Discrete Fracture Network Modeling Based on Seismic Data, Logs, Drilling Losses, Production, and Outcrop Data - Ujung Pangkah Field*

Stephen Smart[1], David Sturrock[1], and Azalea Hidayat[1]

Search and Discovery Article #120090 (2013)*
Posted January 29, 2013

*Adapted from extended abstract prepared in conjunction with poster presentation at AAPG Hedberg Conference, Fundamental Controls on Flow in Carbonates, July 8-13, 2012, Saint-Cyr Sur Mer, Provence, France, AAPG©2012

[1]Hess Indonesia, Jakarta, Indonesia (stephensmart@earthlink.net)

Abstract

The Ujung Pangkah Field is a lean gas condensate field with an oil rim located within the Pangkah PSC just offshore East Java. The field was discovered in 1998 and appraised with two further wells and a sidetrack in 2000. To date, over 40 development and pilot wells have been place in this Miocene Kujung Formation. The data collected from drilling, logging and producing these wells, in conjunction with the seismic field data provides the key to understanding the complex fractured carbonate system. Pangkah is comprised of a fractured and diagenetically enhanced limestone with good to excellent matrix reservoir quality. Ultimate recovery of both oil and gas are affected by water influx from a bottom drive aquifer. Understanding how faults and fractures connect the production wells to the aquifer will help increase field recoveries.

Introduction

Data from wells in the field provide good evidence of the presence and effect of the fault and fracture system. During drilling of the wells, faults encountered in the wellbore cause significant losses of drilling fluid. These losses clearly show the transmissibility of the faults and correlate with distinct breaks on the log curves, specifically the resistivity and neutron/density. Image logs corroborate location and intensity of the fault and fracture networks. Pressure measurements at specific points along some horizontal wellbores show a clear increase in pressure away from faults. This indicates a pressure sink caused by production from other wells producing fluids from the same faults. Several wells in the field with faults in the production section show almost immediate liquid production even though they are positioned over a hundred feet above the fluid contacts. The production history of wells in the field often show distinct step increases in water production. This behavior is indicative of production channeling up the faults.

Discussion

In order to understand the impact of early water breakthrough on ultimate recovery and to make important decisions on development and workovers opportunities, static and dynamic models can be used. The method and workflow for building the models is a function of the available data set. 3D seismic data where faults and lineaments can be interpreted plays a significant role in the distribution of the fractures. More than twenty horizontal wells with high-resolution image logs act like mini outcrops. Interpretation of this data helps us understand the complex nature of the fault and fracture distributions. The log and image data make it possible to consider the different drivers (mechanical and/or lithologic) that were instrumental in development of the subsurface fractures. The horizontal production wells at Pangkah intercept fractures within most of the sequence stratigraphic layers and across different facies (Figure 1). This data is a key factor in the workflow and process of the fracture network modeling.

Results

Even the best reservoir data does not directly provide model components like shape and height of the fractures. Outcrop studies of fault and fracture networks also contribute to the development of concepts for the subsurface fracture model. Ultimately, the combination of interpreted data and conceptual models must be integrated in order to create a three dimensional distribution of fracture intensity (Figure 2). The intensity model results are routinely examined to make sure they reflect the expected outcome based on the real and interpreted data. This fracture intensity model, along with the outcrop observations of height and length of fractures are combined to build a discrete and/or implicit fracture network. The discrete networks are again visually inspected and matched to the reservoir data in order verify the modeling parameters. At Pangkah, a number of different input variables were adjusted to obtain the final desired model. Working at a fine (geologic) scale, most of the fractures at Pangkah can be modeled as discrete. In order to generate a coarse scale dynamic model, the fracture distribution becomes implicit. We are currently in the process of combining the seismic, image, and outcrop data with the assumptions used in the discrete model, to generate a comparable implicit model at the coarse scale.

Conclusions

This presentation demonstrates how we are attempting to use robust data sets at various scales to construct a dual porosity model for the Pangkah Field. The model is currently being tested via simulation and is expected to be the primary tool for performance prediction and recovery estimation.

