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Reservoir Characteristics and Geomechanical Parameters Derived from Dipole Sonic Log In the Asmari Formation, Ramshir Oil field, SW Iran

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INTRODUCTION

Reservoir characterization and its relation with RPM (rate of penetration) and bit selection plays an important subject in oil industry [1-2]. RPM depends on the physical, mechanical, and geological properties of rocks [3-4] or bit size [5]. Generally bit selection using experimental results of adjacent drilled wells is the cheapest way [6-7]. It is evident that there is a relation between optimized bit selection and its function [8-9], geomechanical parameters and bit selection [10-13], but usually mud weight variation is the best case to consider [2, 14]. By reviewing the literature, a few publications are available about the role and determination of geomechanical parameters in southwestern oil fields of Iran such as geomechanical parameters and bit selection and enhanced oil recovery [15], geomechanical modelling, in situ stress, pore pressure and optimization of mud drilling [16].

Therefore, in the present work there is an attempt to consider reservoir properties of Ramshir oil field, SW Iran, and geomechanical parameters measurement using dipole sonic log data to select adequate drilling bit. The results will be useful in the speed and risk reduction of drilling process.

METHODOLOGY

To evaluate reservoir characteristics and reservoir zonation different well logs (gamma ray, sonic, neutron and density) were used. Moreover, lithological variation and lithofacies determination were carried out by 300 thin sections of the Asmari Formation core samples taken from

three drilled wells (4, 14, and 16) and Dunham classification. To understand geomechanical properties of the formation, related elastic parameters (shear, young, bulk, compressibility and lambda modulus and poison ratio) were estimated using dipole sonic, and density logs, data applying related equations and well drilling reports.

DISCUSSION AND RESULTS

To understand the parameters affected geomechanical modulus changes, the reservoir characterization should be studied. The Asmari reservoir divided into 8 zones based on petrophysical and lithological changes. Zone 1 consisted of fine crystalline limestone and dolomite, mudstone to wackestone. Average porosity is 10-15%. Zone 2 is sandstone and shale along with mudstone. Zone 3 is fine crystalline limestone, mudstone to clayey wackestone with sparse sands. Oolitic, pyritic and pleoidal grainstone, thin layered anhydrite, dolomite, shale and red to grey marl as well as thin layered sandstone was detected. Zone 4 presents shale, dolomite and limestone as well as quartz sands rich wackestone-packestone. Zone 6 consists of dolomite and limestone, and sandstone with carbonate cement, shale and marl. Zone 6 indicates mudstone –wackestone with pyritic and clayey sands. Zone 7 is defined as dolomitic limestone and sands, clayey dolomite. Mudstone-bilclast packestone- grainstone and pyritic dolomits determined in the lower part. Zone 8 shows alternative of limestone, dolomite and pyritic rich shale which is increasing the volume of shale and pyrite with depth.

Determined lithofacies in the reservoir consisted of generally, eight lithofacies using Dunham classification including dolomite, clayey limestone, wackestone-packestone, grainstone, anhydrite, marl/shale, pyritic shale and sandstone. Sandstones are indicating three textural variations as weak sorted, sub rounded and angular grains, fine grained, sorted and relatively angular with calcite cement, medium-coarse grained well sorted and rounded with calcite cement.

The Asmari reservoir is lithologically heterogeneous. Practical results have indicated that bit selection while drilling operation is not often optimized and correlated with rock mechanical properties and so to get high drilling speed the process will be done by test/error, adjust weight on drill bit or operator experts. Therefore, unsuitable bit or revolution per minute, inexpert driller leads to increase drilling costs. The Asmari Formation is drilling using rolling cone-PDC bits with 527-517, M132-M355-M345 IADC codes which are favored for hard-moderate rocks [17], WOB (4500-2200 lb) and RPM (35-105 cycle/min).

Geomechanical parameters estimated for the Asmari reservoir in Ramshir oil field (Fig. 1) indicated a range of variability. The values of 6.573-29.891 GPa (average is 17.426) by shear modulus (G) reflected shear resistance of the formation. The lower values related to increasing shear fracturing potential as well as heterogeneity behavior of different horizons which is highlighted in 2 zone. Young modulus (E) varies from 24.12 to 107.47 GPa (average is 59.13), Poison factor (ν) which is longitudinal/transverse deformation ratio is indicating 0.114-0.377 (average is 0.289). Balk modulus (K) and compressibility factor (β) vary from 13.07- 69.96 GPa (average is 35.89) and 0.014-0.076 (average

is 0.031), respectively. These parameters are presenting higher values in porous rocks (an indicator of higher reserve potential) especially 1, 2, and 3 zones. In addition, all parameters are correlated with each other and presenting same trends.

