# Characterization of Fractures in Carbonate Reservoirs of North Zone of Pakistan Using Formation Micro Image Logs Technique

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**Abstract**

*Fracture characterization is an important technique to locate and point out the area, depth, fracture geometry, fracture orientation, fracture aperture, fracture dip, fracture density and occurrence of fractures. In petroleum Industry, knowledge about the fractures is very critical due to lying underline formations of oil and gas. Carbonate reservoirs having low porosity, fractures are the only source of holding capacity (porosity source) and delivering (permeability source) towards the production well. Fractures usually provide fluid flow path from reservoir to the production well. Matrix feeds oil and gas into the fracture and fractures are the source of permeability channels for the carbonate reservoirs having low porosity and low permeability. Production operations in oil and gas reservoirs totally depend on fracture characterization especially in Naturally Fractured Carbonate Reservoirs. Formation Micro Image Log is most advanced technique that can provide real time information about the Fracture orientation, Fracture geometry, Fracture dip, Fracture density at certain intervals of depth. In this study, micro image logs are the techniques used to predict the fracture areas, Lithology, type of fracture with respect to depth. Here, case studies of different wells from North zone of Pakistan have been interpreted and analyzed to validate the fracture characterization of carbonate reservoirs.*

**Key words:** Fracture characterization; Carbonate Reservoirs; Formation Micro Image Logs.

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## INTRODUCTION

Fracture plays a vital role in the migration and production of oil and gas from naturally fractured reservoirs (Roheel, 1985). They have important impact and influence effectively properties of reservoir rock that deal with porosity and permeability. The relationship between natural fractures and stress field have significant effect on reservoir fluid flow (Serra, 1989).The presence of micro fractures even fissures has a great impact on the permeability and information about their scattered shapes (Serra, 2004). It gives important knowledge about stress orientations and field scales at small basins it is of great importance for wellbore stability, hydraulic fracturing and stimulation operations (Bell 1996; Tingay et al., 2005). In the fracture analysis procedure of carbonate reservoir rocks amount of data used from various sources such as drilling data, structural data, core data, petro-physical data, dynamic data and production wells data (Tampson, 2000).The image logs are known as known as best method for fracture analysis. They reduce cost by reducing intervals of coring and determination of perforated zone (Schlumberger, 2005). Such tools provide the high resolution borehole images in the conductive water base muds. One of the example is Formation Micro Image loggers (FMI) (Halliburton, 1996).The induced fractures during drilling and breakouts that are normally formed ahead of drill bit will provide constraints on orientation of the minimum horizontal and regional stress (Rajabi et al., 2010).

## MATERIALS AND METHODS

FMI Images were created on well site. Significant analysis of post-acquisition analysis of FMI Image date with high performance analysis software. FMI analysis technique was used for identification and characteristics of the reservoir. The purpose of this was to systemically study the reservoir and fracture characteristics, direction, bedding, fracture types in carbonate reservoirs, extension of fracture in the reservoir, their generation and determination of permeability zone.

## RESULTS AND DISCUSSION

Three wells from north zone of Pakistan have been analyzed to predict the fracture characterization.

