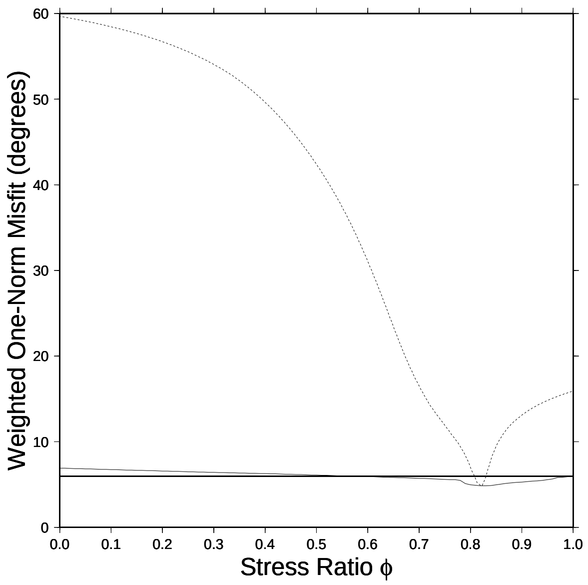

Figure 16. Plot of the weighted one-norm misfit for the Point Pedernales data as a function of ϕ, where the thick solid line is the 95% confidence limit (5.96°), the thin solid line is the minimized misfit when ϕ is held constant and the principal stress directions are unconstrained, and the dotted line is the misfit using the principal stress directions from the best fitting model.

The stress state ϕ ratio is reasonably well constrained by the data we used at the 95% confidence level (Figure 16). This finding is in contrast to the *Qian and Pedersen* [1991] data, which were unable to constrain the stress ratio ϕ. The notable difference here is due to the location of the breakout nodal points, one of which is well constrained in the Point Pedernales data by the difference in breakout orientation between the wells A-13 and A-16. Although we used all the data we could obtain from this drilling platform, we recognize that use of additional data for this region would be preferable in order to better constrain the regional stress state. Obviously, more complete coverage of the borehole orientation space represented by the plot in Figure 14 would allow a better estimation of the overall variability of the measurements and show whether the inferred positions of the nodal points are likely to be correct on a more regional scale.

Conclusion

We developed a technique using genetic algorithms and a Powell optimizer whereby borehole breakout data from variably deviated boreholes are used to constrain the orientation of the principal stress directions and their relative magnitudes. Some of the advantages of GAs are that they efficiently search the problem space, do not require a good starting model, do not get trapped in local minima (unlike gradient search methods), and only require a forward modeling calculation of the misfit between the theoretical breakouts for a model and the data. However, as demonstrated by our inversion of the Point Pedernales data when the misfit as a function of the model is not smooth, the GA may not find the global minimum, requiring many runs of the GA and Powell optimizer to ensure that a reasonable minimum was found. We use a calculation inspired by *Gephart and Forsyth* [1984] to determine the 95% confidence limit on a weighted misfit between a particular model and the data. We then place 95% confidence limits on the results of an inversion by searching the model space around the best fitting model for model misfits that lie at the 95% confidence limit.

In processing our raw dipmeter data we developed a modified list of borehole breakout selection criteria based on *Plumb and Hickman*'s [1985] criteria. The main difference between their criteria and ours is that we do not discard radial breakouts, since theoretical breakout patterns show that there are borehole orientations in which radial breakouts are expected for most stress states.