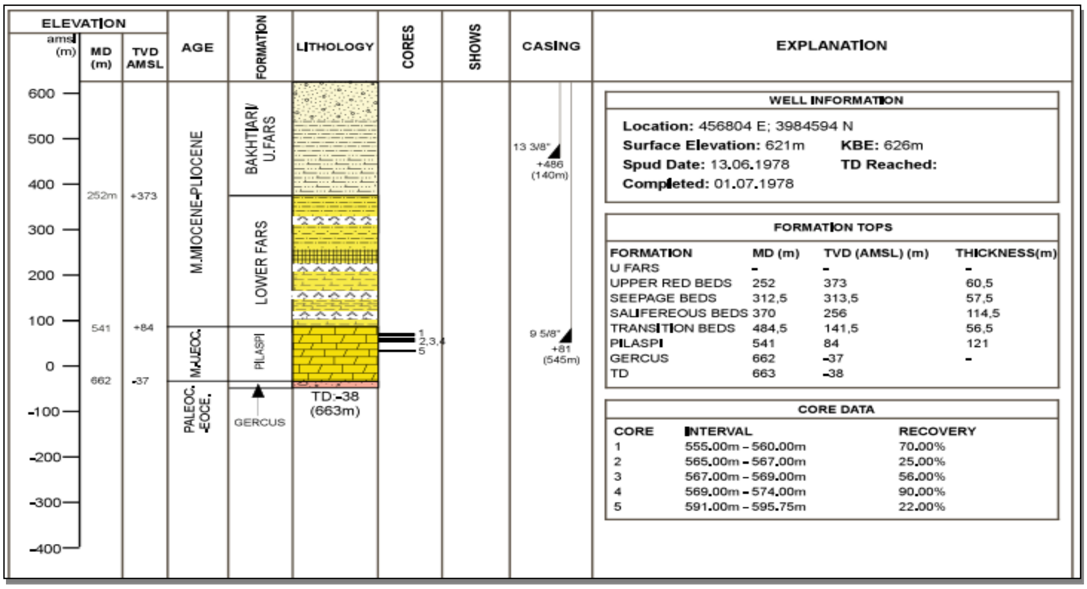


Figure – 1 TT 02 Geological column [1]

Structure: The well is sited very close to the crest maxima of the structure and only 150 m a way from well TT-01. No future information could be added to the current structural interpretation offered from the field survey (GR-219) or drilling of TT-01.
The most collected physical data for the pilaspi formation is illustrated in fig.1.

Bottom hole pressure: The well was drilled in 1978 and still there are a lot of drilling and production related data not clear or are not under hand fortunately the relation of depth is BHP was one of the most one available data.
From the bottom hole pressure survey BHP data we can come out with the pressure gradient or change with depth as in table 2 and 3, for the real pressure survey in two times each was lasting 30 minute for the pay zone interval.

Table -2 TT02 pressure survey

Time (min)	Depth (ft) TVD	BHCIP psig	B.H.P gradient psig/ft
15	1700	683.3	0.396
15	1800	722.9	0.399
15	1900	762.8	0.437
15	2000	806.5	0.446
15	2100	851.1	0.453
15	2150	874.9	

Table - 3 TT02 pressure survey

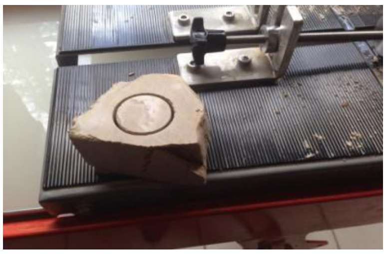
Time (min)	Depth (ft) TVD	BHCIP psig	B.H.P gradient psig/ft
15	1700	688.8	0.392
15	1800	728	0.332
15	1900	767	0.43
15	2000	812.2	0.446
15	2100	856.2	0.45
15	2150	879.6	

4- Lab works

Our working was on samples from on Pilaspi outcrop from Haibat Sultan Mountain and the plug have been prepared in Reservoir Lab, preparing three core samples with dimensions as in table 4 below.

