NATURAL FRACTURE PREDICTION FOR FAULTING AND FOLDING WORKFLOW: TEAPOT DOME CASE-STUDY

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ABSTRACT: Oil & Gas companies are greatly dependent on producing oil and gas from fractured reservoirs. Therefore, modelling 3-D fracture network has become a critical step for fluid flow simulation as fracture can act as a conduit or a baffle. It is thus critical to evaluate and model fracture orientation and intensity near but also away from boreholes for realistic Discrete Fracture Network creation. In this study, an emphasis is put on fracture related to faulting and bending as the main mechanisms controlling the natural fracture distribution. We developed an integrated workflow that uses geomechanics principles to model fractures related to these two mechanisms. This integrated workflow is made of two main components corresponding to fractures related to bending and faulting. To model fractures related to folding, we used here a 3-D geomechanical restoration tool to first model the structure and then to unfold and unfault the geological model at various time steps to model the corresponding stress-strain distribution. The computed stress-strain distributions are used with a fracture criterion to estimate fracture orientation (strike and dip) and intensity in a 3-D grid that are related to bending. To model fracture related to faulting, a geomechanical based stress inversion is used to recover the far field stress under which fractures have developed in response to faulting. Once far field stress is recovered, a forward simulation allows to compute the stress and strain distribution controlled by faulting and the far field stress. As for bending, fracture orientation and intensity can be inferred from the stress-strain field distribution in a 3D grid. Both methods include iterative procedures to fit with the observed data along wells and to calibrate the fracture intensity with the measured fracture intensity along wells. Fracture orientation and intensity for each mechanism are used to condition a discrete fracture network related to faulting and bending in turn. This integrated workflow was applied on case study in the Teapot Dome structure, Wyoming ,USA. The teapot dome can be described as a seismic scale asymmetric anticline. This structure is intersected by several seismic-scale faults. The available data are interpreted seismic horizons and faults as well as interpreted FMI from 3 borehole data. As result we got a model with the stress distribution within the fold together with the optimal fracture inferred from the stress field. The maximum stress magnitude is the lowest at the crest of the dome while higher at the bottom of limbs, which is a typical distribution within a fold. Also it's possible to analyze the maximum compressive stress distribution around the faults for the best far-field stress. These attributes are used to condition discrete fracture network related to faulting and bending.

KEYWORDS: GEOMECHANICAL RESTORATION, STRESS INVERSION, NATURAL FRACTURES, FRACTURE MODELLING, STRUCTURAL GEOLOGY, PETROLEUM GEOLOGY