Study of Faults in Asmari Formation by FMI Image Log, Case Study: Lali Oilfield

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Abstract
Identification and description of faults in an oilfield will help to prevent problems such as casing collapse, wellbore instability, and hydrocarbon leakage. One way to study the performance of faults is using formation micro imager logs. This type of log does this by fully imaging the wellbore wall. In this study major and minor faults were recognized and assessed through analyzing raw data by means of GEOFRAME® software at interval of 1816-2050 m in well Lali-26. Abrupt change of bed dip direction from southwest to northeast at 1816 m showed that there is a fault originated from over thrusting Asmari formation on Gachsaran formation. Furthermore there are several minor faults at deeper than 1845 m, which were mainly identified by lithology contrast. All of studied faults had E-W trend. The minor faults may be caused by compression of lower block in main fault.

Keywords: Fault, Lali, Asmari, Formation Micro Imager, Gachsaran

1. Introduction

Once reservoir section drilled, only a minor proportion will be cored, and one may find that only exceptionally are faults and fractures present in the core material. The main reason is that brittle tectonic deformation is scarce away from faults, and drillers are hesitant to cut cores across faults because of the risk of jamming and potential pressure problems. Moreover, some cored fault rocks may be so unconsolidated that fall apart to form what is known as rubble zones. However, successfully cored faults and damage zones represent valuable information [6]. An alternative to solve this problem is to create a continuous micro resistivity image of the borehole based on the resistivity data from more sophisticated tools, such as Formation Micro Imager (Figure 1). This tool measures micro resistivity by means of a few hundred electrodes. The outcome of this method is a continuous image of the wellbore wall that is reminiscent of an actual picture of the rock [3]. The major purpose of this paper is to study the performance of minor and micro faults acting in Lali oilfield by FMI and extend the results of interpretation to macro scale.
2. Geological Description of Lali Oilfield

Lali oilfield is located in the region of northern Dezful at 112 km northeast of Ahwaz (Figure 2), this anticline is an asymmetrical structure with NE-SW trend and southern flank dip is higher than northern flank, and causes to change the axis to follow west trend in northern part and southern trend in the west. Thickness of Asmari reservoir in this field is about 400 m and is divided to 7 zones based on petrophysical data. Most important character of Asmari is presence of extended natural fracture systems which causes high productivity of wells not withstanding low matrix porosity (8% on average) [1,5].

Figure 1. Correlating the resistivity values to equivalent spectrum of colors [5].

Figure 2. Location of well Lali-26 and main fault in Lali oilfield [2, 5].
3. Faults and Image Logs

Fault is generally defined as any surface or narrow zone with visible shear displacement along the zone [3]. One of important applications of image logs is identification and description of faults [2]. Once the image gathered from wellbore is “unwrapped” and displayed from 0° to 360°, fault crossing the borehole appears as sinusoid [7]. Assuming that the images are properly oriented to the geographic north, the peaks and troughs of the sinusoids are related to the dip and azimuth of the fault, respectively. This therefore provides essential information about the formation encountered that other petrophysical logs are unable to provide. Figure 2 indicates typical response of a fault with details on FMI log. Only faults with displacement less than wellbore diameter is observable on image logs [8]. Figures 3 and 4 show normal and reverse faults with displacements less than wellbore diameter.

![Faults and Image Logs](image1)

Figure 2. Typical response of fault and its parameters on FMI logs [2].

![Faults and Image Logs](image2)

Figure 3. Identification of normal fault by FMI [2].
In case where fault displacement is higher than wellbore diameter indirect observations such as structural dip change, truncated bedding, displacement of sedimentary layers, high angle planar contact between different lithologies, high concentration of fractures in sheared zones, secondary mineralization, brecciation, abrupt change in well trajectory, and development of borehole breakout (Figure 5) are signs of possible fault.

4. Methodology

Gathered raw data from well Lali-26 were processed and interpreted by modules of GEOFRAME® as observable in Figure 6. Image log processing includes procedures which remove errors, enhance quality of logs and autocomputing parameters such as dip and strike of geological events. In next stage the main and minor faults were identified and matched with cross section of oilfield near well Lali-26.
5. Results & Discussion

5.1. Identification of Faults in Asmari Formation of Lali Oilfield

5.1.1. Main Fault

By interpretation of FMI log corresponding to well Lali-26 in Asmari top different faults were identified. According to Figure 3, at shallower than 1816m beds dipped toward southwest, by going deeper dip angle increases and dip direction turns to northeast at 1816 m which could be indication of fault. This hypothesis were confirmed by cross section which is shown in Figure 5.
It should be stated that in addition to 9 criteria mentioned earlier, drilling condition, knowledge about geological situation of area, seismic profiles, and even downhole pressure data can be also useful in detection of faults in an area. Faults will be detected and analyzed by considering following observations:

- Down falling the cap rock and Asmari horizon compared to drilling forecasting program, which could be due to performance of faults present in the well.
- Analyzing the seismic profiles shows that this well is close to main fault which influence the FMI log (Figures 5, 6).
Figure 5. Structural cross section of well under study indicating the main fault and other minor faults in Asmari reservoir of Lali oilfield.

Figure 6. Regional view of main fault acting in Lali oilfield [4].
Output of processing dip data by GEOFRAME\textsuperscript{®} is shown in Figure 7. Depth at which dip direction changes suddenly is location of main fault.

![Figure 7](image)

Figure 7. Structural cross section from interpretation of bedding dip angle and direction measured by FMI in one of well Lali-26 [2].

5.1.2. Minor Faults

Minor faults extended lower than main fault is demonstrated in Figures 8-12. According to these figures, lithology contrast is a key factor to identify fault. It should be mentioned that appearance of lithology of anhydrite and shale is due to over thrusting Asmari formation on Gachsaran formation which could be attributed to difference between strength of Asmari and Gachsaran formation.
Figure 8. Demonstration evidences of minor fault at 1845 m in well under study on FMI log.
Figure 9. Representation of fault existing at depth of 1851 m and 1856 m in well under study along with evidences on FMI.
Figure 10. Demonstration of fault existing at depth of 1960 m in well under study along with evidences on FMI.
Figure 11. Demonstration of fault existing at depth of 1856 m in well under study along with evidences on FMI and structural profile.
6. Conclusions & Recommendations

Results which were obtained from analysis of bedding and fault strike and dip by FMI log had good correlation with 2-D cross section. Bedding dip change and lithology contrast were the key factors in identification of main and minor faults, respectively. Main fault was originated from over thrusting Asmari formation on Gachsaran formation.

Acknowledgement
The Authors would like to thank department of geology of NISOC Company because of providing image logs and data and also scientific consultant.

7. References


