DISCRETE ELEMENT STRESS MODELLING IN THE OTWAY BASIN, AUSTRALIA

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Rock stress can only be measured at local points in space but determination of the state of stress in large rock masses is affected by heterogeneities, most significantly faults and horizon boundaries. Faults and horizon boundaries can greatly affect the magnitude and orientation of the in-situ rock stress state. The effect of heterogeneities on the rock stress state has been the study of many field and numerical modelling studies. There exist various numerical techniques to model heterogeneities in a rock mass, such as the finite element method (FEM), coupled FEM and boundary element method (BEM) and finite difference method (FDM). These methods are difficult to apply when there are numerous fractures. The discrete element method is specifically designed to solve fracture problems.

UDEC (ITASCA) a 2-D discrete element code has been used in this study to model stress perturbation around three simple fault configurations: 1) single inclined fault, 2) a bridged step-over fault and 3) dilational jog, each modelled in an elastic homogeneous rock mass. The results show rotation in the principal stress orientation and stress magnitudes of the regional stress field about the faults. The degree of rotation of the principal stress direction and the stress magnitude are dependant on the fault friction angle parameter, the angle of maximum principal stress to the fault plane and the ratio of maximum to minimum principal stress. The degree of perturbation is demonstrated graphically in the surrounding rock mass along the fault strike, the perturbation generated by the fault can be up to 1.4 times the magnitude of the maximum principal regional stress.

Also, results of a sensitivity analysis study, show that the location and magnitude of regions of minimum principal stress or 'stress lows', in fault configurations 2) and 3), is highly dependent on the fault friction angle parameter.

In the Katnook graben area there are 4 gas fields full-to-spill, 4 partially breached and one fully breached accumulation (Boult et al., 2002). By applying a simple 2D model (Fig 1), in which the major graben bounding faults are assumed to 1/ be less strong than their host rocks and 2/ perturb stress trajectories in accordance with previously described numerical modelling, the location of zones of high stress appear to coincide with breached and partially breached hydrocarbon accumulations.

Reference

BOULT, P.J., CAMAC, B.A. AND DAVIDS, A.W. 2002-3D Fault modelling and assessment of top seal structural permeability – Penola Trough, onshore Otway Basin. Australian Petroleum Production and Exploration Association Journal, 42 (1), 151- 166.

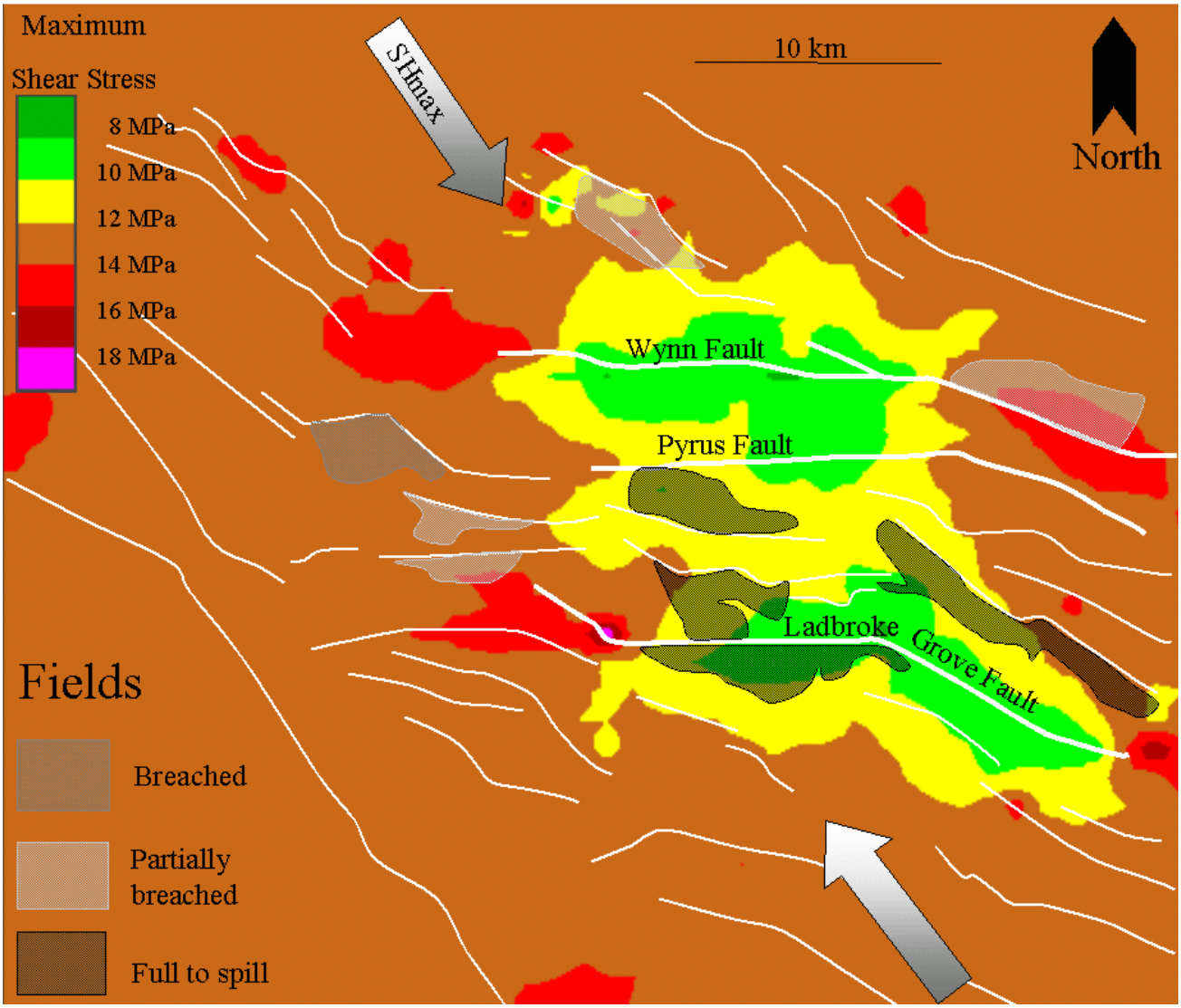

Figure 1: Predicted shear stress perturbation generated by faults within the seal to the top Pretty Hill reservoir : Penola Trough, Onshore Otway Basin