RESERVOIR ROCK EVALUATION OF BALKASSAR OILFIELD POTWAR PLATEAU, PAKISTAN USING GEOPHYSICAL WIRELINE LOGS

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Abstract: The Balkassar Oil field is situated in the eastern Potwar sub-basin, and lies on the Soan Syncline southern flank in Himalayan collisional regime. In this study petrophysical properties of reservoir rock, Sakesar formations of Eocene age encountered in Well 7 of the Balkassar Oilfield, Potwar Basin, Pakistan were evaluated for reservoir rock potentiality. A suite of wireline logs containing neutron, density, gamma ray, spontaneous potential and resistivity logs of well 7 from Balkassar Oilfield were interpreted carefully to estimate porosity, formation water resistivity, water saturation and hydrocarbon saturation. The Petrophysical analysis of Balkassar well 7 shows 24.7% average porosity, 17.7% water saturation and 82.3% hydrocarbons saturation in the Sakesar Formation. Thus, this indicates that Sakesar Formation has a good reservoir potential.

Keywords: Petrophysical analysis; geophysical wireline logs; Balkassar oil field; Indus basin.

I. INTRODUCTION

Geophysical wireline logs analysis is a technique that transfer raw logs data into useful information capable of providing estimation of oil and gas in the subsurface such technique is wireline logs analysis (Quijada et al., 2007). The key to success for exploration of hydrocarbon is petrophysical analysis as highlighted by Aadil et al (2014) and Khalid et al (2015). Wireline logs are very useful for defining the rocks characteristics such as, lithology, permeability and porosity which are the most important properties of rocks in oil and gas exploration (Asquith et al., 2004).

II. OBJECTIVES

The aim of this study is to interpret wireline logs of Balkassar well 7, with the following main objectives:
To identify lithology and calculate porosity, water saturation and hydrocarbon saturation.

II. LOCATION OF STUDY AREA

The Balkassar oilfield is situated in the middle of the Potwar Plateau in Upper Indus Basin, Punjab, Pakistan (Figure 1). Elevation of Balkassar region is 499 meters above the sea level (Khan et al., 1986). Its coordinates are 32°55' N and 72°39' E.

III. MATERIAL AND METHODS

This study uses one well (Balkassar 7) for investigation of Eocene reservoir rock to evaluate hydrocarbons potentiality. The well logs data for this study was provided by the Directorate General Petroleum Concessions (DGPC), Islamabad Pakistan.

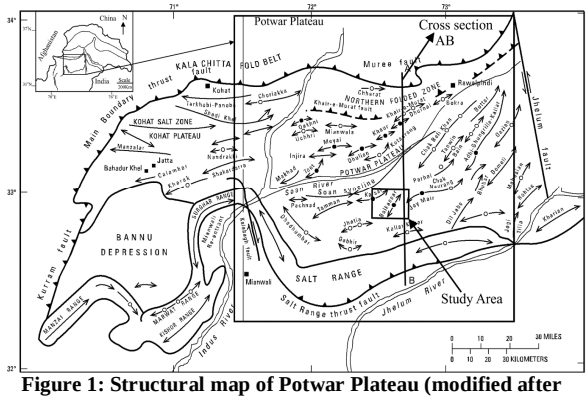

Figure 1: Structural map of Potwar Plateau (modified after Kazmi and Rana, 1986; Khan et al., 1986; Gee, 1989).

IV. PETROPHYSICAL ANALYSIS

The petrophysical analysis based on wireline logs (Neutron, Density, Resistivity, Gamma Ray and Spontaneous-potential) for Eocene age Sakesar Formation in the Balkassar well 7 was conducted. The analysis was performed to calculate porosity, formation water resistivity, water saturation and hydrocarbon saturation. All of these parameters are very useful in investigating the reservoir hydrocarbon potential.

