Exploration Geophysics (2004) ***35****, 217–223*

In-situ stress field and fault reactivation in the Mutineer and Exeter Fields, Australian North West Shelf

Adrian White[1] **Richard Hillis**[2]

Key Words: Mutineer and Exeter fields, in-situ stress field, geomechanical modelling, fault reactivation, Australian North West Shelf

ABSTRACT

This study evaluates the in-situ stress field and the potential risk of fault reactivation and seal breach in the Mutineer and Exeter fields, Australian North West Shelf. Stress determinations are undertaken using pumping pressure test, rock mechanical, and log data from twelve wells. Subsequent geomechanical modelling uses the stress data to assess pore pressure changes that may induce slip on mapped faults cutting the region.

The principal stresses are assumed to be the vertical stress (S_V), and a maximum and minimum horizontal stress, S_H and S_h respectively. Borehole breakouts and drilling-induced tensile fractures (DITFs) interpreted from image logs indicate S_H has an average orientation of 107°N and S_h is orientated 017°N. Leak-off test data compiled from well completion reports reveal the magnitude of S_h increases with depth at a rate of 17.1 MPa/km. Density log data show S_V can be approximated by a power law function. An upper bound to S_H is calculated using the frictional limit to stress beyond which faulting occurs when using a frictional coefficient of 0.6. Better constraints on the magnitude of S_H are gained using rock mechanical data, knowledge of S_h and S_V, mud weights, and the occurrence of borehole breakouts and DITFs. Stress magnitudes show that the tectonic regime is strike-slip ($S_h < S_V < S_H$).

The likelihood of fault reactivation in Mutineer-Exeter is expressed as the increase in pore pressure required for fault slip. Results show that faults are non-optimally orientated for reactivation by the stress field. The likelihood of brittle seal failure due to fault reactivation is low, primarily because of non-optimally orientated faults. The creation of new faults requires greater increases in pore pressure than reactivation and is thus seen as being more unlikely. The results have implications for seal integrity, well bore stability, and the safe and successful production of the fields.

INTRODUCTION

During the life of hydrocarbon fields, brittle failure of reservoirs and rocks in their vicinity may arise. A well-documented example of such failure occurred during the production of the Ekofisk Field in the Norwegian North Sea (Teufel et al., 1991). Brittle failure can have positive implications for production, namely the increase in fracture permeability thus aiding the extraction of hydrocarbons. However, pore pressure (P_p) drawdown can have negative effects. Reducing pore pressure may induce casing failure with the results being well bore destabilisation and damage to production infrastructure (Streit and Hillis, 2002).

Quantification of the in-situ stress field and geomechanical analyses conducted on faults is undertaken for the Mutineer and Exeter fields. The fields are located within the Carnarvon Basin on the Australian North West Shelf (Figure 1). Exeter lies approximately 150 km N of Dampier in Western Australia while Mutineer is located a further 10 km to the NE. Both fields are situated on the NE–SW trending, fault bounded, Rankin Platform. The reservoir unit is the Jurassic-age Angel Formation, the top of which occurs at approximately 3100 metres TVDSS. The orientations and magnitudes of the in-situ stresses are determined using data from 12 vertical pre-production wells drilled between 1978 and the end of 2002. Stress orientations are resolved from borehole breakouts and drilling-induced tensile fractures (DITFs) seen on image logs (Figures 2 and 3). These features show the orientation of the maximum and minimum horizontal stresses, S_H and S_h. Pumping pressure test and wireline log data quantify the magnitudes of the minimum horizontal stress and the vertical stress while a combination of modelled and measured data constrains the maximum horizontal stress.

The threat of damage to wells and the reservoir can be minimised by considering the critical changes in pore pressure likely to cause reactivation of existing faults or the creation of new ones. Geomechanical modelling is undertaken to assess the risk of reactivation of faults cutting Mutineer-Exeter. Modelling

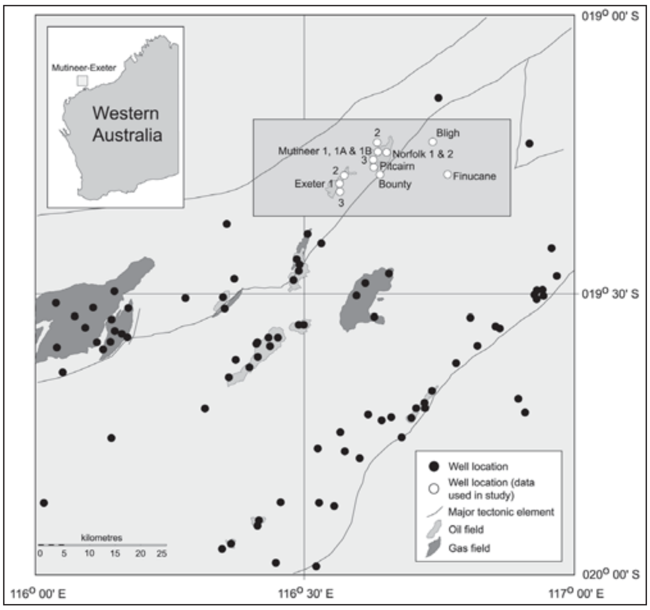

Fig. 1. The location of the Mutineer and Exeter fields.

[1] *Australian School of Petroleum*
The University of Adelaide
SA 5005, Australia
Tel: +61 8 8303 4293
Fax: +61 8 8303 4345
Email: awhite@asp.adelaide.edu.au

[2] *Australian School of Petroleum*
The University of Adelaide
SA 5005, Australia
Email: rhillis@asp.adelaide.edu.au

Manuscript received 23 January, 2004
Revised manuscript received 1 July, 2004