PS Natural Fracture Patterns in Fault-Related Folds in the Tight Sandstone Reservoirs, the Southern Margin of Junggar Basin, Northwestern China*

Guoping Liu[1,2] and Lianbo Zeng[1,2]

Search and Discovery Article #11192 (2019)**
Posted February 11, 2019

*Adapted from poster presentation given at AAPG 2018 AAPG Annual Convention and Exhibition, Salt Lake City, Utah, May 20-23, 2018
 DOI:10.1306/11192Liu2019

[1]Collegeof Geosciences, China University of Petroleum (Beijing), Beijing, China (liugpzy228@gmail.com)
[2]State Key Laboratory of Petroleum Resources and Prospecting, Beijing, China

Abstract

The spatial distribution and development of natural fractures in foreland thrust belts are extremely related to the structural styles and deformation strength of stratum. The southern margin of the Junggar Basin in northwestern China, bounded by the northern Tianshan orogen, has experienced four orogenies since the Permian, as indicated by the characteristics of Mesozoic–Cenozoic fault-related folds. Most hydrocarbon reserves in this area are stored in Jurassic and Cretaceous tight sandstone reservoirs, and natural fracture systems have a significant impact on the performance of such reservoirs. This paper focuses on the potential control that fault-related folds may exert on the fracture patterns using the data of outcrops, cores, image logging, and 3-D seismic. The research indicates that the characteristics of natural fractures show a clear relationship to the fault-related folds in both the outcrop and subsurface. In high curvature regions of folds, such as cores and forelimbs, fracture intensities are high, and fractures are short. In low curvature regions fractures have variable intensities and are longer. The dominant orientations of fractures vary in different regions of the fold. Fractures usually intersect the bedding planes at high angles, and some inclined fractures with a large scale are developed near the faults and the core of folds. The development degree of fractures decreases exponentially with increasing distance to the fault plane, and there is a fracture belt near the fault. These variations are also related to strain history of fault-related folds. Structures with longer deformation histories exhibit consistent fracture attributes, despite present day low curvature. This is in contrast to younger structures with similar curvature but shorter deformation histories. We suggest in high strain regions fracturing is influenced by structural styles, whereas in low strain regions lithology, layer thickness, and sedimentary facies become more important in influencing fracturing. Therefore, according to the structural positions, curvature, and strain characteristics, we divide the fault-related folds into six fracture domains. In the same fracture domain, the developmental characteristics of fractures have a strong similarity. The results of this study can help us to better understand the distribution of natural fractures in fault-related folds and reduce the uncertainty of fracture prediction in such reservoirs.

Natural Fracture Patterns in Fault-related Folds in the Tight Sandstone Reservoirs, the Southern Margin of Junggar Basin, Northwestern China

Guoping Liu [a,b] Lianbo Zeng [a,b]

a. College of Geosciences, China University of Petroleum (Beijing), NO.18 Fuxue Road, Beijing 102249, China

b. State Key Laboratory of Petroleum Resources and Prospecting, NO.18 Fuxue Road, Beijing 102249, China

Introduction

The spatial distribution of natural fractures in foreland thrust belts are extremely related to the structural styles and deformation strength of stratum. The southern margin of Junggar Basin in northwestern China, bounded by the northern Tianshan orogen, has experienced four orogenies since the Permian, as indicated by the characteristics of Mesozoic–Cenozoic fault-related folds. Natural fracture systems have a significant impact on the performance of such tight sandstone reservoirs. This study focuses on the potential control that fault-related folds may exert on the fracture patterns using the data of outcrops.

Geological Setting

The Junggar Basin in the northwest of China is a typical foreland basin and characterized by widely developed fault-related folds in the thrust belt of the southern basin. The Jurassic formation in the southern Junggar Foreland Basin contains rich natural gas resources, and is mainly composed of sandstone with a bury depth of more than 6000m, an average porosity of less than 6.0%, and an average air permeability of less than 0.5mD. Natural fractures are ubiquitous in these deep tight sandstone reservoirs, and are thought to play a fundamental role in the accumulation and production of natural gas in these reservoirs.

Figure 1. The outcrop section of the Badaowan Formation in the southern margin of Junggar Basin. According to the geometrical model of the fault-related fold, we divided it into six domains of A, B, C, D, E and F.

