DEEP, SUB-SURFACE DEFORMATION MEASUREMENTS OBTAINED USING COMBINED GEOMECHANICAL MODELING AND INVERSION TECHNIQUES WITH SURFACE MICRO-DEFORMATION MEASUREMENTS

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Abstract: The use of micro-deformation measurements (movements on the order of 10e-6 meters or 0.01 millimeters) to monitor production, waterflooding, steamflooding, and waste injections in oilfields has grown extensively over the past decade. A revolution in the sensitivity, accuracy, and cost of micro-deformation measurements has not only produced the ability to report smaller and more accurate numbers. We may now also combine these high sensitivity deformation measurements with advanced analytical techniques and geomechanical models into a whole new class of sub-surface source characterization tools.

This paper describes the successful combination of micro-deformation observations with inversion-based analytical techniques to back-calculate remote, sub-surface deformation parameters. These calculations are based solely upon the characteristics of the deformation field, generated at depth, and propagated through the earth. This deformation field is precisely characterized at the surface with a strategically deployed array of high-resolution tiltmeters. These tilt responses are then fed into a combined geomechanical model/inversion routine to locate and characterize the deformation sources at depth. The inversion approach, simulation runs, and a recent successful application in an oilfield environment are presented and discussed.

Key words: Tilt, Tiltmeters, Deformation Monitoring, Inversion, Source Mechanics

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