V. PROCEDURE FOR FINDING DIFFERENT PARAMETERS FROM LOGS.

The following parameters were directly read from the log track:

- Bulk density of formation (RHOB) (scale 1.95 to 2.95)
- Bulk resistivity of the formation (LLD) scale (0-2000) ohm.m
- Formation depth (ft)
- Spontaneous potential (SP) (scale 0-100mv)

- Neutron porosity (NPHI) scale (0.45 to -0.15)

VI. SATURATION OF HYDROCARBON (SH)

Schlumberger log interpretation charts along with several equations were used to find out certain unknown values to determine saturation of hydrocarbons in Sakesar Formation encountered in Balkassar 7 well. These equations and charts include:

1. Bottom-hole temperature of 180 °F and 72 °F surface temperature was given on wireline logs. Fig. 2 (a). Formation temperature was determined by using Equation:
   Tf = Ts + Df (BHT-Ts/TD)
2. Corrected R_{mf}Mud filtrate resistivity and R_m resistivity of mud at formation temperature. Fig. 3 (a).
3. Self-Potential was determined directly by reading it from SP curve on log chart.
4. For measuring R_{mf} / R_{we} ratio. Fig. 3 (b), was used to measure the value.
5. R_{we} was determined by dividing the corrected value forR_{mf} by the ratio ofR_{mf}/R_{we} value.
6. For R_{we} the equation is: $R_{we} = R_{mf} / (R_{mf}/R_{we})$
7. R_{we} correction to R_w were done by using Fig 2 (b), and the value of R_{we} calculated in step 5 to determine the correct R_{we} value.
8. Saturation of water was determined by Archie's equation. $S_w = \sqrt{\frac{R_w}{\phi^m * R_t}}$
9. Saturation of hydrocarbon can be determined at a given temperature by equation:
   $S_H = 1 - S_w$

Table: Values for the different parameters calculated for well logs analysis.

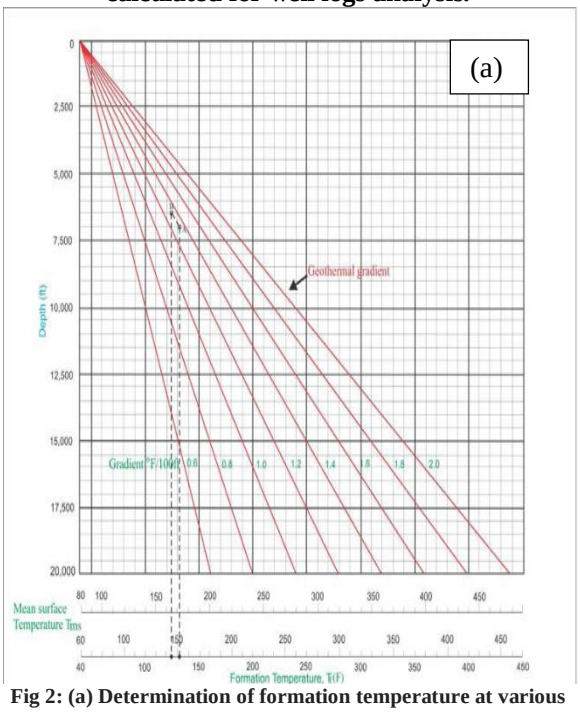

Fig 2: (a) Determination of formation temperature at various depths,

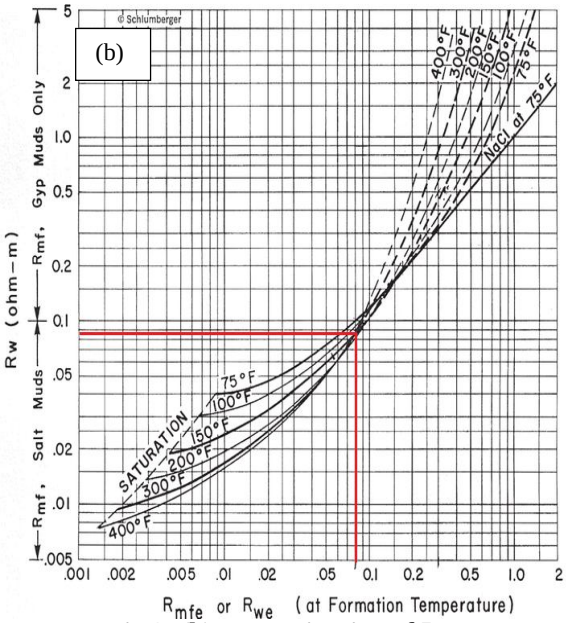

Fig 2: (b) Determination of R_w from R_{we}(Schlumberger 1972).

