PORE PRESSURE PREDICTION AND LATERAL STRESS DETERMINATION FOR AN EXPLORATION WELL, A CASE STUDIES

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ABSTRACT

Pore pressures trend are different in certain areas. This is due to the geological factor that took place over the geological time. Most of the hydrocarbon reservoir are lies beneath the thick sedimentary shale that are not hydrostatic pressure, instead they are an abnormal pressures especially for deep water sedimentary with small margin mud weight window. If the abnormal formation pressure are not accurately predicted prior to drilling, there will be a catastrophic incidents not only asset to the investor but also to the offshore worker life. Occurrences of abnormal pore pressure came from several geological factor that could be cause to various elements either from small scale i.e. minerals to the formed of mega structure or area. At present, more and more energy companies are investing billions of dollars in exploration to the new frontier and challenging harsh areas to find the oil and gas. Exploration becomes more challenging in this new frontier area, still technology are far behind due to natural complexity. This study analyses the outcome of one exploratory well for pore pressure prediction, fracture gradient and overburden gradient by using Drillworks© software. Eaton's and Bower's method were used with the integration of all relevance data to understand what are the pore pressure model compaction history and lateral stress determination exist. The method was tested in the Western Australia Field in the Western Australia Sea, where the field possibly dominated by normal faulting stress state ($S_V > SH_{max} > Sh_{min}$). Results suggest that the Bower's sonic method with gave better results for the area than the Eaton resistivity method.

ABSTRAK

Tekanan liang dibawah muka bumi adalah berbeza di sesetengah tempat. Ini disebabakan faktor geologi masa lampau yang bertindak terhadap masa .Kebanyakkan takungan hidrokarbon konventional terletak dibawah batuan syal yang tebal berkemungkinan bukan tekanan hidrostatik.Malah mempunyai tekanan tidak normal terutamanya bagi sedimen pengenapan laut dalam. Jika tekanan formasi tidak normal at jangkaannya secara tepat sebelum penggerudian sesuatu telaga Berkemungkinan bencana akan menimpa bukan sahaja kepada aset pelabur malahan pekerja pelantar minyak.Pembentukkan tekanan liang tidak normal ini disebabkan dari faktor geologi yang datangnya dari beberapa elemen dari sekecil mineral sehinggalah ke struktur mega berlaku setempat. Pada masa sekarang kebanyakan syarikat minyak dan gas melabur bilion dolar dalam eksplorasi di persempadanan yang lebih mencabar, teknologi masih lagi tidak dapat mengatasi kawasan yang mencabar ini.Projek ini adalah untuk menganalisa hasil dari satu perigi eksplorasi untuk menentukan tekanan liang formasi, kecerunan patahan batuan dengan menggunakan perisian Drillworks©. Cara Eaton's dan Bower's telah digunakan dan kesemua data data yang relevan untuk mengetahui sejarah kompaksi pengenapan dan arah tekanan sisi yang mendominasi di sekitar kawasan kajian. Cara ini telah digunakan di lapangan barat Australia di lautan barat Australia,dimana berkemungkinan didominasi oleh tekanan sesaran normal (S_V> SH_{max} >Sh_{min}). Keputusan menunjukkan cara penggunaan sonic Bower's lebih baik dan tepat dikawasan kajian berbanding dengan cara rintangan Eaton's

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LIST OF ABBREVIATION

CSG	Casing
DT	Delta T Sonic Logging
FG	Fracture Gradient
GR	Gamma Ray readings, API
LOT	Leak off Test, ppg, psi
LWD	Logging While Drilling
MDT	Modular Formation Tester
MW	Mud Weight (ppg)
nct/NCT	Normal Compaction Trend
OBG	Overburden Gradient
POR	Porosity
PP	pore pressure. Psi, ppg, s.g.
RES	Resistivity reading, ohmm
RFT	Repeated Formation Tester
RHOB	Density (g/cc)
ROP	Rate of Penetration
SH_{max}	Maximum principal stress Mpa, psi
Sh_{min}	Intermediate principal stress Mpa, psi
SHPT	Shale Point
S_v	Vertical stress, overburden stress Pa, Mpa, psi, s.g.
TG	Total Gas (%)
Vint	Velocity Interval (m/s)
Wl/WL	Wireline

LIST OF SYMBOLS

A	Curve fit parameter for Bower's equation.
α	Biot constant
ρ	Density, g/cc, sg, ppg
V	velocity, ft/s

CHAPTER 1

INTRODUCTION

Drilling for hydrocarbon becomes more challenging because operator have to go to more challenging environment and hence drilling and overpressure zones are critical and important within petroleum industry. Drilling success, safety and reservoir depletion history are all affected by the presence overpressure strata Pore pressure studies have been a key consideration in well design; both from well design and well deliverability perspective (formation pressure estimation and fracture gradient). When an abnormal formation a pressures are present in a deep section well ,intermediate casing is set to protect formations below the surface casing from the pressures created by the drilling fluid specific mud weight required to balance the abnormal pore pressure (Rahman et al, 1995) . Casing design and mud weight designs are planned according to the estimated pore pressure and in the absence of direct pressure measurements, pore pressure estimation becomes even more critical in the delivery of safe, cost effective and potentially productive well. If the mud weight is not adjusted for the correct pore pressure, unwanted events like kicks, wellbore instability losses can occur, which may result in nonproductive time and or even blowouts.

