Characterization of Fractures of Asmari Formation by Using Image Logs, Case study: Marun Oilfield

Erfan Hosseini 1, Jalal Neshat Ghojogh 2, Bahram Habibnia 3

1 Abadan Faculty of Petroleum Engineering, Petroleum University of Technology, Abadan, Iran
2 Ahwaz Institute of Technology, Petroleum University of Technology, Ahwaz, Iran
3 Abadan Institute of Technology, Petroleum University of Technology, Abadan, Iran

Abstract
Asmari formation is one of most important reservoirs in southwest of Iran. Production from this reservoir is mostly due to presence of fracture systems especially in Marun oilfield, hence characterization of fracture zones in reservoir facilitate the specification of perforation zones, analyzing the performance of local faults and fracture networks to prevent problems during drilling operation, and modelling the fracture distribution in reservoir and affect it to geological model of reservoir. In this paper fractures of Asmari reservoir in Marun oilfield were studied by UBI and OBMI. Firstly raw data obtained from logging instrument were processed by GPIT survey, Bore ID, Bore Dip. The results were analyzed by visual and statistical methods, and matched with cores at various depths. Geological features like shear fracture and borehole breakout were identified. Image logs in depth of 3338 m to 3340 m were interpreted and results showed that bedding dip varies between 25° and 56° and most of dip data is between 30° and 46°. Fractures have dip of 35° to 84° that most of dip data range is between 58° to 66°.

Keywords: Asmari, Marun, Fracture, Image Log, UBI, OBMI.

1. Introduction
A tedious way to model reservoir rock deposition system and sedimentary environment is coring the reservoir rock and study it in combination with geological information. However, coring may not be possible all over the whole reservoir and non-reservoir parts because of some obligations such as cost of coring, time of rig and problematic formations. A proper and cost/time saving tool is borehole imaging which has been developed in oil industry to combine with limited core information and analyze the reservoir sedimentary environments. Borehole image logs provide important sedimentological and structural data to use in reservoir evaluation. They contain information about bedding style (bedding dip and azimuth), orientation of faults and fractures, structural regimes, unconformities accompanied by recognition of palaeo-slopes, palaeo-currents and etc. Best source of information which can be used to strengthen the image log evaluation is to join them together with core data [1]. Fractures are the most common geological structures that may exist and form in any rock. One of the main features of fractures is their effect on increasing porosity and permeability, which increased productivity of carbonate reservoirs in southwest of Iran. Fractures are the main path of fluid flow in carbonate reservoir [6]. Arian and Mohammadian (2000) analyzed the fractures of Asmari reservoir in Marun oilfield. They identified two fracture systems with regional and local sources such that regional fractures had E-W trend and local fractures are related to folding and structural bending. Investigation of curvature by differentiation yielded south limb and some areas of east of northern limb as potential fracturing regions. Gholi et al. (2011) evaluated the fractures of cores and image logs (FMI) of Sarvak formation in Ahwaz oilfield. They determined statistical characteristics of fractures for different zones and realized that fracture density in zones D, E, and F is higher than other zones. They also determined stress applied to borehole based on structural trend of borehole breakout.
Noraee Nejad et al. (2012) investigated geometrical and kinematic variables of Asmari reservoir of Marun oilfield using subsurface data. By studying folding and fracturing mechanism in this oilfield, they found that Marun anticline is a trust fault related fold (detachment fault or translational detachment). They observed a good correlation between geometrical analysis, mud loss data, productivity index at bending region of Marun anticline, and fractures in this region. Analyses of these correlation showed that fracturing occurred in central to western area of southern limb and in some regions of northern east. The aim of this paper is detailed study of fractures in Asmari reservoir of Marun oilfield by means of UBI and OBMI image logs visually and statistically then compare the results with observation from cores.

2. Description of Marun Oilfield

Most Zagros oil fields are stretched anticlines generated as a result of Paleocene, Late Miocene and Paleo-Pleistocene orogenesis, forming uplift zones of Lurestan (in north) and Fars (in south). The Dezful is embayment between these zones, with area of 60,000 km$^2$. Marun is one of the most important oil fields of Iran, which is located in the southwest of Iran in the south of North Dezful embayment between Kupal, Aghajari, Ramin, Shadegan and Ramshir oil fields (Figure 1). This field is an asymmetric anticline with NW-SE trend. This oil field at the Asmari horizon is 67 km in length and 7 km in width [2]. This field as a giant oil fields in Iran, consists of Asmari, Bangestan, Khami, and Dehram reservoirs, which were discovered in 1965 by means of seismic operation and drilling of the first well in Asmari formation. Because of tectonic activity, there are highly fractured area in this oil field, which causes upward migration of hydrocarbon [3].

[Figure 1. Location of Marun oilfield [3, 10].]

2.1. Marun Asmari Reservoir

Marun Asmari reservoir is one of the huge reservoirs in Iran. It is divided into 5 members, members 1 and 2 are dolomitic limestone and in some sections shaly and sandy, member 3 is made of dolomitic limestone and sandy at lower sections. Member 4 contains limestone and sandy shales and member 5 is transitional zone between Pabdeh and Asmari formation and contains compressed clayey limestone and pyrity gloconic dark shales [5, 6].