Porosity, permeability and ROP data indicated the upper part including 1, 2, and 3 zones of the reservoir is prone. However the middle part of this section having more reservoir potential. Also, mud weight is also increasing more than the lower part due to increasing pore pressure that hydrostatic and lithostatic pressures are the same. This point is also interpreted using geomechanical parameters variation. Therefore, it should be taken a care to select a suitable drilling bit in different parts. It is offered to make drilling operation using 527-IADC code bit in respect to geomechanical parameters data.

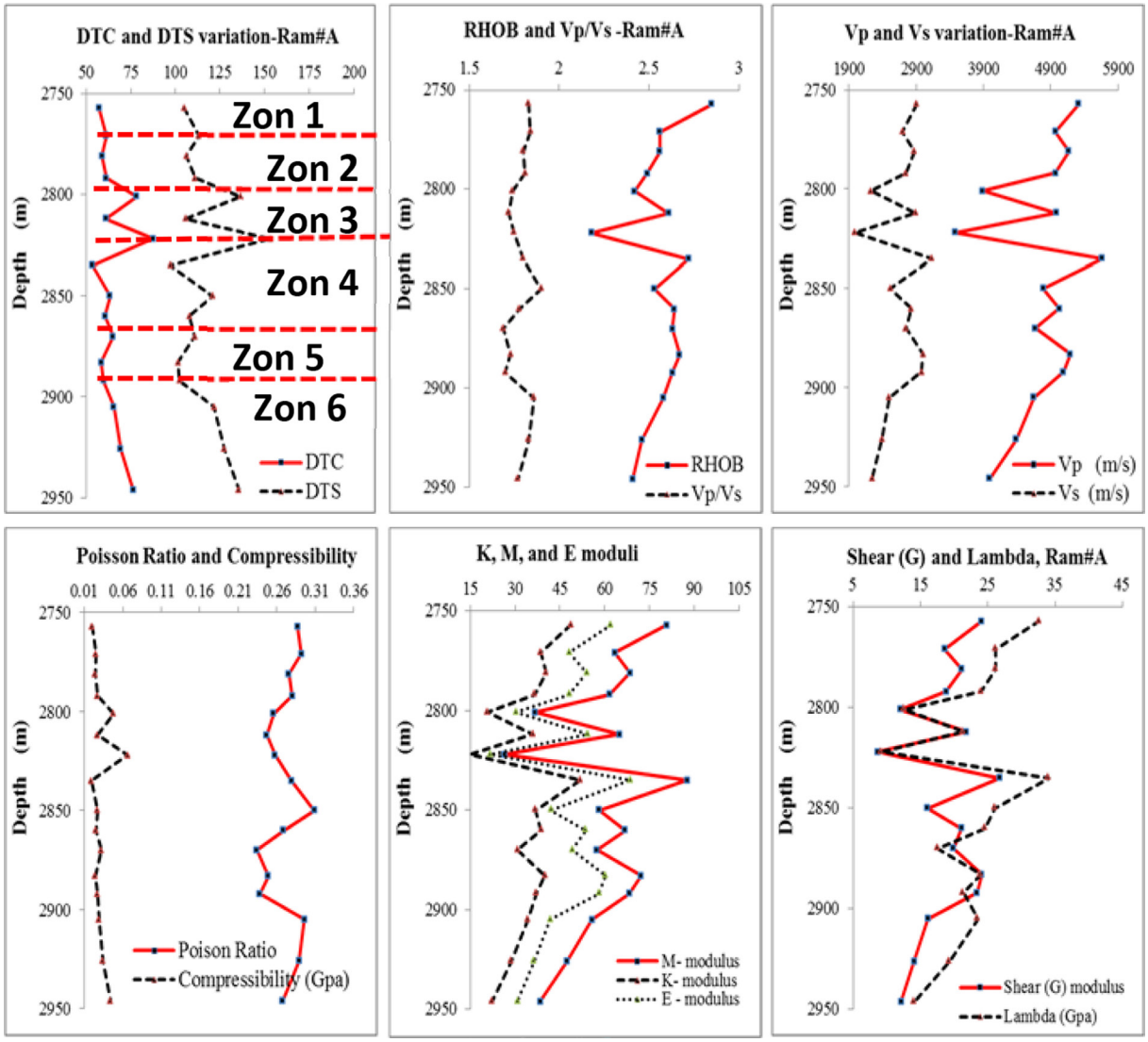

Figure 1: Geomechanical parameters variation in the Asmari reservoir, Well #A, Ramshir oil field.

CONCLUSIONS

Geomechanical parameters are the responses of rock physic properties, their variability can be the indicator of lithological changes. In the present work, compressive and shear waves speed (Vp and Vs) exhibit a decrease of density or the presence of reservoir fluids. Finally, in this field, this variation are coincide to production zones (i.e. 1, 2, and 3 zones) and similar to other geomechanical parameters (E, G, M, K, and lambda). This result should be involved in bit selection or drilling speed. It is proposed to operate drilling bits having 527- IADC code.

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