Table-4 Core samples dimensions

Core plug	Sample 1	Sample 2	Sample 3
Diameter (cm)	3.8	3.8	3.8
Length (cm)	4.58	4.6	7.88



The second step was cleaning the core plug for 5 hrs by using Distillation-Extraction (Dean-Stark) and drying the core plug inside the oven for 5 hrs at temp 200 C degree.
The third step was using (STEADY STATE GAS PERMEAMETER fig. 3) for determining the air permeability with letting N2 to flow under constant rate of following pressure with increasing the flowing pressure to different values as it clear in the table 5.
The final step in our lab works was saturating the core samples with water for determining the porosities with water based on the normal procedure of Archimedes method by determining the difference in weight.

V. Lab work Results

1. Our samples were from Pilaspi outcrop on the surface.
2. The room temperature was 22degree centigrade.
3. All the tools and equipments worked properly without any problem.
4. There were no accident or incident, we followed all related standard working procedure.
5. Used gas for determining permeability was clean N_2.
6. All the tests period was 8 days which we spent most of the times in cleaning and drying for getting accurate results.
7. Determination of permeability done using different pressure difference.
8. During the permeability determination we were under the working condition of Darcy regarding the steady state flow.
9. With all those points above both porosity and permeability was zero for all samples.

And the result for sample 1 calculation was as below and same result for sample 2 and 3.

Table - 5 Permeability test result

Sample Name	Dia (mm)	Length (mm)	Atm. Press. (psia)	Confining Pressure Radial (psig)	Date Time of test	PT01 (psia)	Temp. (°C)	FQT01 (Ncc/min)	Ka (mD)	Darcy conditions granted
Pilaspi Sample 1	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	14.25	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	15.20	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	15.97	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	16.45	20.0	0.000	0.000	
	38.00	45.90	13.49	250	10/6/14 1:00 PM	17.06	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	17.92	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	18.74	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	20.54	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	24.34	20.0	0.000	0.000	
	38.00	45.90	13.49	250	10/6/14 1:00 PM	26.49	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	27.85	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	31.55	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	32.05	20.0	0.000	0.000	
	38.00	45.90	13.49	250.00	10/6/14 1:00 PM	33.00	20.0	0.000	0.000	
	38.00	45.90	13.49	250	10/6/14 1:00 PM	34.05	20.0	0.000	0.000	

Sample: 1	Dryweight	W1=	137.34	gm
To find Vp:	saturated weight	W2=	137.34	gm

S=So+Sw+Sg=1 means Vp because Vw=Sw/Vp , Vo=So/Vp and Vg=Sg/Vp
assum Sg=0 , Sw= 0 Vp = So/Vp + Sw/Vp + Sg/Vp
S=So=Vp Vp=1

Vp= W1-W2/ water density water density= 1
Vp = 0.000 cc

To find Vb:
1. measure the length of plug smaple L 4.58 cm
2. Measyre the diamter of plug samlpe D 3.8 cm R= 1.9

Vb= ∏ R2 L

Vb= 51.942 cc

Calculations

To find popsity:

Porosity = vp/vb 0

Table 6 samples saturation results

Core plug	Sample 1	Sample 2	Sample 3
Dry weight (gm)	137.34	136.7	233.52
saturated by water (gm)	137.34	136.7	233.52

5- Conclusions

1- Pilaspi formation has no primary porosity, this was clear in both used methods (Steady state Permeability and saturation), so we can come out to a cretin result that all hydrocarbons in TT-2 is because of highly fractured layers and not because of any other types of porosity.

2- Based on Klinkinberge effect results gas permeability is higher liquid permeability, we can say that the original porosity and permeability are both zero

3- Based on the point above and zero primary porosity still we can say that the only path of flow are because of fractures belong the tectonic movements that build fractures and cavities.

4- Both pressure and temperature have a liner effect on porosity so we can say that our results in ambulant condition can represent reservoir condition also

5- Real pressure gradients from the operator reports give the value of (0.4 psi/ft) with can confirm the result of that we have a difference with normal overburden pressure gradient 0.5 psi/ft which are of course because of hydrocarbon content in the interval from (1700 to 2150) ft and liquid fluid above.

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