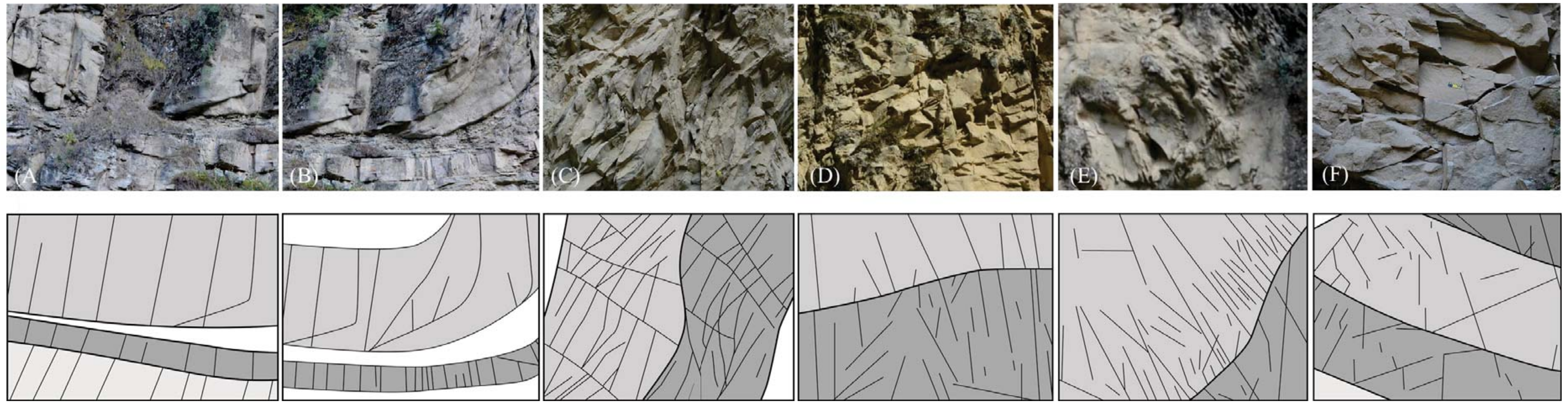

Figure 2. The fracture characteristics in six different domains of the fault-related fold in outcrops.

Methodology and results

This study is based on fracture characteristics at outcrops, with emphasis on the differences in different domains of the fault-related fold. According to the geometrical model, the fault-related fold can be divided into six domains of A, B, C, D, E and F. We studied the scale and density of natural fractures in different domains. The data on fracture parameters used in this paper were collected from observations and measurements on outcrops.

The research indicates that the characteristics of natural fractures show a clear relationship to the fault-related folds. In low curvature domains of folds, such as C and E, fracture intensities are high and fractures are short. In high curvature domains fractures have variable intensities and are longer, such as B and D. The development degree of natural fractures decreases with increasing distance to the fault plane. Two groups of shear fractures oblique to the fault are usually developed and they are generally conjugated but differ in development degree, such as F. In domains where no folds occur, the fractures are the least developed, such as A.

