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Xiaojun Huang[1], Zhenya Zhu[1], Daniel R. Burns[1], M. Nafi Toksoz[1] (1) Massachusetts Institute of Technology, Cambridge, MA

Stress Profile Estimation Using Sonic Logs

Experiments have long proved that both P- and S-wave velocities of rocks are functions of applied stresses. Borehole sonic logs then surely carry formation stress information, an important parameter for predicting borehole stability. We study both experimentally and numerically characteristics of a variety of borehole modes when the borehole is subject to formation stresses. As anisotropy is induced by the formation stress, shear splitting is observed in monopole log and very sensitive to stress change. The dispersion behavior of borehole exural wave also varies with formation stress. We thus propose a method to combine cross-dipole log and monopole log to estimate formation stress profile, including direction and magnitude. The underlying procedure consists of the following steps: first, we locate stressed zones in the formation by searching for crossovers in exural dispersions. Second, the fast shear direction is estimated from the cross-dipole waveforms. It corresponds to the direction of the maximum horizontal stress (SH). Finally, stress magnitudes are inverted from exural and Stoneley dispersions.