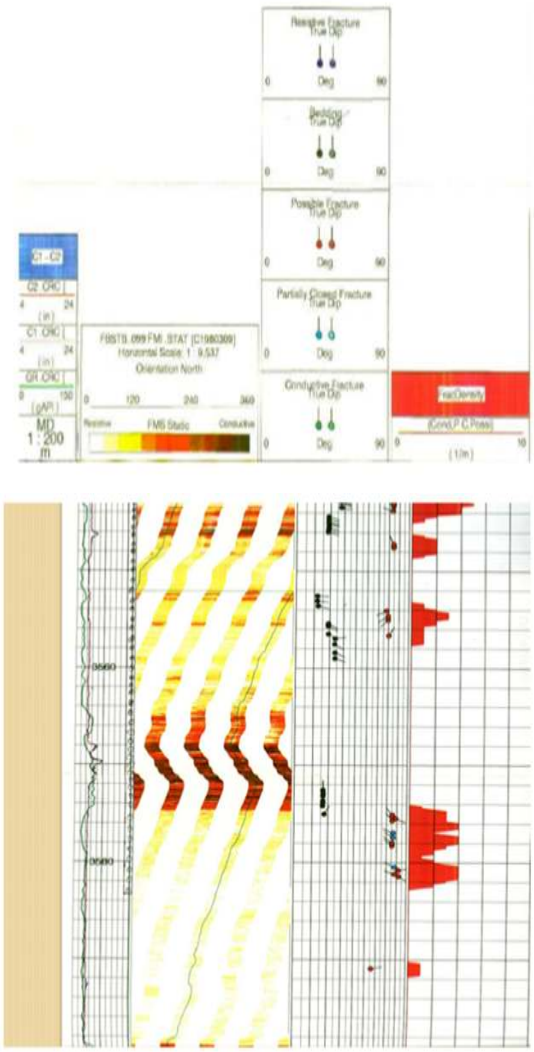

**Figure 1:** FMI Log of well X-1

- At a depth of 3550 to 3552 and from 3575 to 3580 ft, caliper log response showing bore hole enlargement effect due to possible and conductive fractures resulting density progression is increased.
- At a depth of 3590 - 3610 ft, the log response showing conductive fractures.
- At a depth of 3620-3660 ft, the resistive fractures.
- At a depth of 3680-3700 ft, the partially closed fractures.
- At a depth of 3960-4000 ft, once again the medium represents conductive fractures.