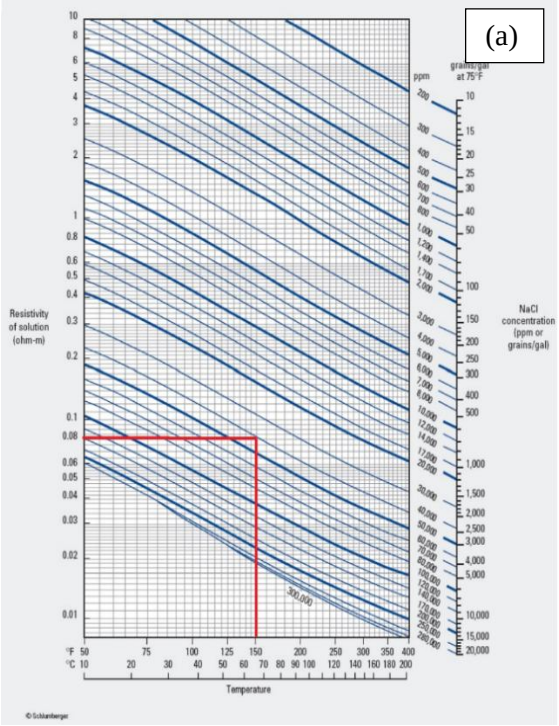

Fig 3: (a) Correction of R_{mf} and R_{we} according to temperature.

CONCLUDING REMARKS

Petrophysical properties evaluation were performed by careful interpretation and analysis of well logs of Balkassar well 7. The average porosity indicates a suitable reservoir ranges from 17% to 34%, average water saturation ranges from 8% to 33% and hydrocarbon saturation ranges from 67% to 92% indicating a high hydrocarbon production. Based on the statistical analysis performed, it can be concluded

that the Sakesar Formation in Balkassar oilfield possess good petrophysical properties and have the potential to produce hydrocarbons.

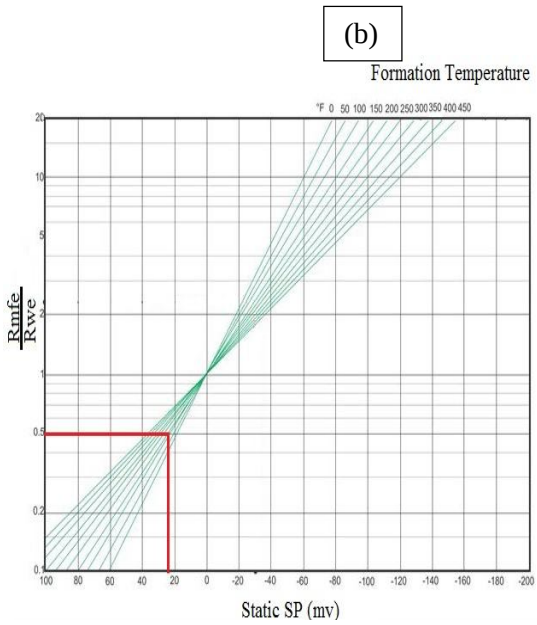

Fig 3: (b)R_{mf} / R_{we} determination from Self-Potential (Schlumberger 1972).

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Depth (ft)	Temp	RHOB	ΦD	SP	Φ (N.D)	Rt (LLD)	Rwe	Rw	Sw	SH	Lithology
8031	153.1	2.73	0.38	-26	0.34	430	0.41	0.72	21%	79%	Limestone
8086	153.7	2.71	0.32	-13	0.17	1130	0.59	0.79	22%	82%	Limestone
8141	154.2	2.67	0.07	-29	0.20	1550	0.37	0.66	33%	67%	Limestone
8196	154.8	2.63	0.15	-36	0.29	1790	0.38	0.33	8%	92%	Limestone
8251	155.3	2.56	0.09	-46	0.24	1720	0.35	0.62	16%	87%	Limestone
8306	155.8	2.62	0.24	-33	0.26	1730	0.37	0.41	12%	88%	Limestone
8361	156.3	2.49	0.25	-31	0.23	930	0.36	0.43	19%	81%	Limestone

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