



## **Borehole Deformation and Failure in Anisotropic Media**

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Borehole breakouts develop due to compressive shear failure along the borehole wall and subsequent spalling of near wellbore rock. These compressive shear failures can occur during drilling and lead to a borehole enlargement in the direction of the minimum horizontal stress. In order to investigate the initiation of borehole breakouts in anisotropic media a numerical analysis of the borehole deformation has been performed. The numerical model is based on an extensive geophysical and geomechanical dataset, provided by BHP Billiton Petroleum. This dataset was established during the development and production phase of an oil reservoir on the North West Shelf, Western Australia. The aim of this study is to estimate the severity of the influence of anisotropy on the breakout process. It is proposed that there is a hierarchy among the possible influences on the breakout process:

1. The regional stress field has a first order effect on the borehole breakout direction.
2. This is followed by a preferential fracture direction or anisotropic failure criterion of the medium.
3. And finally the elastic anisotropy of the medium affecting the local stress field around the borehole.

A clear separation of these influences through methods of observation is not always trivial. Firstly, the preferential fracture direction and the elastic anisotropy, at least to some degree, are functions of the regional stress field. Secondly, most of the knowledge we have about the regional stress field in relatively aseismic regions is inferred from borehole breakout data. Therefore a numerical simulation is chosen as a method of study. Material properties like elastic anisotropy or failure criterion and even their dependency on the stress field can easily be manipulated.

This geophysical and geomechanical data is used to populate the numerical model. The regional stress field is implemented as a boundary condition. The commercial Finite Element package ABAQUS is used to obtain the stress / strain field around the borehole. The resulting borehole deformation and failure are compared with data from a six-arm caliper and an acoustic Circumferential Borehole Imaging Log (SM Baker Hughes). We can show that the elastic anisotropy derived from the shear wave splitting, in our field example, is not strong enough to significantly affect the fracture process. Further parametric studies were conducted to prove the proposed hierarchy. We would like to thank the BHPB geoscientists in the Perth office for helpful discussions.