270
3. Image Logs

Oil-based micro imager tool (OBMI) log is type of micro resistivity imaging logs, which are designed for nonconductive environments. The OBMI is used for structural and sedimentological analysis of carbonate and clastic formations. The gained images from these implements are shown as dark and light colors. The dark colors show the conductive regions and light colors show the non-conductive regions. The open fractures and the cracks filled by minerals such as calcite and anhydrite have same OBMI image outward. By reason of the fractures filling with oil-based mud, these have light showing. In addition, the filled cracks with clay and shale have conductive performance because drilling mud does not influx to surface of formation. Besides the electrical pictorial device, which gives us limited information about fractures in oil-based mud (while it gives good information about the gradient of structure), the ultrasonic borehole imager tool (UBI) can also be used. This log was introduced commercially in 1990. The application of UBI is same as OBMI, but the big underground cavities can also be recognized by this tool. In addition, the stability of wells can be estimated and the stresses can be analyzed by using high-quality images. The UBI tool also has application in dug wells with water-based mud more than their application in oil-based mud. As one of its benefits comparing with another tools such as FMI, its ability to recognize the open and close fractures and the cohesions of fractures can be implied. Furthermore, the natural fractures can be separated from induced fractures using UBI image. In overall, all the necessary information for surveying the fractures can be gained by using these two tools. In addition, the lithology of formation and the filling materials for fractures can be some deal assessed by precisely explaining the images [11].

Fracture Related Events in Wellbore Fractures are surfaces of brittle mechanical failure in a rock. They are openings caused by stress release and/or tectonic forces. According to Luthi (2001), fractures can be distinguished based on their morphology. They can be [4]:

1. Irregular fractures associated with brecciation (fault zones, deposition) or formed as a result of collapse after karstification.
2. Solution-enlarged fractures that ultimately become vuggy or cavernous pores.
3. Thin localized joints terminated within the borehole and caused by tectonics, thermal stress, or borehole-related stress amplification.
4. Single, usually planar fractures caused by shearing or tension tectonic movements.
5. Drilling-induced fractures.
6. Healed (resistive) fractures.

4. Fractures

4.1. Borehole breakouts

Borehole breakouts are stress-induced enlargements of the wellbore cross-section. When a wellbore is drilled, the material removed from the subsurface is no longer supporting the surrounding rock. As a result, the stresses become concentrated in the surrounding rock (i.e. the wellbore wall). Borehole breakout occurs when the stresses around the borehole exceed that required to cause compressive failure of the borehole wall. The enlargement of the wellbore is caused by the development of intersecting conjugate shear planes that cause pieces of the borehole wall to spall off. The stress concentration around a vertical borehole is greatest in the direction of the minimum horizontal stress ($S_h$). Hence, the long axes of borehole breakouts are oriented approximately perpendicular to the maximum horizontal compressive stress orientation.

![Figure 3](image1.png)

Figure 3. Borehole failure and breakout in an elastic formation [8].

![Figure 4](image2.png)

Figure 4. Example of borehole breakout taken by downhole camera [12].
4.2. Drilling-Induced Fractures
DIFs are created when the stresses concentrated around a borehole exceed that required to cause tensile failure of the wellbore wall. DIFs typically develop as narrow sharply defined features that are sub-parallel or slightly inclined to the borehole axis in vertical wells and are generally not associated with significant borehole enlargement in the fracture direction (note that DIFs and breakouts can form at the same depth in orthogonal directions). The stress concentration around a vertical borehole is at a minimum in the SH direction. Hence, DIFs develop approximately parallel to the SH orientation (Figure 5).

![DIFs and SH orientation](image)

Figure 5. Natural and induced fractures in cores [9].

5. Methodology
In this study OBMI and UBI image logs at depth of 3338 m to 3340 m in well Marun 322 were analyzed in order to identify and describe different types of fractures.

6. Results & Discussion
6.1. Identification of Fractures by Image Logs

6.1.1. Interpretation of Image Logs
Figure 6 and 7 show the shear fracture and borehole breakout on image logs in well Marun 322.

![Shear fracture and borehole breakout](image)

Figure 6. Indication of borehole breakout on OBMI/UBI logs in Asmari formation of Marun 322 well [8].
Figure 7. Indication of shear fracture on OBMI/UBI logs in Asmari formation of Marun 322 well [8].

6.1.2. Statistical Analysis of Image Logs

The output resulted from interpretation of fractures in well Marun 322 is represented on steronet, Rose diagram and histogram, as illustrated in Figures 8 and 9. It is obvious in Figure 8a there is two classes of fractures in well which are denoted by red and blue outlines. The fracture system which is specified by red line is in same trend as bedding and is classified as longitudinal fractures while the system with blue line is perpendicular to bedding trend and is classified as traverse fracture. This situation is also observable in Figure 8b. According to histogram illustrated in Figure 9 it could be observed that beds have dip angle of 25° to 46° and most of them have dip in range of 30° to 46°. Fractures have dip angle of 35° to 84° that most frequent dips are in range of 58° to 66°.

Figure 8. Representation of dip angle and trend of open fractures (blue) versus bedding planes (green) for specific well in Asmari formation of Marun oilfield on (a) steronet (b) Rose diagram [8].
7. Conclusions & Recommendations

Borehole breakout and drilling induced fractures are two main classes of fractures which occur in Marun oilfield. Intensity of fractures in southwest of field is high which is due to bending of this oilfield at this region. Statistical analysis show that most of open fractures are longitudinal type which approves that bending is major reason for fracturing in Marun oilfield and location of well 322 confirms this.

Acknowledgement

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

8. References