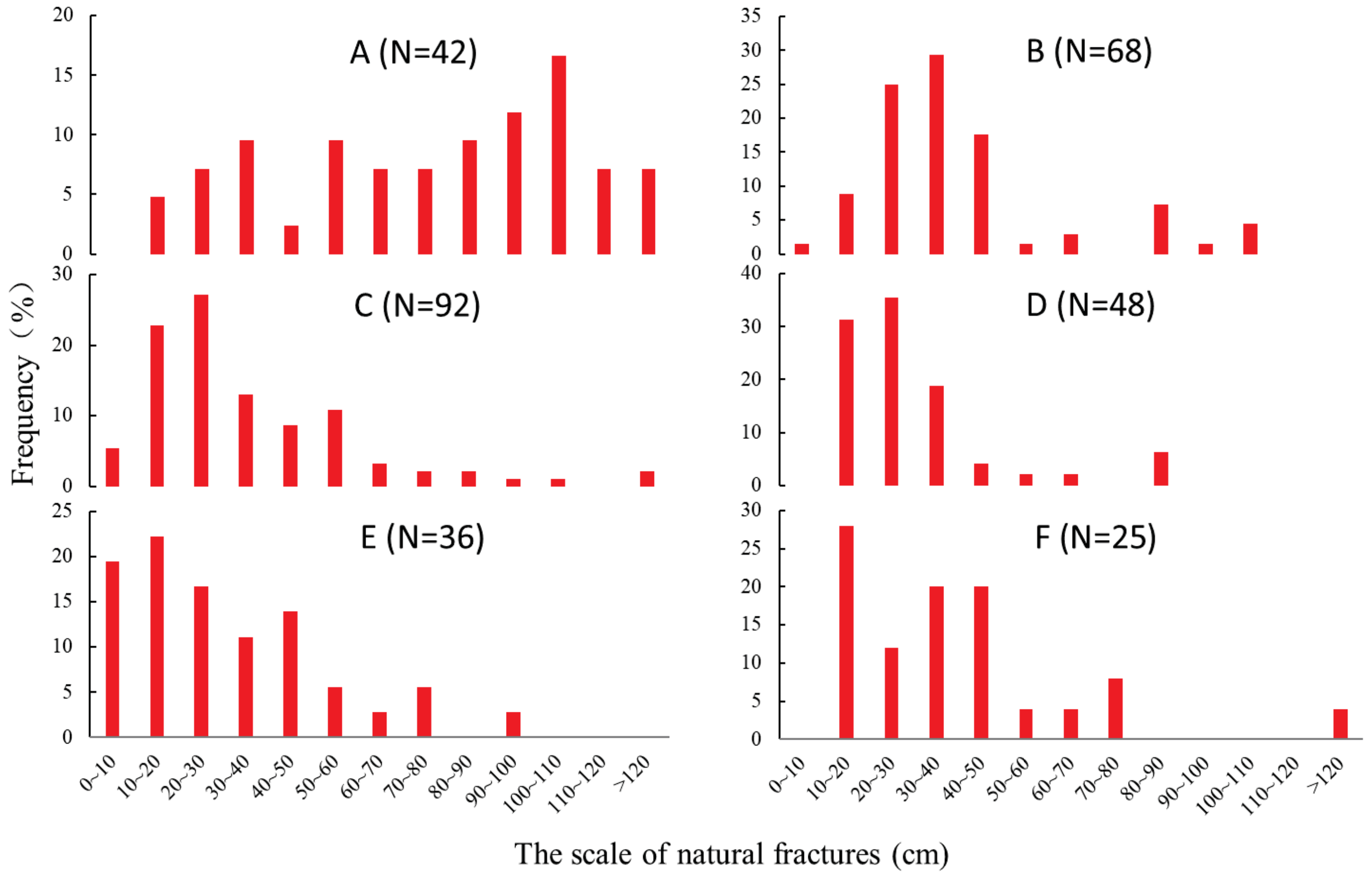

Figure 3. The scale of natural fractures in six different domains of the fault-related fold in outcrops.

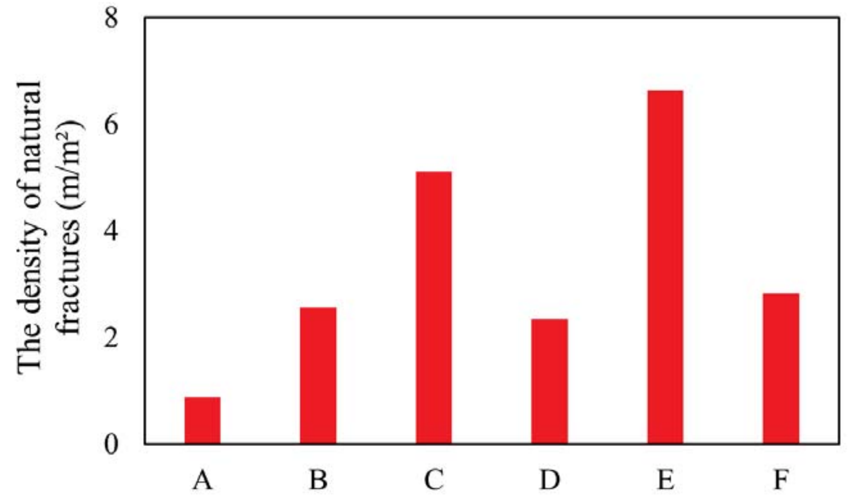

Figure 4. The density of natural fractures in six different domains of the fault-related fold in outcrops.

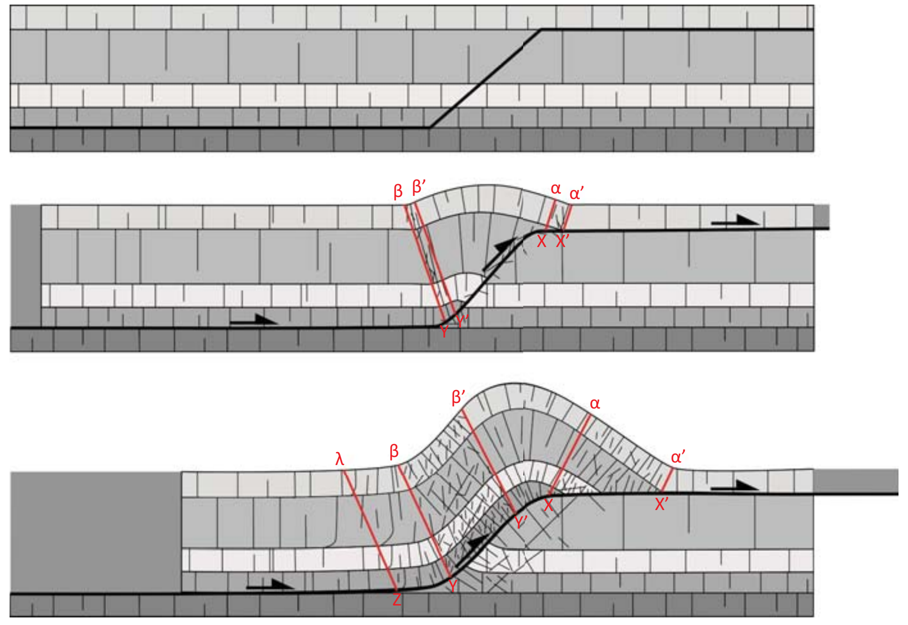

Figure 5. The natural fracture patterns in the fault-related fold in outcrops.

Conclusions

Therefore, according to the structural positions, curvature and strain characteristics, we divide the fault-related fold into six fracture domains. In the same fracture domain, the developmental characteristics of fractures have a strong similarity. The results of this study can help us to better understand the distribution of natural fractures in fault-related folds and reduce the uncertainty of fracture prediction in such reservoirs.