Problem 1 (60 points)

While drilling and logging a highly deviated well in the direction of S_{Hmax}, you begin to notice breakouts in excess of 30°. Wanting to take an extremely conservative approach you decided to adjust the trajectory of the well as you are already drilling with a mud weight close to the frac gradient (i.e., stabilizing the well with increased mud weight will lead to drilling induced tensile fractures and lost circulation). What could you do to prevent breakouts in excess of 90°? Support your recommendation with an explaination and figures.

Below are the reservior characteristics. You can assume a Mohr-Coloumb failure criterion with an unconfined compressive strength of the rock of 145 MPa and an internal friction of $\mu_I = 1$. The Poisson ratio is $\nu = 0.2$.

$S_{Hmax} = 145$ MPa in the direction N30°E

$S_{hmin} = 125$ MPa

$S_v = 70$ MPa

$P_p = P_m = 33$ MPa