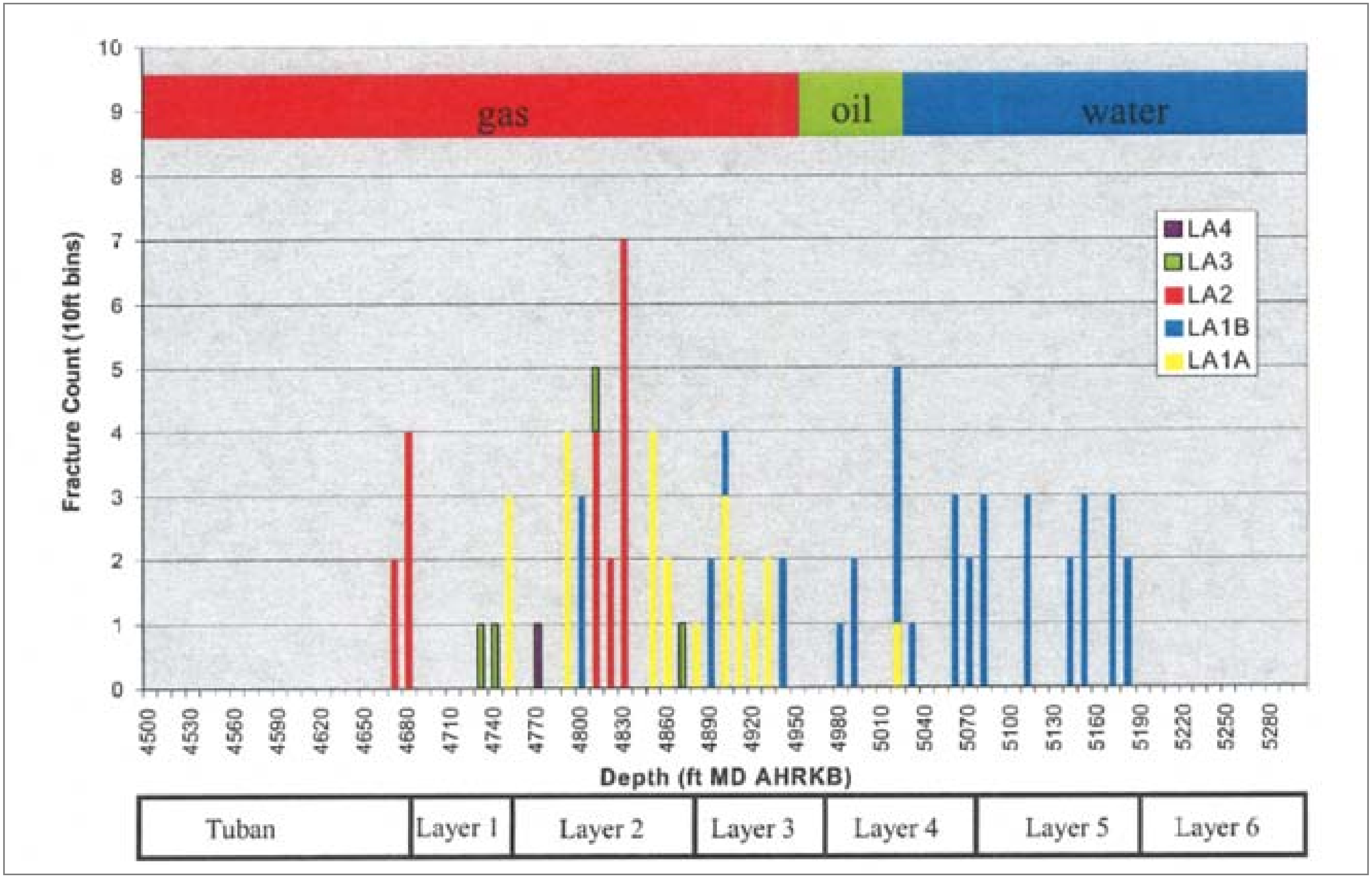

Figure 1. Example using image log data to identify the fracture distribution drivers.

