# Borehole Stability in Deep Bedding Formations

Wang Z.Q.[1,2], Ding L.Q.[1,2], Yang J.[1,2] and Liu B.L.[1,2]

[1]School of Engineering and Technology, China University of Geosciences (Beijing), Beijing 100083, China, zqwang@cugb.edu.cn
[2] Key Laboratory of Deep Geodrilling Technology, Ministry of Land and Resources, Beijing 100083, China

The existence of bedding planes has crucial influence on wellbore stability that is because it can result in anisotropic strength in rocks around the well. Firstly, three analytical models considering strength anisotropy of rocks are discussed and compared in this paper. Former theories are first illustrated in which the prime model is modified to emphasize the randomness of in-situ stress directions. In this process, the Hoek-Brown and Mogi-Coulomb criteria were selected to estimate the strength of a rock matrix after comparison. And the deviation of stress calculated by the “Kirsch equation” around a borehole was also analyzed, which shows that this deviation will affect the calculation of the failure area but has little effect on the collapse pressure. Furthermore, the applicability and accuracy of each model are compared in several real field cases. It reveals that the model based on the circumferential stress can predict that the collapse region extends perpendicularly to the beddings around a borehole but fails to predict the correct collapse pressure in many cases because of the exchange of principal stresses on the borehole wall. The model based on “attack angle” is also not precise enough for only taking the effects of beddings into account without considering the in-situ stress. The fracture pressure of the borehole considering strength anisotropy of rocks was further studied and was incorporated to obtain a recommended model for the safe mud weight window calculating.

Secondly, this paper develops a two-dimensional model to analyze the breakdown process of a preexisting fracture (along the bending plane) intersecting a pressurized wellbore. It is assumed that the wellbore fluid penetrates the fracture only in the part where the fracture is open. This problem is solved semi-analytically by making use of the exact elastic solution of a finite dislocation, which satisfies homogeneous boundary conditions at the borehole and at infinity. The results show that the breakdown pressure is strongly dependent on fracture toughness of the bedding plane but also on the mode of loading. The model also shows that the use of Kirsch's solution to predict the breakdown pressure is only valid if the fluid does not penetrate the fracture. This work has application not only to wellbore stability, but also to stress measurements.