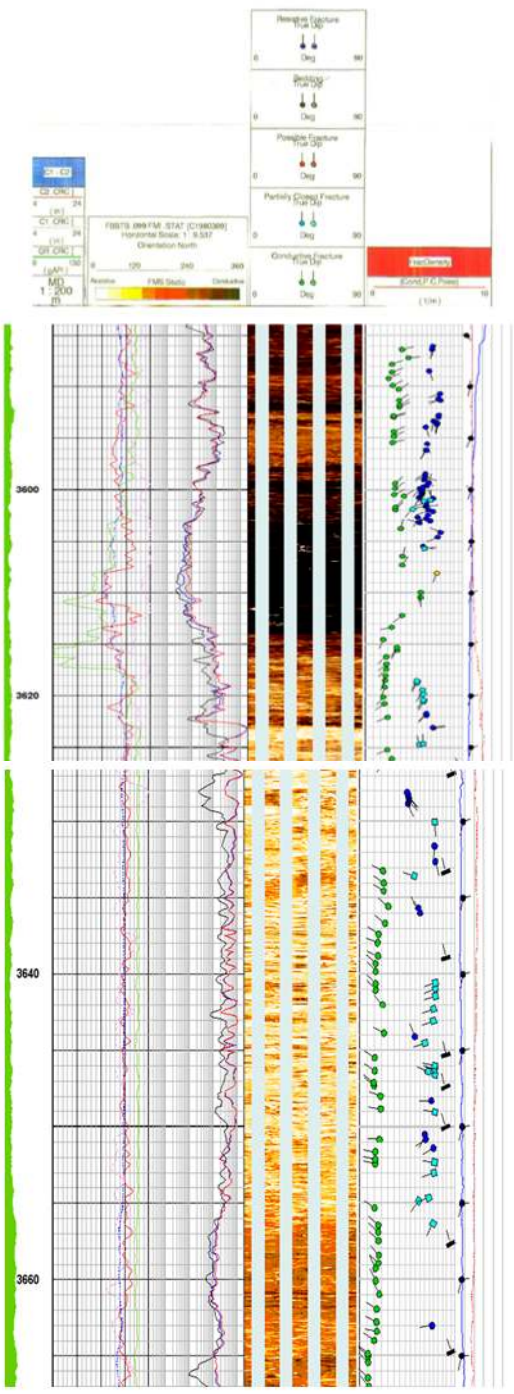


**Figure 2:** FMI Log of well X-2

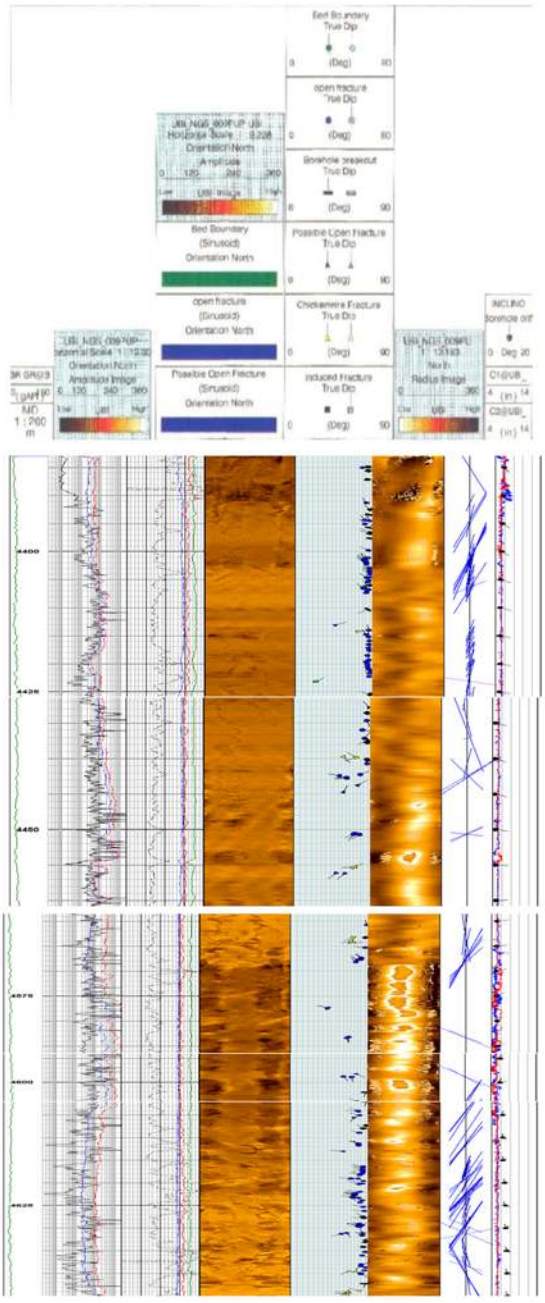

**Figure 3:** FMI Log of well X-3

- At a depth 4400-4425 ft, the Gamma ray log response is smooth, while UBI black colored curve response shows rising amplitude signal on the curve which is the indication of open fractures in the formation at certain depth.

## CONCLUSION

- Naturally fractured reservoirs are of extremely heterogeneous nature.
- The conventional logs are the important information sources and used at a large range of scales.
- Fracture characterization is straightforward technique.
- Formation micro image logs helps in reservoir characterization for better well design, well locations, well spacing on the basis of fracture density, fracture orientation and fracture distribution.
- FMI logs provide fracture identification, fracture direction and rock lithology whether strong or loose.
- Reservoir characterization is the key tool for future production operation and Reservoir Management.

## REFERENCES


- Khoshbakht F, Memarian H, Mohammadnia M. (2009). Comparison ofAsmari, Pabdeh and Gurpi formation.s fractures, derived from image log. J. Petrol. Sci. Eng. 67(1):65-74
- Movahed Z, Junin R, Safarkhanlou Z ans Akhbar M. (2014). Formation evaluation in Dezful embayment of Iran using oil-based-mud imaging techniques. J. Petrol. Sci. Eng. 121:23-37
- Movahed Z. (2007). Enhanced Reservoir Description in Carbonate and Clastic Reservoirs, Paper presented at the SPE Asia Pacific oil & Gas Conference and Exhibition, Jakarta, Indonesia
- Nelson RA. (2001). Geologic analysis of naturally fractured reservoirs 2th Edition, Houston; Texas, Gulf publishing company
- Nimmagadda SL and Dreher H. (2010). Ontology based warehouse modeling of fractured reservoir ecosystems for an effective borehole and petroleum production management, Paper presented at the 4th IEEE International Conference, Dubai

- Ozkaya SI and Mattner J. (2003). Fracture Connectivity From Fracture Intersections in Borehole Image Logs. Computers & Geosciences 29(2):143-153.
- Palmer ID and Sparks P. (1991). Measurement of Induced Fractures by Down-hole TV Camera in Black Warrior Baskin Coal-beds. SPE20660. J. Petrol. Tec. 270-275
- Song X, Zhu and Liao M. (1998). Identification and Distribution of Natural Fractures SPE50877, International Conference and Exhibition, Beijing, China, Nov. 2-6.
- Bell J.S. and Adams J. (1992). Attempts to Detect Open Fractures and Non-sealing Faults with Dip meter Logs. In: Hurst A. et al. (eds) Geological Applications of Wire line Logs II. Geological Society, London, England, 65:211-220.
- Guerreiro and Soares A. (2000). Integrated Reservoir Characterization of a Fractured Carbonate Reservoir SPE58995, Society of Petroleum Engineers International Petroleum Conference and Exhibition, Villahermosa, Mexico, Feb.1-3.
- Baker RO and Sztukowski D. (2000). Characterization of the Dynamic Fracture Transport Properties in a Naturally Fractured Reservoir, SPE59690, Society of Petroleum Engineers Permian Basin Oil and Gas Recovery Conference, Texas, USA, Mar.21-23.
- Kacewicz M. (1994). Model-free Estimation of Fracture Aperture with Neural Networks. Mathematical Geology 26(8):985-994.
- Aguilera R. (2003). Geologic and Engineering Aspects of Naturally Fractured Reservoirs, Canadian Society of Exploration Geophysicists Recorder (February), pp.44-49.
- Belfield W. (2000). Predicting Natural Fracture Distribution in Reservoirs from 3D Seismic Estimates of Structural Curvature, SPE60298, Society of Petroleum Engineers Rocky Mountain Regional Low Permeability Reservoirs Symposium, Colorado, USA, Mar.12-15.
- Quintero and Gupta A. (2001). Characterization of Naturally Fractured Reservoirs Using Artificial Intelligence, SPE67286, Society of Petroleum Engineers Production and Operations Symposium, Oklahoma, USA, Mar.24-27.