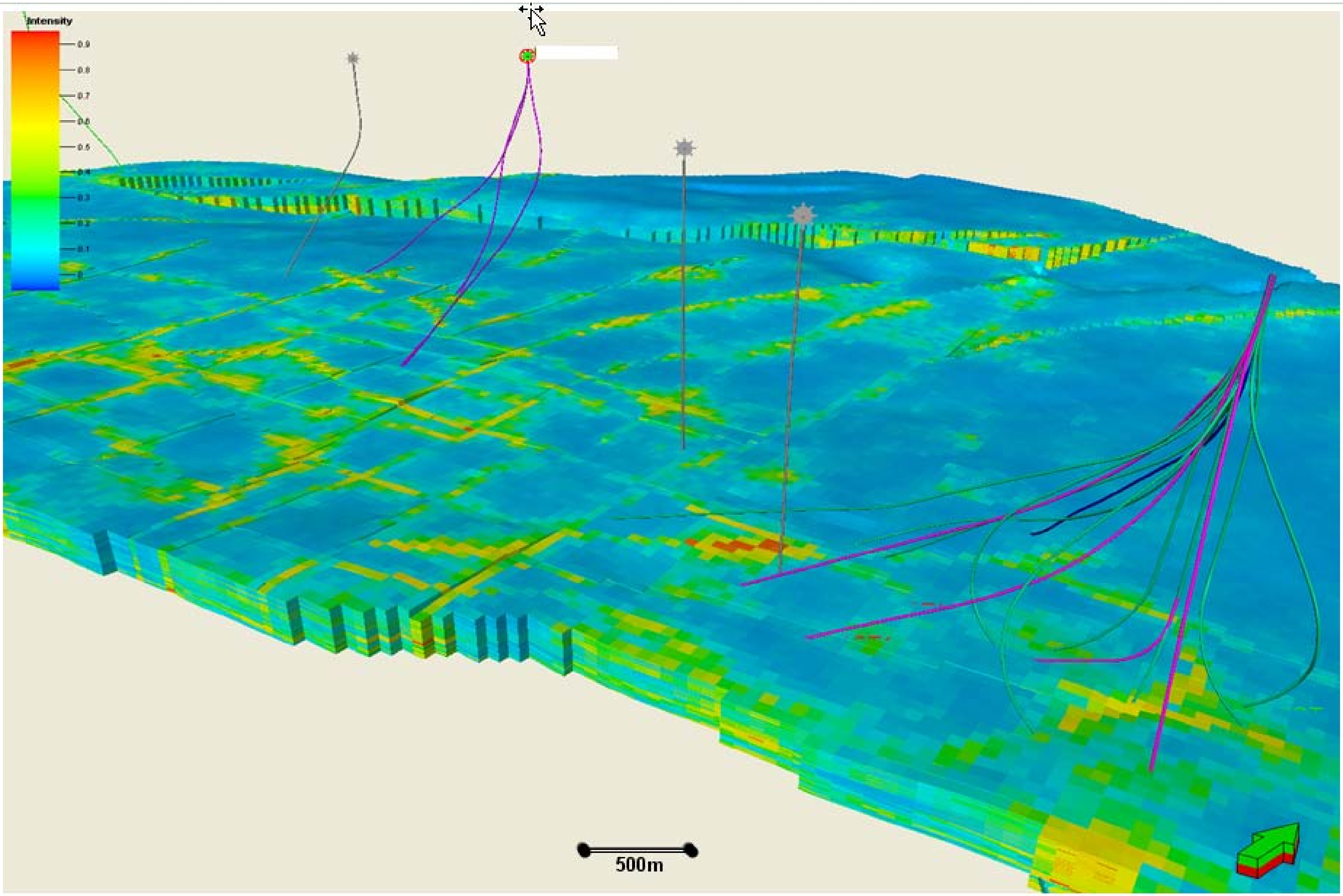

Figure 2. Fracture intensity distribution based on log and seismic data.