Integrating Borehole Imaging and Full Waveform Dipole Sonic Data to Estimate Fracture Porosity in Tight Formations: A Workflow for Accurate Characterization of Natural Fractures

Doina Irofti¹, Ghoulem Ifrene¹, Fethi Ali Cheddad², Safouane Djemai²

Search and Discovery Article #42582 (2023)**
Posted June 16, 2023

*Adapted from extended abstract based on oral presentation given at 2023 AAPG Rocky Mountain Section Meeting, Bismarck, North Dakota, June 4-6, 2023

**Datapages © 2023. Serial rights given by author. For all other rights contact author directly. DOI:10.1306/42582Irofti2023

¹University of North Dakota, Department of Petroleum Engineering
²University of Sciences and technology Houari Boumediene

Abstract

This paper introduces an integrated workflow that combines high-resolution electrical borehole imaging and full waveform dipole sonic data to estimate fracture porosity in tight formations. The study focuses on the Cambro-Ordovician tight sand reservoir in the Central Ahnet basin, Algeria. Three wells were selected for analysis to assess natural fractures using Formation Micro-Imager (FMI) images and Sonic Scanner data. The classification of fractures based on Sonic Scanner data resulted in the identification of 267 open fractures and 231 closed fractures. An advanced processing workflow was applied to estimate kinematic and hydraulic aperture, enabling the characterization of fracture porosity and identification of three sets of open natural fractures. Accurate fracture characterization is crucial for optimizing production and recovery in fractured reservoirs, and this study highlights its importance. The workflow demonstrated its applicability in estimating fracture porosity and provides valuable insights for reservoir management and development strategies. The results obtained from the application of the workflow in the Cambro-Ordovician tight sand reservoir showcase its effectiveness in enhancing reservoir performance.

Keywords:

Fracture porosity, Sonic scanner, Borehole imaging, Natural fractures.

References:


Integrating Borehole Imaging and Full Waveform Dipole Sonic Data to Estimate Fracture Porosity in Tight Formations: A Workflow for Accurate Characterization of Natural Fractures

Doina Irofti¹, Ghoulem Ifrone¹, Fethi Ali Cheddad², Safouane Djemai²

¹University of North Dakota, Department of Petroleum Engineering  
²University of Sciences and technology Houari Boumediene

Introduction

This paper introduces an integrated workflow that combines high-resolution electrical borehole imaging and full waveform dipole sonic data to estimate fracture porosity in tight formations.

The study focuses on the Cambro-Ordovician tight sand reservoir in the Central Ahnet basin, Algeria.

Three wells were selected for analysis to assess natural fractures using Formation Micro-Imager (FMI) images and Sonic Scanner data.

The classification of fractures based on Sonic Scanner data resulted in the identification of 267 open fractures and 231 closed fractures.

An advanced processing workflow was applied to estimate kinematic and hydraulic aperture, enabling the characterization of fracture porosity and identification of three sets of open natural fractures.

Accurate fracture characterization is crucial for optimizing production and recovery in fractured reservoirs, and this study highlights its importance.

The workflow demonstrated its applicability in estimating fracture porosity and provides valuable insights for reservoir management and development strategies.

The results obtained from the application of the workflow in the Cambro-Ordovician tight sand reservoir showcase its effectiveness in enhancing reservoir performance.

Objectives

The primary objectives of this study are as follows:

Investigation of the spatial distribution of fractures and their influence on reservoir parameters.

Identification and characterization of open fractures that play a significant role in enhancing productivity in the vicinity of the wellbore.

Characterization of the natural fracture sets within the study area, encompassing crucial parameters such as dip, azimuth, aperture, and porosity.

Area of Investigation

The Ahnet basin is part of the Western province of the Saharan Platform, Southern Algeria. It is primarily a gas province in terms of petroleum system, and its reservoirs under the Paleozoic sedimentary layer are mostly compact.

Methodology

In order to distinguish between open and filled fractures, fast and slow shear dispersion plots were utilized, providing additional insights into the characteristics of the fractures. Anisotropy, or directional variation in the elastic properties of rock, can occur due to fractures present in rock formations. The varying velocities of shear waves in different directions through the rock are caused by acoustic anisotropy. By integrating this technique with image logs, the fractures were differentiated as either open or closed.

Results

In the study, 426 resistive fractures were discerned. To retrieve high confident and reliable data, and in absence of cores, Sonic Scanner tool was integrated and 267 open fractures were recognized.

The natural open fractures are oriented N140, which correspond to the direction of the maximum horizontal stress.

This workflow allowed for an accurate estimation of fracture porosity.

Conclusions

• 426 resistive fractures were discerned.
• To retrieve high confident and reliable data, and in absence of cores, Sonic Scanner tool was integrated and 267 open fractures were recognized.
• The natural open fractures are oriented N140, which correspond to the direction of the maximum horizontal stress.
• This workflow allowed for an accurate estimation of fracture porosity.

References