A good estimate of pore pressure is also crucial to avoid wellbore instability problems like borehole breakouts and induced fractured. This research project is a case studies for the post mortem drill well for pore pressure determination.

1.1 Problem Statement

D-1 vertical exploration well was spudded in 2011 located federally regulated block offshore Western Australia .The water depth ranges from 100 – 130 m in Bonaparte Basin Offshore Western Australia with uncertainty in pore pressure profile due to the thick carbonate below the mudline and believed to be normal hydrostatic at the target reservoir depth.

The well was designed to target Jurassic sandstones in a multi culmination structure of the Malita Graben and was drilled at the bathymetry of 109.3 m with semi –submersible drilling rig.

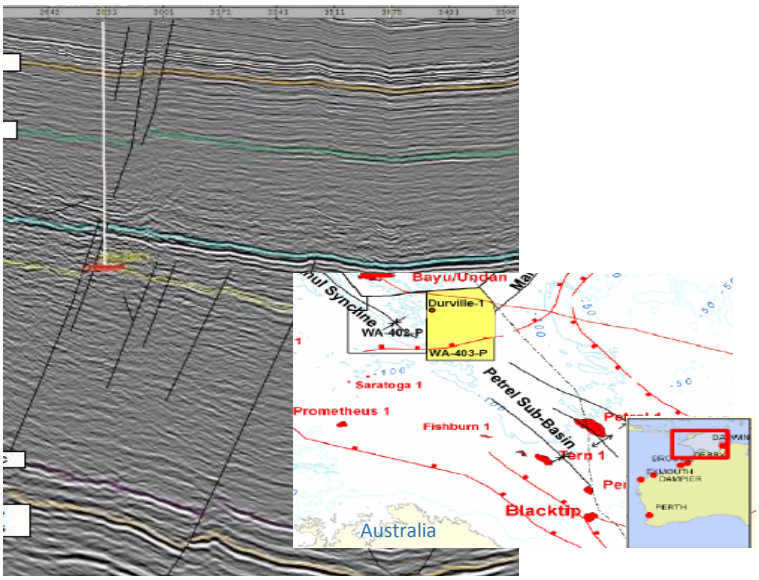

Figure 1.1: D-1 location in Western Australia

1.2 Objective

Objective of this study is to have better understanding on pore pressure behavior, faults and lateral stresses present and how the pore pressure prediction method used to determine for a pore pressure prediction. This study will gave a better understanding as per below:

a) Build a new model of pore pressure in the study area
b) Determining formation fracture gradient
c) And to identified stress magnitude distribution over the areas

Pore pressure prediction for this study area are analyses by using Drillworks© software version 5000. Drillworks© software is set of 1D tools for analysis used for pore pressure prediction (PPP) and Wellbore Stability Analysis (WBS) .It is referred to as 1D tool because it analyses Wellbore Stability (WBS) and Pore Pressure based on True Vertical Depth (TVD) information along the well path to be precise . Drillworks software is based on linear elastic theory and the 2D plane strain conditions (Xinpu et al, 2012) Modular Formation Dynamic Test (MDT), from the well in concern will be used to evaluate the improvement in pore pressure.

The workflow implemented to analyze and ultimately to build the best pore pressure and fracture gradient prediction is outlined below. This workflow was performed with only one exploration well within the block:

1 Identify, acquire and review offset well data including;

- Petrophysical data
- Drilling records
- Measured pressure data

2. Construct pore pressure prediction model using petrophysical data.
3. Include offset well data in the pore pressure prediction model.
4. Calibrate pore pressure prediction model, if necessary.
5. Analyze pore pressure prediction model against data obtained from reviewing drilling records and select or develop an accurate pore pressure prediction model.
6. Construct fracture gradient prediction model using an accurate pore pressure prediction model.
7. Analyze fracture gradient prediction model against data obtained from reviewing drilling records.

1.3 Scope of Study

In this study, data from one exploration well were compiled altogether covering from well data to world stress map and other literature study to build new pore pressure model and to determine the horizontal stresses that governed over the study area. By using Drillworks© pore pressure prediction Software from Halliburton the new pore pressure model were built and correlated with other offset well. Two method were used to distinguish the pore pressure model. Both are Bower's Sonic and Eaton's resistivity method. Near wellbore stress, Fracture Gradient and Overburden Gradient were also determined. This study also covered the Stress classification over the area by using Anderson Stress classification and other data from World Stress map.

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